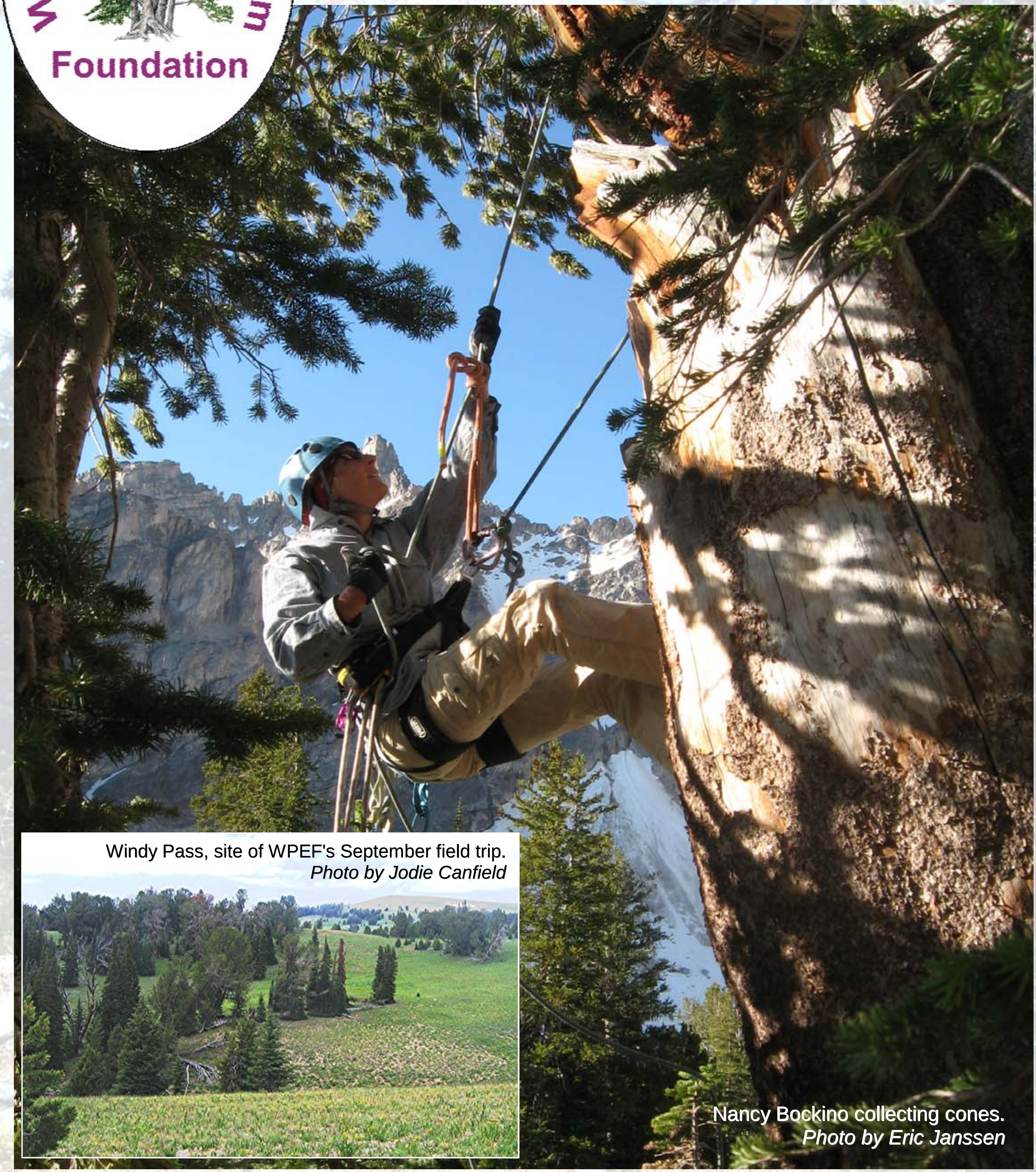
Issue No. 24: Spring/Summer 2013

Nutcracker Notes



Windy Pass, site of WPEF's September field trip.
Photo by Jodie Canfield

Nancy Bockino collecting cones.
Photo by Eric Janssen

Whitebark Pine Ecosystem Foundation

Nutcracker Notes, Issue No. 24; Spring/Summer 2012-2013

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Articles

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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>

WPEF
P.O. Box 17943
Missoula, MT 59808

Director's Message

Diana F. Tomback

Measuring progress

In September 1998, in the afternoon at the very end of the successful symposium, *Restoring Whitebark Pine Ecosystems*, held at the Holiday Inn Missoula-Parkside, a group of organizers and speakers sat around and asked the question, "Where do we go from here? How can we get more attention for whitebark pine?" I believe it was Dana Perkins who suggested that we form a non-profit organization as the next step. Thanks to the efforts of Steve Arno and Bob Keane, and the generous help of Missoula attorney Steve Brown, The Whitebark Pine Ecosystem Foundation was officially incorporated in the State of Montana on December 8, 1999, but we began official work in 2001 with the appointment of the first officers and board of directors.

Decades from now, the 1998 symposium *Restoring Whitebark Pine Ecosystems* should be recognized as an important milestone in the unfolding story of the hard work and dedication of so many in the effort to restore whitebark pine. At this symposium and on its well-attended field trip, Bob Keane and a few other scientists discussed the first experimental projects that applied fire, silvicultural techniques, installed nutcracker openings, and, eventually, planted seedlings—basically pioneering many approaches used today in whitebark pine restoration. At the symposium, speakers discussed the basic ecology, species interactions, threats, and approaches to restoration, including techniques for collecting cones, growing whitebark pine seedlings, and strategies for managing blister rust, as well as the socioeconomic constraints on restoration. In 2001, much of the material presented at the symposium was expanded with more detail and context and published in *Whitebark Pine communities: Ecology and Restoration*, edited by Tomback, Arno, and Keane. This book made the collective knowledge to date very accessible.

In the nearly 15 years that have elapsed since the symposium, there has been tremendous progress in whitebark pine restoration. For example, many rust-resistant parent trees have been identified within the range of whitebark pine, thanks to the support of the US Forest Service leadership, the planning and oversight of several scientists, combined efforts of many national forests, and the nursery and screening facilities at Coeur d'Alene Nursery and Dorena Genetic Resource Center. Seed orchards have been installed in several national forests. There have been three widely recognized restoration strategies written: Pacific Northwest Region (2008), Greater Yellowstone Area (2011), and the Range-wide Strategy (2012). The province of Alberta, Canada, where whitebark pine is listed as endangered, is currently completing its recovery plan. Whitebark pine has been evaluated as warranting listing by the U.S. Fish and Wildlife Service under the Endangered Species Act; Canada has listed whitebark pine as endangered under the national Species at Risk Act, and their? Recovery Plan is underway. Furthermore, through funding from the US Forest Service, Forest Health Protection branch's Whitebark Pine Restoration Program, as well as projects initiated and supported independently by national forests, many restoration projects, including cone collecting, thinning, and planting, have been completed. New and efficient methods for restoration are also being explored, such as direct seeding, which could be applied to wilderness areas and national parks.

This progress is laudable, but we all know that the work has just begun. While these activities were on-going, losses of whitebark pine from mountain pine beetle outbreaks over the last decade have been staggering, and blister rust infection rates have increased within the Greater Yellowstone Area and elsewhere. The recent re-measurement of whitebark pine plots in the Canadian Rocky Mountains by Smith et al. (2013, Changes in blister rust infection and mortality in whitebark pine over time. *Canadian Journal of Forest Research* 43:90-96.) clearly indicates rising blister rust infection levels and increasing mortality. Many of the whitebark pine communities of the Northern Continental Divide Ecosystem are non-functional due to disastrous levels of mortality, and we are experiencing a major genetic bottleneck in this region.

The previous 15 years were the beginning. We now have the toolkit—the nuts and bolts of restoration. More than ever, we need the continuing support of the Washington Office of the US Forest Service and the National Park Service, support from provincial and federal governments in Canada, as well as partnerships with non-profit organizations and community groups, for this critical endeavor. This restoration effort requires consistent sources of funding in our new resource-challenged environment. It is the collective responsibility of all partners and participants to implement restoration plans efficiently and with best practices. We must make every effort to ensure that whitebark pine lives on to play its keystone ecological role in the high mountains of western North America.

Term limits and looking towards the future

With the outcome of our recent, annual election (see accompanying article), I am to be Director for another three years. Serving the WPEF as Director has been a privilege but also a calling, given my 40-year career connection to whitebark pine. My first field season with Clark's nutcrackers and whitebark pine was the summer of 1973, spent in the vicinity of Mammoth Lakes in the eastern Sierra Nevada, while working on my doctorate at the University of California at Santa Barbara.

This fall begins my last term as Director, because our by-laws limit all officers to three consecutive three-year terms. I mention this not to wax nostalgic, but to jumpstart the process of finding someone to run for Director in three years. What are the requirements? Given that we are no longer pioneering restoration, but supporting and expanding restoration, we do not necessarily need a scientist but we do need someone who can work effectively with our key partner in this effort, the US Forest Service, and also reach out to other non-profit organizations. In addition, this individual sometimes needs to move into the political arena, working with congressional delegates and their staffers. This means that the director cannot be employed by the federal government.

There are a couple of alternative directions to consider. We could maintain the "working board" model, which is how we currently operate. All projects and activities are accomplished by volunteer effort from the board members and officers, plus a few active WPEF members. We have accomplished a lot with this model, but it has been inefficient and at times too unpredictable. For me personally, there has been so much more I could have accomplished for the WPEF and for whitebark pine if I did not already have an immensely demanding job as a full professor (and chair/ associate chair of an academic department). If in three years we are still operating within the "working board" model, we will need a Director who is not as over-committed and can aggressively keep whitebark pine restoration and outreach moving along. A variation of this model would be to distribute the workload more effectively. With a change in by-laws, we could create an Executive Director, who could do the outreach and help set the agenda, and a Managing Director, who could take care of the day to day oversight requirements for the WPEF.

I believe that the best model in the long-term for whitebark pine and for the WPEF is to hire a part-time or full-time dedicated director. This will require that the WPEF complete its transition to a professional non-profit with paid staff, modifying the full working board model. This "professional" model will require that significant grant money and donations be received each year. But with a dedicated director, much more can be accomplished for whitebark pine. I believe that the next 25 years will make or break the restoration effort for whitebark pine, particularly in the Rocky Mountains. There is no time to lose.

