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nutcracker notes

JOURNAL OF THE WHITEBARK PINE ECOSYSTEM FOUNDATION

The Slyest Seed Predator: Interactions between red fox and whitebark pine in the Greater Yellowstone Ecosystem

Rocky Mountain red fox (*Vulpes fulva macroura)* near Cooke City, MT

Story and photos by Patrick Cross
- Yellowstone Ecological Research Center

"Aha, there's a fox scat for you, Joel!" I proclaimed, pointing ahead with my ski pole across the otherwise unblemished snow. It was a crisp January day, with alpine sunshine sparkling off ice crystals suspended in the mountain air, high on the Beartooth Plateau near Top of the World, Wyoming. Field technician Joel Forrest and I were there to conduct snow tracking surveys, collecting habitat use data that could explain why the red foxes that live there seem different from those at lower elevations. With kit-rearing dens up to 9,400' (2,820 m) and year-round occupation of elevations as high as 11,000' (3,300 m), this is the highest known fox population in North America*(1)*. It is also distinguished by unique physical and genetic characteristics: visitors to nearby Yellowstone National

Red Fox continued on page 10

OUR MISSION The Whitebark Pine Ecosystem Foundation is a science-based nonprofit organization dedicated to counteracting the decline of whitebark pine and enhancing knowledge of its ecosystems.

WHITEBARK PINE
ECOSYSTEM FOUNDATION

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PO Box 17943
Missoula, MT 59808
www.whitebarkfound.org

Inside *Nutcracker Notes*

Foundation News:

Director's Message....2
WPEF Canada Director's Message....3
Restoration Website Launched....4
Membership Report....5
Pint Night Thank You....5
Election News....6
Treasurer's Report....6
SAVE THE DATE: Annual Meeting Sep 17-20....back

Articles:

The Slyest Seed Predator: Interactions between Red Fox & Whitebark Pine in the Greater Yellowstone Ecosystem - *Cross*....front

Whitebark Pine in Northwest California - *Kaufmann*....7

Chainsaws and Fire for Restoring Whitebark Pine: Lessons Learned - *Aniballi*....13

Protecting and Restoring Whitebark Pine at Grouse Mountain - *Buermeyer*....16

American Forests and Whitebark Pine - Westerhold....18

Whitebark & Limber Pine Experience and Outreach in the Canadian Rocky Mountain National Parks - *Shepherd*....19

Does Fire Improve Conditions for Whitebark Pine Seedling Establishment? - *Perkins*....22

WHITEBARK PINE FOREVER 2015
Restoration Fund Campaign

How can you help? Donate now to fund restoration projects such as:

- Plant whitebark pine seedlings
- Collect whitebark pine cones for future seedlings
- Grow blister rust resistant trees in whitebark pine seed orchards
- Protect high value whitebark pine trees from bark beetle attacks
- Remove other trees from growing whitebark pine

Go to our website whitebarkpinefound.org and donate NOW to Whitebark Pine Forever 2015.

DIRECTOR'S MESSAGE - WHITEBARK PINE RESTORATION IN WILDERNESS

Diana F. Tomback

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…

-- U.S. Wilderness Act, Sec. 2c,1964.

In the last issue of Nutcracker Notes, I discussed the significant contribution of the Wilderness Act, on the occasion of its 50th anniversary, to the American conservation movement. The Wilderness Act established the only system of reserves in the U.S. with the objective of maintaining a truly natural state. It still represents one of the most powerful and important pieces of environmental legislation in the United States, and a global model.

The Wilderness Act has benefited whitebark pine. Among the first wilderness areas established, three had extensive whitebark pine communities: the Bob Marshall Wilderness, Montana; the Bridger Wilderness, Wyoming; and the Ansel Adams Wilderness, California. In fact, in my previous message I pointed out that whitebark pine is a "wilderness species" with more than 2 million hectares (nearly 5 million acres) or nearly 40% of all whitebark pine habitat in the United States protected by wilderness designation.

But, I also pointed out some of the failings of the Act. Fifty years ago, the thoughtful and earnest authors of the Wilderness Act could not begin to imagine how humans could impact or "trammel" the most remote and pristine wilderness areas from afar, although evidence was growing. Their concern was to protect natural areas from the changes imposed by a growing human population, and to keep these areas in pristine condition for the enjoyment of future generations. The major activities they noted and prohibited included road-building, use of motorized vehicles or equipment, aircraft, and permanent installations or structures. These activities, or human "trammeling", clearly alter the wilderness character and experience, and prohibition was vital for protection of these lands.