Annual meeting

I would like to call your attention to the announcement in this issue for our annual Whitebark Pine Science and Management Workshop. This year, the workshop is co-sponsored by the Northern Rockies Fire Science Network, and will be held on the campus of Montana State University in Bozeman on Friday, September 20, with a fieldtrip on the 21st. The workshop theme is the competing challenges in whitebark pine restoration, including the conflicting mandates for managing fire, lynx, and grizzly bear, and the issue of restoration in wilderness. Following the precedent established at our 2011workshop in Cody, WY, and the 2012 meeting in Kimberley, B.C., we will have an evening program open to the public, with reception, silent auction, and short presentation, as well as a general fund-raiser for whitebark pine. We thank Laura DeNitto, who has consented to head the organization of the silent auction (see accompanying announcement). The public program at the Kimberley meeting successfully piloted the silent auction, which featured many donated arts and crafts and food items from the region.

Fund-raising and membership: please help

With the formation of the Development Committee last year, the WPEF is attempting to write more grant proposals in order to fund new initiatives and to contribute to whitebark pine restoration. But also we are asking you, our members, to increase your support for our efforts as well. All donations are tax-deductible. Our overhead expenses are growing, especially with our website and additional outreach activities. <u>Please introduce the WPEF and its work to your colleagues, friends, and family who value whitebark pine ecosystems or even the backcountry experience.</u> <u>Please tell us about grant proposal opportunities, and ask acquaintances who support environmental organizations to consider donating to the WPEF.</u>

We are part of your community; we are grassroots, working for your high elevation forests. Tell your Facebook friends about the implications of the losses of this important high elevation community and to "friend" us on Facebook. Also, when we hold our annual Science and Management Workshop in your area, please come out and support our efforts. Let us know if you can help us organize these meetings. Any volunteers from Bozeman? ■

Director's Message: WPEF Canada

Randy Moody

After WPEF's annual meeting last September in Kimberley, B.C. meeting, things were a little slow with whitebark pine in Canada; however the onset of spring has brought out a sudden onslaught of recovery planning documents, the completion of a limber pine information brochure, and some field opportunities.

Recovery Planning

It appears the recovery planning for whitebark pine is off and running at Federal, Provincial, and Regional levels. Although this planning is not being completed by WPEF, its members and directors have been integral in contributing to this process. For those who attended the Kimberley meeting, the Recovery Strategy that Peter Achuff mentioned during his COSEWIC (Committee on the Status of Endangered Wildlife in Canada) summary and the Alberta Recovery Strategy described by Brad Jones are both nearing completion.

Many of the WPEF members likely attended the two planning meetings held in Banff and Vancouver to discuss the development of the Federal Recovery Strategy. This strategy will serve as a higher level planning document and should hopefully open the doors to increased recovery work with whitebark pine. The Alberta Recovery Strategy is due to be submitted anytime according to team members and may likely be submitted by the time this is published. At a more regional scale, Alana Clason has recently completed a Tactical Plan or the Omineca Region, which is a more detailed planning document that identifies specific actions for the region, which lies northwest of Prince George, B.C. We certainly look forward to additional plans such as this in the future.

Educational Brochures

An information brochure on limber pine in B.C. was recently completed. The completion of this brochure highlighted that other such brochures are also in distribution and may be of use to members looking for educational materials. If members are interested in brochures regarding whitebark or limber pine in BC they should contact Don Pigott at: ypp@shaw.ca; for a combined limber/whitebark pine brochure from the Alberta perspective, members should contact Brad Jones at: Brad.Jones@gov.ab.ca.

Field Opportunities

Each summer in B.C. and Alberta botanists congregate at attractive field settings to discuss all things botany. This year Botany B.C. (http://members.shaw.ca/botanybc/) will be held in Revelstoke from August 8th to 11th and Botany Alberta (www.anpc.ab.ca) will be held in Lake Louise from August 2nd to 5th. Both of these events mention whitebark and limber pine in their programs and represent a great outreach opportunity for whitebark pine enthusiasts to mingle with other botanists and spread the whitebark pine message.

Strategic Planning

With regards to WPEF Canada, the Board of Directors has been meeting to conduct strategic planning in order to map out a path forward on our role in whitebark pine recovery. As governmental plans are developed, the role of a non-profit should become clearer. As WPEF Canada's strategic plan is developed, we will present outcomes to the Canadian members and encourage the membership to provide feedback, and hopefully over time, sit on committees to aid species recovery. ■

WPEF 2013 Science Meeting:

Bozeman, MT, September 20-21

WPEF's Annual Science and Management Conference is scheduled for Friday and Saturday, September 20-21, 2013 at Montana State University in Bozeman, Montana, the gateway city to the Greater Yellowstone Ecosystem (GYE). The GYE is the focal point of many whitebark pine restoration projects, and we look forward to hearing about them as well as spending a day in some outstanding whitebark pine habitat. The meeting starts at 8:00 a.m. on Friday in the Strand Union Building at the heart of the MSU campus, and is co-sponsored by the Northern Rockies Fire Science Network (http://nrfirescience.org/).

The conference theme, "Challenges of Whitebark Pine Restoration," will be addressed in three plenary talks followed by two concurrent sessions--one describing current research in whitebark and limber pine ecosystems and the other updating us on restoration activities. On Friday evening, the WPEF hosts a reception, program, and fund-raiser, open to the Bozeman community. A field trip is scheduled for Saturday to visit interesting whitebark pine communities around Windy Pass south of Bozeman (see cover photo), where we will hear from local experts and have ample time for questions and discussion. We are also planning an optional Sunday field trip along the Beartooth Highway--the highest paved road north of Colorado--to visit an array of whitebark pine and limber pine stands and timberline communities that approach the 10,000-foot level.

Please contact Program Chair Bob Keane (rkeane@fs.fed.us), if you wish to give a presentation or present a poster. We hope to see you there for an exciting scientific exchange. (Members of the Society of American Foresters can sign up for SAF Continuing Education Credit at this meeting.)

Registration information will appear on WPEF's web site (www.whitebarkfound.org) by August 1st.

Bozeman is one of the most diverse and interesting cities inside the Rocky Mountains--a slice of western Americana set amidst productive ranch country surrounded by towering peaks. An eclectic mix of scientists, artists, ski enthusiasts, and high-tech entrepreneurs are drawn here by the city's magnificent setting and Montana State University. Bozeman has an ample variety of lodging opportunities, restaurants, and special attractions including the Museum of the Rockies, the Emerson Cultural Center, and access to mountain resorts and Yellowstone National Park. For information on Bozeman and places to stay, go to: http://www.tripadvisor.com/Attractions-g45095-Activities-Bozeman_Montana.html ■

ELECTION NEWS--Spring 2013

Cyndi Smith, WPEF Associate Director

More than half of WPEF's members participated in the recent mail-in election and bylaw ballot. Diana Tomback was re-elected as Director of our Board of Directors (BOD). Thanks are due her for long-term commitment to this very demanding position. We welcome Melissa Jenkins as our new Secretary, and thank Helen Smith for her many years of faithful service in this position and as a founding member of WPEF. Melissa had already served on the BOD for the last year. Although neither of these positions were contested, our bylaws require the membership to ratify acclamations, which they did through the mail-in ballot card. We also welcome back general BOD members Bob Keane and Michael Murray. All of their terms start after the September 2013 annual meeting.

A number of bylaw revisions were also voted on by the membership. We had 91 ballots returned from a possible 160 members, for a 57% participation rate. [Unfortunately 6 ballots were postmarked after the published voting deadline of April 5th—so in future elections, be sure to return your ballot in time to make it count!] All six bylaw revisions were passed, with 98-100% in favor of each. The most significant revision was to Bylaw E(f), which now reads:

WPEF Annual Meeting Fundraiser

Can you help? The WPEF needs auction and raffle items for the 2013 annual meeting. This fundraiser will help to support activities of the Foundation.

Desirable items include those locally made or specific to your area. Hand crafted items that you or someone you know make are desirable, i.e. pottery, woodworking, knit and handcrafts. Also, items that would be of use to the visitors who attend our conference.

Items from the 2012 meeting in Kimberley B.C. that were sought-after included lip balm, pottery, homemade baked goods, ski/hiking socks, photography and art work.

If you are attending the 2013 meeting in Bozeman, MT, please bring your items with you. If you would like to donate and cannot attend, please mail your items to Laura DeNitto, 7020 West Carlton Creek Road, Florence MT 59833. 406-273-3635. myfunnyfarm4@msn.com

General board members are nominated to the BOD at least 1 month prior to a BOD meeting and:

i) Five must be voted onto the BOD by a simple majority of the votes cast by the membership.

ii) Two may be voted onto the BOD by a simple majority of existing BOD members.

This change means that 10 of the 12 members of the BOD (five Executive Committee and five general board members) would be elected by the membership, reserving up to two general board members to be elected by the BOD only. The BOD feels that requiring 10 of the 12 positions to be elected by the membership maintains participation and oversight, while keeping two positions to be elected by the existing BOD allows the Board to target particular skills and expertise, and to help balance geographical representation. A change to Bylaw E(i) maintains the limit of three consecutive 3-year terms for the 10 positions voted on by the membership, while limiting the two BOD-elected positions to one 3-year term. The term limit provisions were implemented when the bylaws were established in 2007, so, for instance, although Diana Tomback has been Director since WPEF's inception in 1999, she is just now beginning her 3rd term. ■

Show us *your* whitebark: 2014 Photo Contest!

Last year's whitebark pine photo contest for the 2013 calendar was a great success, so we are doing it again! We are requesting photo submissions to create the 2014 WPEF Calendar. Send us your best, because this year, the competition is getting fierce…board members will also be allowed to submit pictures. Any snapshot taken in a whitebark pine ecosystem is welcome, provided that there is at least one whitebark in the photo. After the submission period closes on July 31st, we will post the submissions on our website and have members vote for their favorites. The thirteen pictures with the most votes will be used in our official WPEF 2014 calendar, which will be available late fall, 2013. The calendar will be available a nominal price, and will also be used as an incentive gift for recruiting new members. The beautiful calendar in your home or office will be a reminder that whitebark pine is "up there" and benefits from our conservation efforts!

Please send high quality images (6 megapixel minimum) along with the photographers name, picture location, date and a small description (50-75 words), to Libby Pansing at erpansing@gmail.com. Submission deadline is July 31, 2013. For more information, please visit our website: www.whitebarkfound.org ■

WHITEBARK PINE ECOSYSTEM FOUNDATION

Treasurers Report - 12/31/2012

	1/1/2011	1/1/2012
BALANCE (Beginning Year - Checking and Savings)	$23,319.96	**$37,937.70**
EXPENSES		
Web site	$500.00	**$500.00**
Nutcracker Notes	$1,314.40	**$1,785.08**
Mailing/operating expenses	$442.90	**$787.73**
P.O. Box fee - Yearly	$70.00	**$86.00**
Accountant fee (Tackett) 1/	$100.00	**$300.00**
Travel - Plane fares and lodging	$2,011.04	**$2,403.66**
Membership expenses		**$207.53**
Room rental (Annual meeting)	$1,399.32	**$532.27**
Bank fees	$4.20	**$111.09**
PayPal fees	$70.88	**$118.52**
All Merchandise		**$1,517.61**
Bumper Stickers		**$322.25**
Student Research Grant		**$1,000.00**
Administrative assistant	$5,000.00	**$6,000.00**
Facilitator	$400.00	
Total Expenses	$11,312.74	**$15,671.74**
INCOME		
Membership	$8,512.52	**$10,453.44**
Symposium/Annual Mtg/Merchandise 2/	$15,898.72	**$1,512.51**
Books/Nutcracker Notes	$1,045.00	
Shirts	$62.00	
Posters	$8.00	
Merchandise - Calendars		**$228.00**
Donations	$350.00	**$551.74**
Donation for Bumper Stickers (Tomback)		**$322.25**
Interest Earned	$54.24	**$32.27**
Total Income	$25,930.48	**$13,100.21**
BALANCE (Ending Year)	**$37,937.70**	**$35,366.17**
	as of 12/31/2011	as of 12/31/2012

1/ Accountant Fee, $200 is donation

2/ Includes 2011 Symposium Income

Call for Proposals: Whitebark Pine Student Research Grant

The mission of the Whitebark Pine Ecosystem Foundation (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 will be offering a research grant of

$1000 to an undergraduate who is writing an undergraduate 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 grizzly bears; restoration strategies for whitebark pine, including both field operations and nursery seedling production; and ecosystem level impacts of whitebark pine die off.

Monies will only be awarded 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:

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

Grant recipients are encouraged to present the findings of their research at the 2014 WPEF annual meeting and are expected to publish a summary of the research in Nutcracker Notes. In addition to the proposal, applications should include a CV as well as a letter of recommendation from the student's research advisor. All applicants are encouraged to join 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 August 31st, 2013. ■

Interview with Liz Davy
WPEF Board Member

Editor: How did you first become acquainted with whitebark pine and its habitat?

Davy: I first saw remnants of whitebark pine in White Clouds wilderness area in the early 1980s. these mottled ghost trees captured my attention and little did I know at that time as a budding forester that I would have the opportunity in the future to work with this magnificent tree

in the early 2000s when I was a fuels specialist on the Salmon-Challis National Forest, that is when the Greater Yellowstone Coordinating Committee's (GYCC) Whitebark Pine Subcommittee was formed, and I became active in that group. When I moved to the Bridger-Teton NF as the Forest Silviculturist, I was in charge of the whitebark pine restoration program as well.

Editor: What features of whitebark pine habitat are considered most important in your region?

Davy: The high-country recreational experience, the ancient whitebarks, and wildlife food come to mind. Whitebark pine cones are cached in abundance, and provide an important food source for bears and other wildlife in our region. In the high mountains, whitebark pines make up many of the tree clusters where hikers and skiers take shelter. These sturdy trees are part of the beautiful high-mountain scenery that inspires visitors with an esthetic and spiritual experience.

Editor: What changes in whitebark pine habitat have you observed during your 30-year tenure in the Northern Rockies.

Davy: I've seen healthy mature forests of whitebark gradually transform into rust- and bark-beetle infested stands, and then into grey ghosts. I am also seeing more young trees in the disturbed areas such as old burns and clearcuts, which gives me hope.

Editor: Briefly describe the whitebark pine restoration projects your national forest has accomplished, and what is planned for the near future.

Davy: I have worked on the Caribou-Targhee and Bridger-Teton National Forests in the Greater Yellowstone Ecosystem. On both Forests we have collected cones from Plus Trees (healthy trees within heavily rust-damaged areas) for breeding of rust resistant seedlings. We have planted trees in disturbed areas and worked in cooperation with ski resorts to protect whitebark pine from bark beetle outbreaks. We reduced fuel hazards around some whitebark forests and protected Plus Trees from wildfire. We wrote the comprehensive strategy for whitebark pine restoration in the Greater Yellowstone Ecosystem. We thinned to remove competing conifers from around young whitebark pines, to encourage their growth and development. We also participated in research projects to test the effectiveness of planting whitebark pine seeds on suitable sites, and cooperated with volunteer groups involved in planting seedlings and in putting up Verbenone patches to ward off bark beetle attack.

For the near future we hope to continue our planting program and increasing our supply of seed through additional cone collections. I also hope we can do more release-thinnings around young whitebark pines, and we will support research on this effort.

Editor: What influence if any has WPEF had your restoration efforts?

Davy: Over several years WPEF has helped by providing research information, and by sharing the expertise and advice of its board members. WPEF's annual science and management conferences have been very helpful in providing the latest information from the research activities and management experience. The GYE has also benefited from hosting some of the research projects. I have been able to call any of the board members for advice about a variety of topics related to whitebark pine ecosystems. ■

FHP Whitebark Pine Restoration Program Purpose, History, and Project Evaluation Process

Sandy Kegley, Program Coordinator/Entomologist
USDA Forest Service, Coeur d'Alene, ID

The Whitebark Pine Restoration Program was initiated by Forest Health Protection (FHP) in 2007 with the goal of enhancing restoration of whitebark pine in response to its dramatic decline throughout the West due to white pine blister rust, mountain pine beetle, competition, severe wildfires, and climate change. The program provides funding for whitebark pine restoration projects such as cone collections, sowing seed and growing seedlings, planting (fig. 1), enhancing seedling survival, surveys and monitoring, silvicultural treatments to reduce competition from other tree species (fig. 2), prescribed burning, education and public outreach.

Under the guidance of Plant Pathologist John Schwandt, the original program coordinator, the Whitebark Pine Restoration Program funded 177 projects from 2007 to2012 with $2.2 million FHP and $2.9 million matching funds to provide over $5 million for restoration projects throughout the West (table 1). There is tremendous support for this program from a diverse array of cooperators that include 30 national forests across five USFS regions, state and private agencies, Native American tribes, national parks, foundations, and universities.

	2007	2008	2009	2010	2011	2012	Total 2007-2012
# Proposals Rec'd	56	62	60	39	50	59	326
Total $ Requested	1,005,700	2,200,000	960,000	688,450	1,153,619	1,293,987	7,301,756
# Projects Funded	24	26	32	28	33	34	177
FHP Funds awarded	267,400	398,900	517,000	300,200	406,942	275,000	2,165,442
Matching funds	291,700	433,900	380,000	491,850	665,251	613,798	2,876,499
Total Funds Invested	**559,100**	**832,800**	**897,000**	**792,050**	**1,072,193**	**888,798**	**5,041,941**

Table 1. Summary of Whitebark Pine Restoration Program from 2007-2012 (data from John Schwandt).

FHP has received a baseline of $250,000 each year since 2007 for funding whitebark pine projects. Some years additional funding has become available. The requests for funding always exceed the amount available to award. Even though we are only meeting a small portion of the overall need, we hope that the funded projects will have a positive impact in at least some whitebark pine areas to increase tree survival and improve the function of these high elevation ecosystems.

Proposal Submittal and Evaluation Process

The process for funding begins with a request for proposals sent in September or October with a due date sometime in November. Proposals are reviewed by a committee of ten specialists with backgrounds in genetics, reforestation, silviculture, fire, ecology, pathology and entomology. Proposals are rated on background, objectives and justification; technical merit; measures of success; outcomes, products, or results; and budget and cost efficiency. A report is required from all funded proposals and due in November of the year the project was completed. This report is important to keep track of completed projects and to promote the future of the restoration program.

2013 Proposals

A total of 70 proposals were submitted in 2013 requesting $1.1 million. The committee rated the proposals and recommended funding 26 projects based on $250,000 of FHP funding expected. Project coordinators have been notified and funds will be transferred as soon as possible after receipt. If we receive additional FHP funding, more proposals will be funded. Proposals that were recommended for funding in 2013 include cone, scion, and pollen collections, planting seedlings, reducing competition, improving nursery inoculation of ectomycorrhizal fungi to enhance seedling survival, comparing planted seedlings with sowing seed at various depths, evaluating growth release following thinning, assessing health of whitebark pine, and seed orchard development. These proposals were submitted by Forest Service Regions 1, 4, and 6, BLM, Glacier and Crater Lake National Parks, Rocky Mountain Research Station, and Montana State University.

We expect that the FHP Whitebark Pine Restoration Program will continue into the future although the funding levels are unknown. ■

Figure 1. Planting a WBP seedling in a microsite on the North Fork RD, Clearwater National Forest.

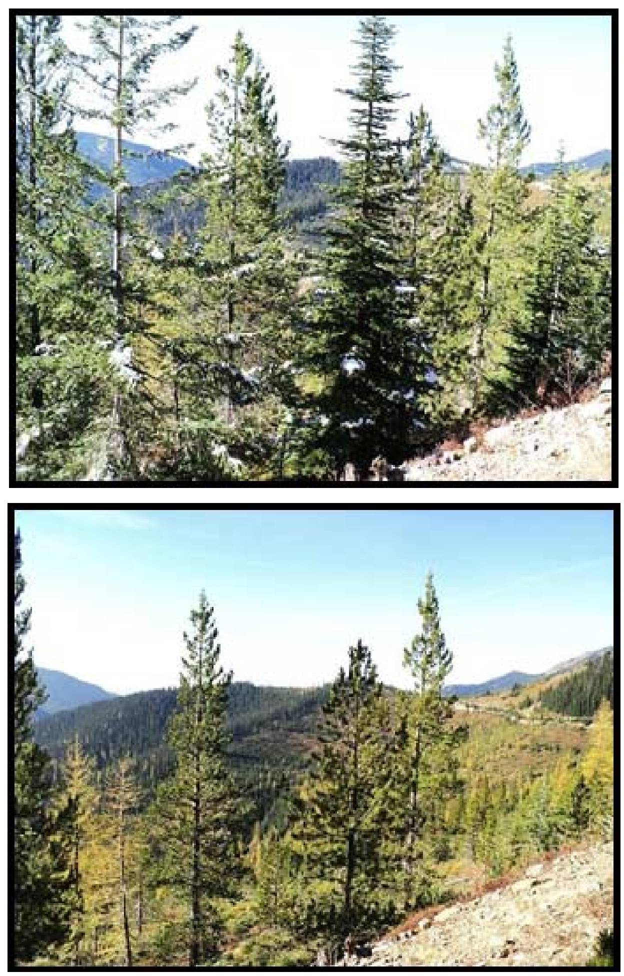


Figure 2. Before and after photos of a Lolo National Forest project to reduce whitebark pine competition from other tree species.

Developing a Method for Mapping Whitebark Pine

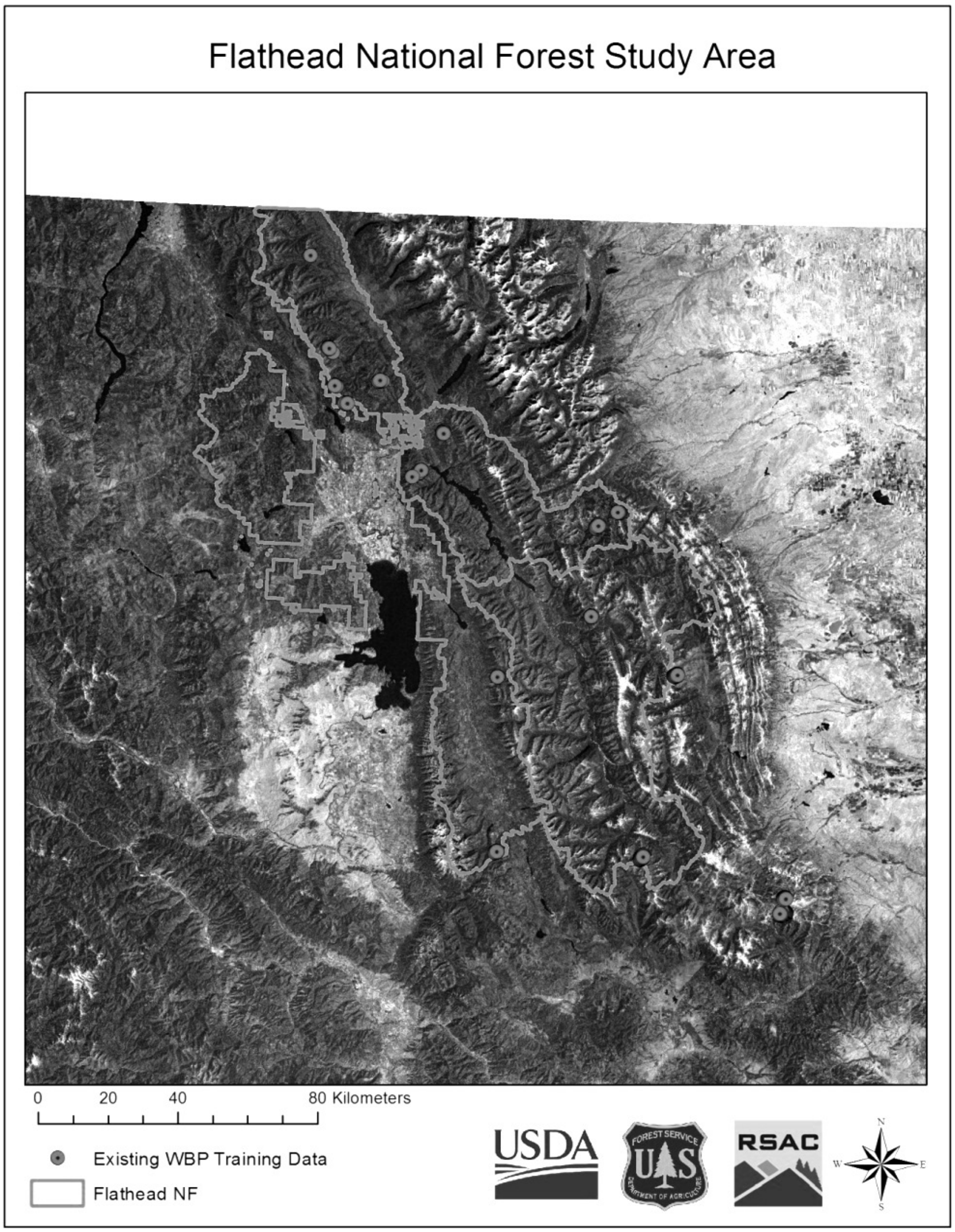
Stephen R. Brown, Jr., Remote Sensing Coordinator
USFS, Northern Region, Missoula, MT

Each year the USDA Forest Service Remote Sensing Steering Committee (RSSC) puts out a call for proposals for projects that demonstrate the application of remote sensing technologies to natural resource management issues. The proposal process is not a funding mechanism but rather a means for the Forest Service Remote Sensing Applications Center (RSAC) to partner with field units in addressing critical resource issues through the use of remote sensing technologies. The RSSC then provides funding for RSAC staff to complete the geospatial portion of the proposed project, a skill set that is generally lacking at field offices. In March, 2012, a proposal was submitted by the USFS Northern Region for the development of a methodology for the mapping of whitebark pine (*Pinus albicaulis*) on the Flathead National Forest. The proposal was selected and work was begun on field data collection in the summer of 2012 and by RSAC starting in the fall. A brief description of the project need, objectives, and current state of the work follows.

Whitebark pine historically dominated many upper subalpine plant communities in the western United States, with populations in MT, WY, ID, WA, OR, CA, and NV it comprises 10-15% of total forest cover in the US Northern Rocky Mountains. There are an estimated 11.6 million acres of whitebark pine on Forest Service lands nationally, of which ~5 million acres occurs in the Northern Region.

Whitebark pine is in "substantial and pervasive decline" (U.S. Fish and Wildlife Service, 2011) throughout its range, largely as a result of white pine blister rust (*Cronartium ribicola*) and mountain pine beetle (*Dendroctonous ponderosae*) infestations. This decline is dramatic enough to warrant whitebark pine's current station at priority number 2 for listing under the Endangered Species Act (ESA) and is a primary reason for the continued listing of the grizzly bear (*Ursus arctos horribilis*).

Due to its extensive occurrence, the general inaccessibility of whitebark pine habitats, and the rapid rate of decline due to pathogen caused mortality, field mapping of the species is untenable. Current Regional maps of existing vegetation are not constructed with a single-species focus and, as such, do not contain the precision necessary to identify areas where whitebark pine seed sources may still remain or where there is significant stand regeneration occurring, both critical pieces of information for land use planning purposes.



A spatially explicit, species-specific map would aid in conducting restoration of whitebark pine habitats and in planning wildland fire activities. Without a Region-wide effort, each National Forest or Ranger District will have to develop its own map of existing conditions, which would result in an inconsistent and discontinuous data set that could impede both restoration projects and wildland fire planning.

The principal objectives of this project are to:

- Create a comprehensive set of methods to produce maps that depict the current extent of whitebark pine, current potential range of the species, and suitable regeneration areas for the Flathead National Forest.
- Create a benchmark product across the Flathead National Forest that will depict whitebark pine extent at a past point in time (~30 years ago) for comparison with current extent.

While previous efforts have concentrated on mapping whitebark pine across the Greater Yellowstone Ecosystem (GYE) where it can be more of a dominant within a stand, this effort will concentrate on areas where the species is generally inter-mixed with other species and likely not even co-dominant within a stand. This occurs largely in the regions to the north of the GYE with a dramatic change in distribution taking place near the Continental Divide. With this in mind, then, the study area selected was the Flathead National Forest (Figure 1).

Figure 1. Project study area showing whitebark training sites (hollow circles).

The reason for this being that the Flathead National Forest will exhibit both types of whitebark pine occurrence, dominant and limited, and methodologies developed here will better transfer to Forests in the northwestern part of the Northern Region.

Maps of the extent of whitebark pine will require a suite of spectral, topographic, and climatic predictor data. Development of the maps will also require training or reference data on the presence or absence of whitebark pine in the overstory in order to calibrate model alrgorithms to identify suitable locations and spectral information that is inherent to whitebark pine. The whitebark pine regeneration map will likely require a combination of products that depict areas that have had stand-clearing events and limited recovery. Such outputs will likely come from the Monitoring Trends in Burn Severity program, a Nation-wide program that tracks fires greater than 1,000 acres on all lands and models burn severity based on canopy removal, and the Vegetation Change Tracker, which is a remote sensing change detection algorithm that identifies change through a time-series image stack where change is located and then tracked as being either positive or negative in direction. Each of these products will depict areas that have experienced disturbance events in the recent past and identify areas of both mortality and likely regeneration.
Additional data collected as part of a field-validation of the data products during the FY 2013 field season will be used to further refine and improve the classification algorithms.
Ultimately it is anticipated that not only will this process result in an reasonably accurate depiction of whitebark pine distribution across the landscape managed by the Flathead National Forest, but also yield a repeatable methodology to be employed across the remainder of the Northern Region and, perhaps, the other Forest Service Regions where whitebark pine is known to exist. ■

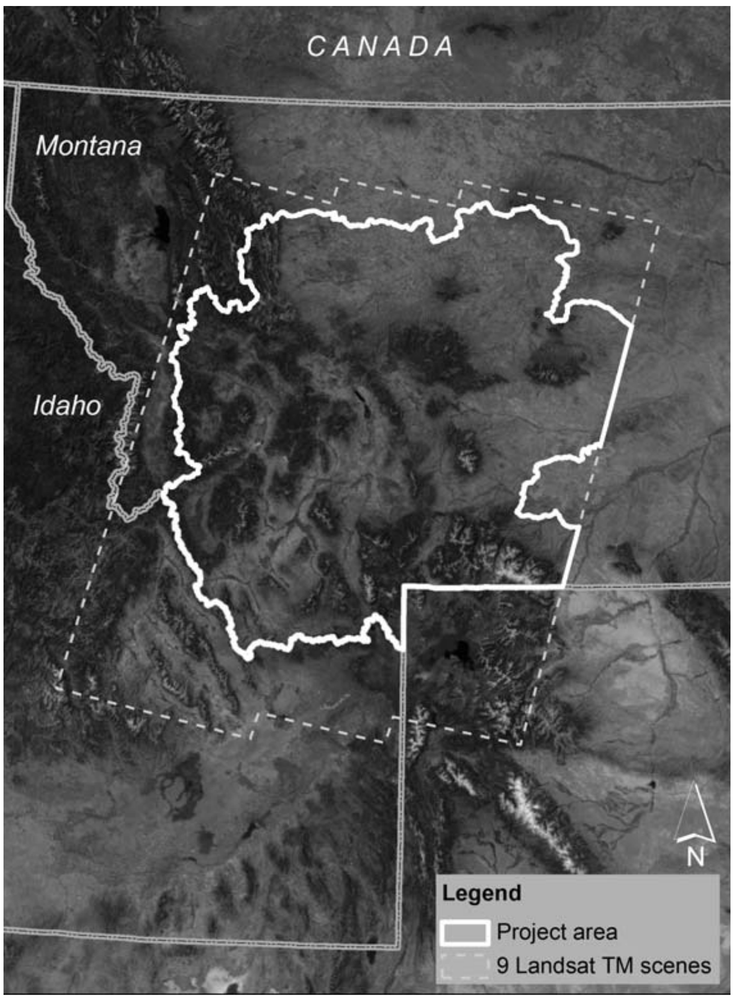
Mapping Whitebark Pine and Spruce-fir Forests

Linda Vance[1] and Rick Lawrence[2]

Resource managers have a well-recognized need for accurate mapping of whitebark pine (*Pinus albicaulis*) and spruce-fir (*Picea engelmannii/Abies lasiocarpa*) forests. Whitebark pine is, of course, a keystone species that has been massively impacted across its range by insects and disease, and is “warranted but precluded for listing” under the Endangered Species Act. In addition to the above impacts, climatic change threatens the probability of its persistence across its range. Certain types of spruce-fir forests are critical habitat for the federally listed Canada lynx (*Lynx canadensis*). Although they co-occur, fire prescriptions for the two forest types are sometimes in direct conflict, presenting real challenges to managers. With increased forest mortality and increasing wildfire likelihood and severity across the Northwest, managers need vegetation models to support decisions about wildfire suppression response, vegetation treatments and prescribed fire, and long-term climate change scenario planning.
With NASA funding and Forest Service support, we have undertaken a feasibility study to map whitebark pine and spruce-fir forests in several Montana National Forests (see accompanying map) with an eye to improving wildland fire decision support tools in the long term. This is a joint project between The University of Montana (UM) and Montana State University (MSU), with input from USGS statistician Kathi Irvine, building on previous work by Rick Lawrence and others mapping whitebark pine in the Greater Yellowstone Ecosystem (Landenburger et al. 2008, Jewett et al. 2011). For this study, researchers at UM are focusing on whitebark pine, while MSU researchers are working on spruce-fir forests. Remote sensing specialists from the Forest Service Remote Sensing Applications Center in Utah are also involved, mapping whitebark in the Flathead National Forest.
Our feasibility study explores the following questions:
1) Do sufficient data exist to develop precise and

accurate maps of whitebark pine? 2) Can whitebark regeneration be mapped with the same methods used to map mature trees? 3) Can seed tree sites be mapped using object oriented image classification of high-resolution imagery? 4) Can the same methods that have been successfully used to map a single species (whitebark pine) be used to map spruce-fir associations? 5) How well can this mapping be combined with regional climate models (downscaled from Global Circulation Models) to predict mountain pine beetle infestation, and fire probability and severity under different climate change scenarios?

Our project area for whitebark pine mapping covers nine Landsat Thematic Mapper (TM) scenes in southwestern and central Montana. Currently, we are working to:



- Gather as much existing field data as possible to inform the classification process. So far, we have plots from the Whitebark – Limber Pine Information System (WLIS) and the upcoming High-Five database; polygons from the USFS Northern Region's vegetation mapping (VMap) database; ground truth points from Montana Gap Analysis and Northwest ReGap, and points from earlier whitebark classification efforts. (Please see references for links to more information.)
- Develop a baseline (1991) map of whitebark pine using the random forest classifier within R software based on Landsat TM imagery (following Landenburger et al. 2008). Twenty variables are input to the model: TM bands 1-5 and 7; principal components 1-6, tasseled cap brightness, greenness, and wetness bands; normalized difference vegetation index (NDVI); elevation, slope, and transformed aspect from 10 m digital elevation models (resampled to 30 m); and relative effective annual precipitation.
- Using change detection methods, develop maps of whitebark pine in 1995, 2000, 2005, and 2011 (following Jewett et al. 2011). The ultimate goal will be to look for regeneration within areas where whitebark has been lost over time to blister rust, beetles, or wildfire.
- Conduct field work this summer (2013) to evaluate and improve on preliminary products.

As of April 2013 we are making good progress on the baseline map and beginning work on the change detection process. We welcome input on draft maps from people with good knowledge of whitebark pine distribution in the project area. Feel free to contact project staff at 406-243-5196, or email livance@mt.gov with questions.

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VMap. http://www.fs.usda.gov/detailfull/r1/landmanagement/gis/?cid=stelprdb5331054&width=full

WLIS. http://www.fs.usda.gov/wps/portal/fsinternet/!ut/p/c4/04_SB8K8xLLM9MSSzPy8xBz9CP0os3gDfxMDT8MwRydLA1cj72DTUE8TAwjQL8h2VAQAMtzFUw!!/?ss=1101&navtype=BROWSEBYSUBJECT&cid=stelprdb5157913&navid=140000000000000&pnavid=null&position=Not

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Chainsaws and Fire for Restoring Whitebark Pine

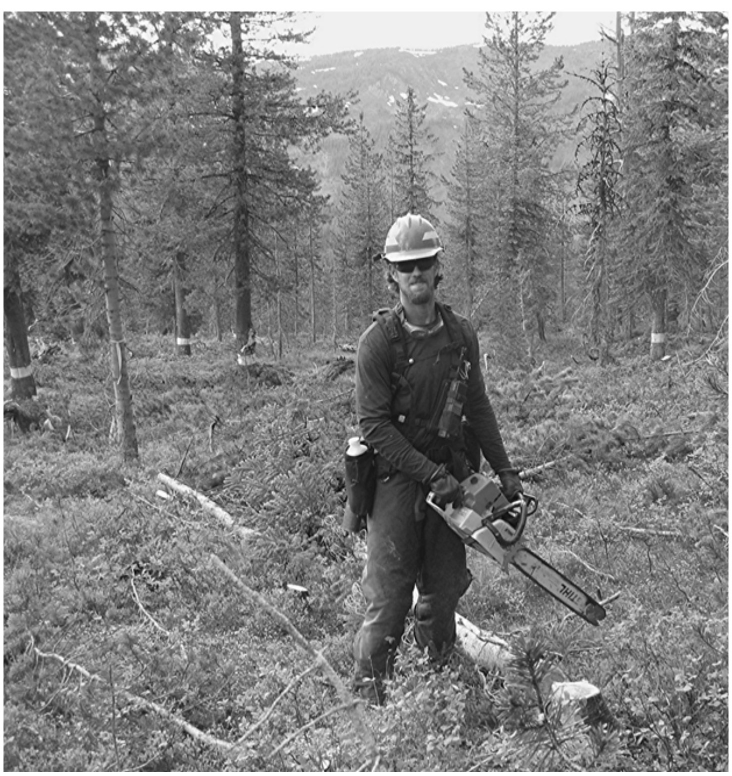
Bruce Erickson, Silviculturist, Lolo National Forest
Robert Keane, Research Ecologist, Rocky Mountain Research Sta.
Nancy Sturdevant, Entomologist, USFS, Forest Health Protection

Would you take a chainsaw to living whitebark pine trees? Would you intentionally try to burn them down?

Mink Peak lies at the end of a bone-jarring, single lane, low-standard, poor excuse for a road built by a miner with a cat in the early 1900s to access his claims. The 6,863-foot elevation Mink Peak, located about 12 air miles southwest of Superior, Montana, had a stand-replacing wildfire in 1910 and slowly regenerated to a mix of whitebark pine, lodgepole pine, subalpine fir, and Engelmann spruce. The whitebark pine trees range in size from six-inch tall seedlings to 50-foot tall trees over 15 inches in diameter. Suppressed four- to ten-foot tall trees are the greatest whitebark pine component numerically, but healthy whitebark pine trees of all sizes are scattered throughout the upper subalpine basin.

A localized mountain pine beetle outbreak swept through this area in the early 2000s and has faded to scattered small pockets of lodgepole pine mortality in the past few years. Some whitebark pine were killed, but the vast majority of the mortality in the area is lodgepole pine.

White pine blister rust has been active in the area with almost half of the trees having branch flagging and stem cankers but the other half are symptom-free, perhaps indicating a high level of resistance in this population considering these trees have been exposed to blister rust for several decades.



The Mink Peak whitebark pine stand is nearly 150 acres of young whitebark pine. Largely ignored for the past century, Mink Peak has become a hotbed of whitebark pine restoration activities on Superior Ranger District within the past three years due to its abundance of rust-free whitebark pine, large area, uniform slope and aspect, and the fact it's just plain fun driving a truck up there. A loose partnership between the Superior Ranger District, Bob Keane from the Rocky Mountain Research Station, and USDA Forest Service State and Private Forestry - Forest Health Protection (FHP) has resulted in a mix of projects, funding, and contributed time.

The projects include:

- Three rust-free trees were selected and cones were collected for use in the Tree Improvement breeding program for blister rust-resistant whitebark pine.
- A long-term RMRS research study initiated by Keane to explore the effects of various management treatments on growth and development of whitebark pine has been established. The four treatments include: (1) control, (2) daylight whitebark pine by cutting non-whitebark pine conifers from within 15 feet of selected whitebark pine trees and (2a) lopping and scattering slash or (2b) prescribed underburning of the slash, and (3) prescribed underburning to reduce stocking of competing conifers.
- Nancy Sturdevant (FHP) designed a short-term field study to explore the effectiveness of pruning whitebark pine to allow more solar radiation to heat the tree boles and thereby discourage mountain pine beetle attacks.
- The district is planning a prescribed mixed- to stand-replacement severity burn on an adjacent hillside stand of lodgepole pine with high bark beetle-caused mortality to reduce down fuel accumulations and provide opportunities to regenerate whitebark pine through natural regeneration and perhaps supplemental planting.

Keane's whitebark pine daylighting was completed in 2012. Rather than have the saw crew try to identify whitebark pine trees on-the-fly, two people flagged the whitebark pine trees ahead of the sawyers. The crew was careful to directionally fall trees away from whitebark pine trees in the daylight-and-underburn block to manage fuel accumulations. Where fuel accumulations threatened survival of the whitebark pine trees, larger competing conifers were girdled instead of felled. The prescribed fires in the burn-only and daylight-and-underburn blocks are planned for the fall of 2013.

Sturdevant's pruning was completed in 2012. Thirty trees each of (1) daylighted but unpruned controls and (2)trees daylighted and pruned to at least 12 feet were selected randomly from mountain pine beetle-susceptible trees over seven inches in diameter that had no stem cankers. An additional thirty trees that have not been daylighted or pruned will be selected for a control population in the spring. Since the whitebark pine gradually recolonized the site over an extended period, the older trees that developed under open grown conditions have retained limbs nearly to the ground. Pruning the limbs changed bole microsites from a dark, shaded environment attractive to mountain pine beetles to a sunny, exposed environment with increased bole temperatures and air movement that have been shown to discourage mountain pine beetle attacks in lodgepole pine. These trees will be periodically monitored starting in the late summer this year, and any beetle-attacked trees will be felled and developing brood destroyed to discourage further beetle activity in the stand.

The prescribed burn on the adjacent lodgepole pine hillside will occur within the next ten to fifteen years as funding and burn window weather conditions coincide. So did we take chainsaws to the whitebark pine? Yes, but we only cut the competing conifers. We retained all the whitebark pine trees no matter how pathetic they looked. Will we intentionally burn them down? Maybe. We will be underburning in young, small diameter whitebark pine under conditions that we hope will give them a sporting chance to survive. In the long term, the knowledge gained from the Mink Peak studies and paired similar treatments on Prospect Mountain about six miles to the east and in other locations will be shared with restoration-minded managers across the range of whitebark pine. ■

Whitebark Pine Restoration in the Greater Yellowstone Area

Karl Buermeyer, Bridger-Teton National Forest
Moran, WY

The Greater Yellowstone Coordinating Committee (GYCC) Whitebark Pine Subcommittee was formed in 2000 as an interagency effort to protect and restore whitebark pine in the Greater Yellowstone Area (GYA). The GYA is a largely intact ecosystem ranging from 50 – 100 miles outward in all directions from the boundary of Yellowstone National Park, and includes portions of southeastern Idaho, south-central Montana and northwestern Wyoming. Participating agencies include six National Forests, Grand Teton and Yellowstone National Parks, two National Wildlife Refuges, and most recently the Bureau of Land Management from each of the three states.

Threats of altered fire regimes, with associated competition and successional pressures, and white pine blister rust are characteristic of the range as a whole. In addition, whitebark pines in portions of the GYA, particularly Wyoming, have been hit exceptionally hard by mountain pine beetle since the early 2000s. Warm weather over the last decade has allowed mountain pine beetle to complete its life cycle at high elevations where it was not generally prevalent in the past. In response to these threats, the Whitebark Pine Subcommittee collaborated with the US Geological Survey and National Park Service to begin monitoring distribution and condition of whitebark pine in the GYA. In 2010 a map and data set showing the location and stand attributes for whitebark pine in the GYA was completed. A Whitebark Pine Strategy for the Greater Yellowstone Area ("The Strategy") was released in May of 2011, using this data to strategize protection and restoration efforts, as well as outlining specific management, monitoring and outreach efforts. This effort earned the Committee the Forest Lands Leadership Award from the Arbor Day Foundation in 2012. The Strategy can be viewed on the GYCC website: http://www.fedgycc.org/documents/WBPStrategyFINAL5.31.11.pdf .

Activities that the Committee and their agencies have been engaged in since its inception include continued and intensified monitoring of whitebark pine, collecting cones from phenotypically rust resistant whitebark pines, planting seedlings grown from these seeds, protecting whitebark pines from fire and bark beetles, silvicultural treatments to protect and promote whitebark pine stands, and a genetics program to develop blister rust resistant and cold hardy planting stock. The resistance program involves identifying and collecting seed, pollen and grafting material from phenotypically resistant ("plus") trees. Seedlings grown from these trees are inoculated with blister rust spores at US Forest Service Coeur d'Alene Nursery.

Based on the results from the rust screening, scion from the original parent trees is grafted onto rootstock and those grafts are planted in a seed orchard on the Gallatin National Forest near Bozeman, MT. The first of these elite trees will be planted in the spring of 2013, alongside a performance test to monitor the long-term durability of rust resistance and cold hardiness under more local conditions. Research efforts by Forest Service and academic collaborators, and supported by the committee, include tests of direct seeding, and potential effects of climate change and how it might affect our restoration and site selection priorities.

Based on the overall direction of the Strategy, Restoration Priorities and List of Proposed Project Sites has been developed and will be updated to guide implementation of planting and other restoration efforts on the ground on a yearly basis. Recent and planned planting efforts are listed below:

2012	Spring: Ski areas/C-T, B-T, Gallatin	7,000 seedlings
	Fall: Caribou-Targhee	15,000 seedlings
	Fall: Bridger-Teton	6,700 seedlings
Total Acres Planted 2012: 131		
2013	Spring: Shoshone	6,700 seedlings
	Spring: Gallatin	17,000 seedlings
	Fall: Bridger-Teton	24,400 seedlings
	Fall: Grand Teton NP	3,000 seedlings
	Fall: Beaverhead-Deerlodge/BLM	5,000 seedlings
Planned Acres 2013: 380		
2014	Spring: Shoshone	42,800 seedlings
	Spring: Gallatin	16,000 seedlings
	Spring: Caribou-Targhee	5,000 seedlings
	Fall: Bridger-Teton	50,000 seedlings
	Fall: Caribou-Targhee	30,000 seedlings
Planned Acres 2014: 619		

In addition to planting, the Gallatin and Bridger-Teton National Forests have silvicultural restoration projects in the works, in which competing trees are removed around exiting whitebark pines to release them and protect from fire, and to create openings favorable for whitebark pine regeneration. The Caribou-Targhee National Forest has implemented a program of protecting individual whitebark pines from fire by clearing around them.

The ultimate goal for the GYA is to restore 40,000 acres of whitebark pine habitat over 20 years. This is an ambitious goal as whitebark pine seedlings are expensive to grow, and the sites where planting and stand treatments take place are often remote. In addition to funding through the participating agencies, the committee works to prioritize and develop funding proposals to the GYCC, Forest Health Protection (a Forest Service inter-regional program), and other outside groups. The table above shows a gradual buildup of acres planted, but achieving the goal of 2000 acres per year will require significantly more funding. We are collaborating with non-governmental organizations to increase awareness of the threats, our efforts, and the need to fund these efforts. Watch the video on American Forest's "Endangered Western Forest" website: http://www.americanforests.org/our-programs/endangered-western-forests/.

As chair of the GYCC's Whitebark Pine Subcommittee, I am privileged to work with such a dynamic and dedicated group in a truly cooperative effort, and am optimistic that we will continue to make progress in protecting and restoring whitebark pine in the Greater Yellowstone Area. ■

Ageing whitebark and limber pine plus trees in Waterton Lakes National Park, Alberta

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Whitebark (*Pinus albicaulis*) and limber (*P. flexilis*) pine are in serious decline in Waterton Lakes National Park (WLNP) in southwestern Alberta, from a combination of white pine blister rust (*Cronartium ribicola*), mountain pine beetle (*Dendroctonus ponderosae*), fire exclusion and climate change (Smith et al. 2008, 2011, 2013). To counteract this decline, Parks Canada has undertaken a broad range of restoration activities, including identifying potentially rust-resistant trees (termed "plus trees"), collecting seed, protecting plus trees from mountain pine beetle using semio-chemicals, and planting potentially rust-resistant seedlings (Smith 2009).

The first plus trees were identified and protected in 2006 (Smith and Backman 2006) and, in the intervening years, 79 whitebark and 33 limber pine plus trees have been identified. In 2009, staff at WLNP began to collect seeds from these plus trees, which are part of the Missions/Glacier Park seed zone. Some of the seeds have been contributed to the Inland West Whitebark Pine Genetics Restoration Program at the Coeur d'Alene Nursery in Idaho. Besides identifying and harnessing blister rust resistance, researchers are studying genecology and molecular genetics (Mahalovich 2012). A number of variables are used in these analyses, including tree age.

While some of WLNP's whitebark pine plus trees had been cored in 2006 and aged (unpubl. data), we had an incomplete record, and none of the limber pine had been aged. Our goal in 2011 was to core the remaining 42 whitebark and 32 limber pine plus trees and use dendrochronology techniques to estimate their ages.

Methods

Each tree had already been tagged with a unique identification number, and diameter at breast height (dbh, taken in cm at 1.3 m) was recorded. One to three cores were sampled from individual trees (n = 124 cores total). One or two cores were taken near the base of the stem and one or two cores were taken at breast height. Attempts were made to intercept the pith of the stem or to ensure that the core passed close to the pith to maximize the number of rings and improve the accuracy of age estimates. For some trees, stem-wood decay near the pith prevented high quality cores from being taken at the base or at breast height.

Individual cores were dried, mounted on

wooden supports and sanded with paper of successively finer grit (220, 320 and 400 grit) to ensure the wood cells forming annual tree rings were clearly visible when viewed with a stereo microscope. Calendar years were assigned to individual rings of each core by visually crossdating. Each core was assessed to ensure the proper date was assigned to narrow marker rings, rings that are consistently narrow in the regional chronology for whitebark pine growing in WLNP (Wong 2012). This method increases the accuracy over simple ring counts by identifying false and missing rings. Since we did not have a chronology for the limber pine from the Park, we used the list method (Yamaguchi 1991) to cross-reference cores, identify common narrow rings and increase the accuracy of age estimates.

The most accurate age estimates were derived for cores taken from the base of the tree that intercepted the pith. For these cores, the calendar year of the pith estimated the year of establishment from which tree age (years) was calculated as:

Age = 2011 – year of pith + 1

For cores that did not intercepted the pith but were close enough that the innermost rings formed arcs, we measured the dimensions of the inner-most rings and used geometry to estimate the number of missed rings (Duncan 1989). This correction factor was used to estimate the pith date and year of establishment:

Age = 2011 – year of inner ring + number of missed rings to pith + 1

For trees that did not intercept the pith and did not include arced rings, minimum age (years) was calculated as:

Minimum age = 2011 – year of inner ring + 1

Similarly, the calendar year of the pith or inner ring was determined for the cores extracted at breast height from each tree. However, a core taken at breast height underestimates the full age of a tree by the number of years it took for the tree to grow to that height. We calculated a correction factor for this by estimating the difference in ages from cores taken at both the base and at breast height of a subsample of trees (Wong and Lertzman 2000). We calculated the averages for whitebark pine (n = 9 trees) and limber pine (n = 15 trees) to provide species-specific corrections. For trees that had decayed stemwood at their base, the age estimates from the breast height cores were corrected for the average number of years to grow to breast height from this subsample as follows:

Age = 2011 – year of inner ring + number of missed rings to pith + correction to coring height + 1

Results

A) Whitebark pine

Whitebark pine age estimates and minimum ages ranged from 56 to 501 years (Figure 1), but ranged in accuracy depending on the quality of the core. Ages were derived from 17 basal and 25 breast height cores (n = 42 total). The basal cores provided the most accurate age estimates and included:

- one core that intercepted the pith with an age of 151 years (tree established in 1861);
- 7 cores with corrections of 5 to 17 years for missed rings, ages of 98 to 151 years (trees established between 1914 and 1861);
- 9 cores with minimum ages ranging from 56 to 166 years; and,
- median minimum age was 99 years, while the median estimated age was 143 years.

The breast height cores were corrected by 35 years, the average number of years it took 9 trees to grow to breast height, based on the difference between basal and breast height estimates of tree ages. The average minimum age was 261 years, while the average estimated age was 157 years. These cores included:

- 3 cores that intercepted the pith with ages of 65, 195 and 303 years (trees established in 1985, 1855 and 1744, respectively);
- 16 cores with corrections of 1 to 31 years for missed rings, ages of 60 to 236 years (trees established between 1987 and 1811); and,
- 6 cores with minimum ages of 114 to 501 years.

The median age from all whitebark pine trees and cores was 150 years.

B) Limber pine

Limber pine age estimated and minimum ages ranged from 26 to 161 years (Figure 2). Ages were derived from 30 basal and 2 breast height cores (n = 32 total). The basal cores provided the most accurate age estimates and included:

- one core that intercepted the pith with an age of 133 years (tree established in 1879);
- 17 cores with corrections of 1 to 15 years for missed rings, ages of 26 to 161 years (trees established between 1986 and 1851);
- 12 cores with minimum ages ranging from 36 to 136 years; and, median minimum age was 73 years, while the median estimated age was 79

years.

The breast height cores were corrected by 23 years, the average number of years it took 15 trees to grow to breast height, based on the difference between basal and breast height estimates of tree ages. These cores included:

- one core with an estimated age of 59 years (tree established in 1952); and,
- one core with a minimum age of 113 years.

The median age from all limber pine trees and cores was 76 years.

Discussion

The oldest whitebark pine age estimates were derived from cores extracted at breast height, many of which yielded minimum ages only. This likely is due to the increased chance of stemwood decay in older trees so that they had to be cored higher on the stem, but also had a lower chance of including the pith. Overall, success of extracting sound cores that were close to the pith was greater for limber pine than whitebark pine. Apparently, stemwood decay was less common in the sampled limber pine. The majority of whitebark pine trees sampled had rotten cores, yet have survived white pine blister rust and are still producing seed.

Generally, the limber pine plus trees were younger than the whitebark pine (median age of 76 versus 150 years). The oldest limber pine tree sampled was estimated to have established only in 1850, while the oldest whitebark pine tree sampled was estimated to have established in 1510. Both species are known to be long-lived, with occasional ages of >1000 years (Schuster et al. 1995, Luckman and Youngblut 1999, Sauchyn 2010).

Acknowledgements

Thanks to Peter Achuff and Carmen Wong for reviews of earlier drafts.

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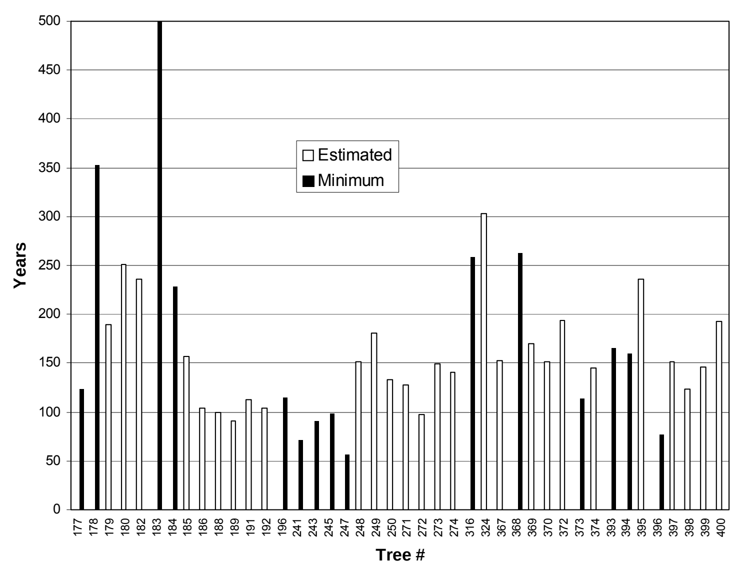

Figure 1
Whitebark pine ages (years) for 42 potential plus trees in Waterton Lakes National Park. Ages estimated from either basal or breast height cores.

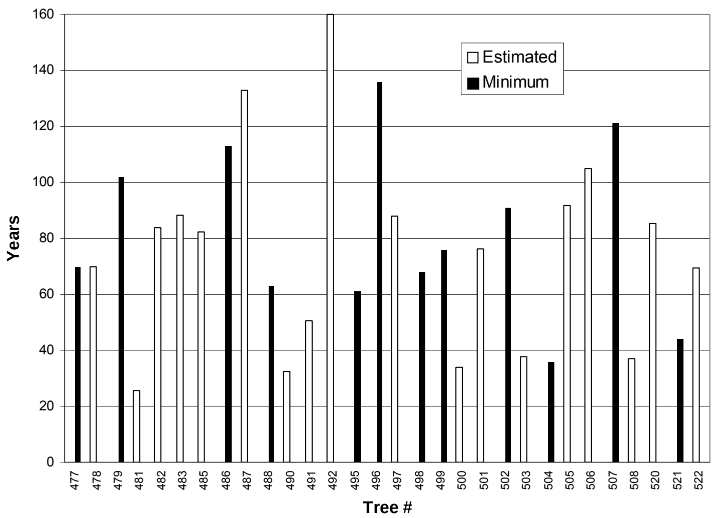

Figure 2
Limber pine ages (years) estimated from basal cores for 22 potential plus trees in Waterton Lakes National Park.

Potential for Enhancing Rust Resistance in Whitebark Pine

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Introduction

The use of whitebark pine seed from parent trees with resistance to white pine blister rust involves collecting seed from parent trees identified as genetically resistant to this disease. Cones with resistant seed can be collected from trees in the field, or to increase resistance further, controlled matings between resistant parents can be done. This article documents the first attempts to produce advance-generation (second-generation) white pine blister rust-resistant seed through control crossing of young seedlings and grafts of whitebark pine (*Pinus albicaulis*) at Dorena Genetic Resource Center (DGRC), the Pacific Northwest Region’s (Region 6) facility for disease resistance work. These modest early efforts have produced a single cone yielding what is likely the first F_2 generation whitebark pine blister rust-resistant seed.

Seed Cone and Pollen Cone Production on Young Trees

Blister rust resistance testing of seedling progeny of whitebark pine parent trees has been underway at DGRC since the small first sowing in 2001—Sow Year (SY2001) and a somewhat larger trial in in 2002 (SY2002) (Sniezko and others 2007). A large trial of 101 families (family=seedling progeny of a parent tree) was sown in 2004 (SY2004) and inoculated with rust in September 2005. Subsequent trials have been sown in 2005, 2007, 2011, 2012 and 2013. This SY2004 trial proved to have a good mix of susceptible to moderately resistant families with the percentage of trees with stem infections (cankers and bark reactions) varying from <20% to 100% (Sniezko, unpublished). Survivors in this trial have been maintained in the original boxes and growth has been good despite the close spacing and confinement of roots. The first grafts from some of these rust-resistant seedling progeny were made in 2009 and planted in 2010 in a field at DGRC.

At DGRC, whitebark pine produces pollen and seed cones that are receptive during mid-May to mid-June. The presence of a few seed cones or pollen cones had been observed prior to 2011 in the SY2004 trial. However, a much higher frequency in this trial and in grafted seedlings from this trial was apparent starting in 2011 (Figure 1, back cover). Pollen collection and control pollinations of whitebark pine first-year seed cones (‘flowers’) were done in late spring 2011. Pollinations were performed on unbagged seed cones, but due to the paucity of pollen cones on other whitebark, there is likely only a slight chance of pollen contamination from wind pollination. Flowers on four trees in the SY2004 trial, and five grafts (some from SY2004, some from SY2007 trials) were pollinated with freshly collected pollen on June 16, 2011. The seedlings had one to eight seed cones per tree, the grafts one to six. For five of the nine pollinations, a pollen lot from an 8-year-old progeny of a Mt. Hood National Forest parent was used. Due to limited pollen and other constraints, all trees were pollinated on June 16, and only once. Normally, to maximize cone retention and filled seed yield, timing of pollen application would be guided more precisely by the individual development of the seed cones on each tree.

The first-year conelets generally looked healthy after pollination in June 2011, but only one of the conelets expanded and matured in fall of the second season (2012). This cone originated from a 2009 graft of a seedling from the SY2004 trial. On this graft, one seed cone was pollinated in June 2011, yielding a cone and seed in fall 2012. Due to oversight, the cone was not collected until April 2013 (approximately 6 months after collections from field sites). The graft is still small, 64 cm tall and 2.29 cm diameter at ground level in April 2013. The cone appeared to be average sized (Figure 2) and healthy and showed some sign of starting to open. When harvested and put in a bag, the cone began to break apart with gentle handling. The seed were extracted and counted. Seed were large (Figure 3). The cone yielded 50 total seed, of which 18 appear to be filled (36 percent). Three of the seed had begun germinating in the cone; the remaining seed were put in the germination chamber on April 10th. Seed weight was 0.1424 g/seed (based on 45 seed, but note only ~36% of the seed are filled). This seed weight is less than that of seed from field collections of the two parent trees (0.1733, 0.1728 g), but 98 and 100% of the seed in those seedlots were filled. Thus, the size of the seed produced on this small graft is likely comparable to that of the parent trees. Monitoring germination continues in mid-April 2013. Germinating seed are being sown in individual tubes for future culturing.

Figure 2. Whitebark pine cone at harvest in April 2013 on 2009 graft from SY2004 trial.

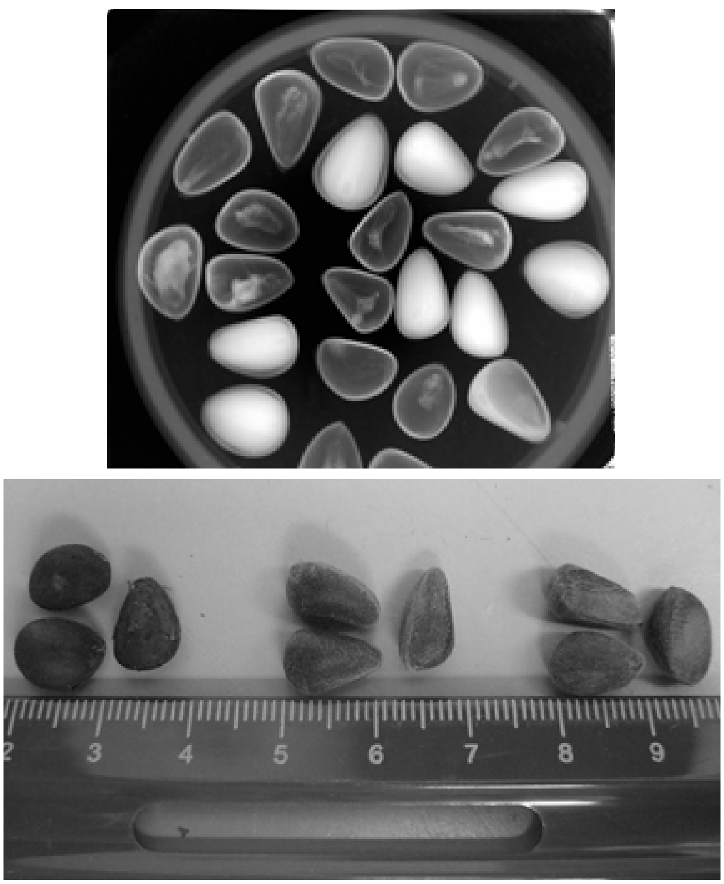

Figure 3. Whitebark pine seed from control cross of two 8-year old rust resistant trees: [a] x-ray showing filled and empty seed, and [b] seed size of controlled cross (left) and its two wind-pollinated grandparents (06017-014 [center] and 06017-016 [right])

The cone was the product of a control cross between two young trees (8 years old at the time of pollen collection and seed cone pollination) in the SY2004 rust trial. The parents of these young trees originated from Mt. Hood National Forest parents (grandparents of this seed).

Progeny of each of the grandparents had been tested for rust resistance and shown moderate levels of rust resistance. A canker-free tree within one family was used as a maternal (seed) parent and a canker-free tree from a second family was used as a pollen parent. The progeny produced here would be expected to show a high level of rust resistance. We will likely have very few additional germinants but have demonstrated the potential to produce mature cones and seed at a young age in whitebark pine. Future efforts, which optimize timing of pollination and tree growth and vigor would be expected to yield greater quantities of seed.

Seed Production for Restoration

The only blister rust-resistant seed currently available for restoration efforts of whitebark pine comes from cone collections of parent trees in natural stands in relatively remote areas. This is very useful for immediate needs, but fires and mountain pine beetle attack have already killed a number of resistant parent trees, potentially putting the long-term viability of this option in doubt for some areas. A backup or alternative strategy that would increase the level of blister rust resistance further, and maintain or increase the level of genetic diversity would be the development of seed orchards for whitebark pine. These orchards could be placed at high elevation where growth would be relatively slow and the timing to the beginning of seed cone and pollen production relatively unknown (this can be a logistically difficult and expensive approach, but some orchards are being established in the Interior West.). Alternatively, seed orchards could be placed at lower elevations where tree growth would be faster and the potential of seed cone and pollen cone production at a much younger age, and the sites could be more accessible. The orchards would be composed of only rust-resistant trees and the resulting seed would be expected to yield even higher levels of resistance than seed currently collected from the field. In addition, controlled matings such as the one documented in this report could cross the very best parents to produce the highest level of disease resistance.

The trials at DGRC show that healthy, fast growing whitebark pine can be grown at low elevation, and that at least for some seed sources these trees start production of seed cones and pollen cones at a relatively early age. Observations in the next five to ten years at DGRC, and at the small field trials at low and high elevation sites in the Pacific Northwest should provide useful information about levels of cone production and seed yields. Seed from any of these areas could be compared to that from wild collections to examine growth, phenology and blister rust resistance. The potential of producing higher rust-resistant seed in a relatively few years expands the exciting possibilities for restoration work with whitebark pine.

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Precocious Flowering of High Elevation White Pines: A Promising Development

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Introduction

This article documents the production of seed cones and pollen cones on very young trees of several high elevation white pine species at a low elevation site (Dorena Genetic Resource Center, DGRC, 787 feet elevation) in western Oregon. Observations on the occurrence and timing of 'flowering' of young seedling families of whitebark pine (*Pinus albicaulis*), limber pine (*P. flexilis*), southwestern white pine (SWWP--*P. strobiformis*), Rocky Mountain bristlecone pine (*P. aristata*) and Armand pine (*P. armandii*) seed sources from Taiwan and China have been made over the last several years.

Whitebark Pine

At DGRC, whitebark pine has been sown for trials in a number of years beginning in 2001. A large trial (101 families) sown in 2004—Sow Year (SY2004)—is the focus in this article. At DGRC, whitebark pine produces pollen and seed cones during mid-May to early June, perhaps two months earlier than high elevation sites such as Crater Lake National Park where whitebark pine is native. The presence of a few seed cones or pollen cones had been observed prior to 2011 in the SY2004 trial. However, a much higher frequency of seed and pollen cones in this trial and in grafted seedlings from this trial was apparent starting in 2011. Despite the tight spacing of the seedling survivors in the original test boxes and the fact that the grafts were done only in 2009, some trees and grafts produced moderate amounts of pollen and seed cones (Figure 1, back cover) and one mature cone with filled seed.

Limber pine, SWWP, Rocky Mountain bristlecone pine and *Pinus armandii*

Limber pine (SY2007) has produced pollen cones in several years at DGRC, including fairly abundant pollen in 2012 (during the 6th growing season) (Fig. 2, back cover). Approximately 80 surviving limber pine in SY2007 trial had pollen (>=3.2% of trees alive in Dec. 2011, 10.6% of those alive in Dec. 2012). SWWP (SY2002 trial) has also produced abundant pollen several times during this period, as has *P. armandii* (SY2001) (Fig. 2, back cover). Rocky Mountain bristlecone pine (SY2002) has produced small amounts of pollen (on 24 trees, 1.3% of survivors in 2012) and a few first-year seed cones (Fig. 3, back cover).

Flower phenology at 'common garden' (DGRC) site

Based on several years of casual observations of trees of approximately the same age (<10 years old), the whitebark pine, limber pine, southwestern white pine and *P. armandii* flower earliest (mid-May), followed by western white pine (late May), then sugar pine (early June). Vegetative growth in these early-flowering species also begins earlier (early April, based on observations from 2013) and its onset appears to vary less among these species than does reproductive phenology. Depending on the year, there are several weeks to perhaps a month's difference in flowering time among all the species, as well as several weeks' difference in the start of flowering within a species (year to year variation). From a quick look on April 29, 2013, there appears to be pollen cones visible on a number of limber pine in the 2007 trial, and some whitebark pine in the 2004 and 2007 trials. This may be the earliest appearance yet and coincides with a record dry January through April in this area, along with warmer than normal temperatures. Pollen shed may still be a few weeks away. Less data is available for Rocky Mountain bristlecone pine, but it appears to commence flowering even later than sugar pine (vegetative growth for Rocky Mountain bristlecone pine also starts later than the other white pine species).

Whitebark pine has produced the most balanced presence of both seed cones and pollen cones on young trees. Some individual whitebark pine trees have both pollen and seed cones at a young age, something not usually seen in species such as western white pine and sugar pine or the other species reported here. For most other species, pollen cones are much more abundant at an early age than are seed cones (Table 1)—except for western white pine (*P. monticola*), on which seed cones begin appearing several years before pollen is common.

Breeding possibilities and potential for restoration

Knowledge of the age and timing at which the high elevation white pine species become reproductive at low and high elevation sites opens the door for breeding to advance the rust-resistance and restoration success of these species. Controlled crosses could be used to inter-mate rare resistant trees within a breeding zone, perhaps dramatically increasing the level of rust resistance for restoration efforts (although flowering is generally very limited on trees this young); they would also be valuable to use to help resolve inheritance patterns for resistance. At least at a low elevation site such as DGRC, pollen and seed cone production at an early stage (fairly rare, but beginning as early as five years from seed for some trees) may be sufficient to permit control crosses to produce full-sib or self-pollinated families.

The trees evaluated here are not growing under optimum conditions for flower production, and with refinements an increase in flowering and cone production seems reasonable in whitebark pine and probably some of the other species. More abundant flowering of older trees or the aid of flower-induction techniques will be needed to reap the highest benefits for restoration; until then collection of cones from rust-resistant parent trees in the field is recommended. All of the species mentioned here have documented rust resistance in trials at DGRC, and the potential to do control crosses is an exciting possibility. The data here and over the next five years should provide key information to land managers contemplating the potential viability of future seed orchards to provide a reliable source of genetically diverse, blister rust resistant seed of high elevation white pine species.

Table 1. Relative flowering occurrence of trees less than 10 years old at DGRC. (on page 21) ■

Species	First year female conelets	Pollen cones
Whitebark – seedlings	moderate	moderate
Whitebark – seedling grafts	sparse to moderate	sparse to moderate
Western White – seedlings	moderate	rare
Western White – seedling grafts	moderate	rare
Limber	sparse	moderate
Southwestern White	sparse	moderate
RM Bristlecone	sparse	sparse
Sugar Pine	rare	rare

Table 1. Relative flowering occurrence of trees less than 10 years old at DGRC.

Whitebark finding shelter; S. Arno photo

Burned whitebark forest now krummholz; Red Mtn. near Lincoln, MT; S. Arno photo

Fig 1. Whitebark pine pollen cones, first year seed cone, and fully mature cone on seedling (left) and grafts (center, right) at Dorena GRC.

Fig. 2. Pollen cones on 5-year old limber pine (left), 10-year old southwestern white pine (center), and 12-year-old *Pinus armandii* (right)

Fig 3. Rocky Mountain bristlecone pine pollen (left) and seed cones (center, right) on 10-year-old seedlings at Dorena GRC