But, human activities outside wilderness now have serious, larger-scale, and burgeoning impacts within wilderness and are degrading wilderness character. In the case of whitebark pine, human activities outside wilderness have resulted in a precipitous decline of whitebark pine almost everywhere across its range, including inside wilderness. I argue that we should "untrammel" the indirect "trammeling" within our current capabilities.

Indirect trammeling with direct consequences

Whitebark pine is declining across its range from several hazards, all connected to human activities:

Fire exclusion policies that have altered natural fire regimes. The suppression of fires both inside and directly outside wilderness in general eliminates the natural mosaic pattern of different successional stages across the landscape. Whitebark pine prevalence has declined in some wilderness areas in response to successional replacement.

Invasive species and disease. Globalization has resulted in worldwide transport of plants, pests, and diseases that can profoundly alter community composition and structure. *Cronartium ribicola*, the pathogen that causes white pine blister rust was inadvertently transported to the U.S. West in the early 20th century. If all other threats to whitebark pine disappeared, white pine blister rust would still extirpate the species in many areas, and could even lead to its range-wide extinction.

Climate change. Rising levels of greenhouse gases are altering our global climate, with local impact. Major outbreaks of bark beetles, which include mountain pine beetles, during the last 15 years are attributed to rising temperatures, and especially higher

Tomback continued on page 25

Randy Moody

Director's Message

www.whitebarkpine.ca

The Canadian board of directors has recently taken a major shift with three members stepping down – Judy Millar, Joyce Gould, and Brad Jones; we wish each of them the best. A call to stand for these positions was put out with only three members coming forward to fill them: Jodie Krakowski, Adrian Leslie, and a shared Parks Canada position of Danielle Backman and Rob Sissons.

Although we did not have enough interest in becoming board members to hold an election, we are pleased with the individuals that came forward as they are strong advocates for whitebark pine and provide good representation within the Alberta Government, the Nature Conservancy Canada, and Parks Canada.

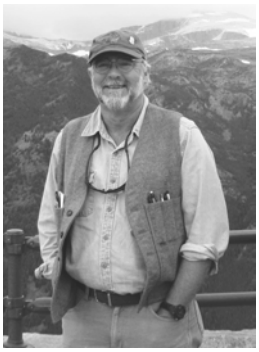
The BC Government (Michael Murray and Joanne Vinnedge along with Don Pigott, Alana Clason and myself) recently completed an extensive project addressing screening in BC, rust monitoring needs, engaging industry, and other recovery related activities. Although this isn't a recovery strategy as the Federal Government and our neighbours in Alberta have, it is somewhat of a blueprint for action and provides numerous recommendations directed at species recovery in BC.

It is hoped that this document will be used by the BC government as the foundation for a recovery strategy and really get whitebark pine recovery off and running (at last).

Five needle pines in Canada really seem to be moving to the forefront and things seem to be happening at last. Limber Pine was recently reviewed by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and assessed as endangered as of November 2014, now it is over to Species at Risk Act (SARA) to see where things go from here for limber pine. There are possibly more grad students working on whitebark and limber pine than ever at Canadian Universities; I am aware of individuals at University of British Columbia, Simon Frasier University, University of Northern British Columbia and University of Alberta all doing good work and I may be missing some.

The WPEF–Canada has been prompted by several individuals to host a meeting as soon as possible as many individuals have travel restrictions and are unable to make meetings south of the border and whitebark is rapidly becoming a hot button item with a strong need for outreach to land managers. On this note, we have decided to host a summer meeting so as not to conflict with the September science meeting in Oregon. This meeting is tentatively scheduled for mid-summer in McBride, BC, so watch for further details. McBride is located just west of Jasper in the Robson Valley of BC. This meeting will primarily be directed at looking at work being conducted along the northern limit of the species' range but we will likely have room for additional presentations. We will send out an email to the entire WPEF to keep interested members informed.

Mourning the loss of our friend and colleague Bob Means



On behalf of the Whitebark Pine Ecosystem Foundation, we regret to report deeply sad news. Bob Means passed away May 27, 2015, due to a sudden heart attack. Bob was a wonderful person and friend. As the BLM Wyoming state forester, Bob was known for the passion he showed everyday to help build one of our most successful programs. He served 26 years in the federal government, beginning his career with the U.S. Forest Service. In 2001, Bob joined the BLM Wyoming team and quickly became well respected among our partners in the state and throughout the bureau. He was also active in the Society of American Foresters. Bob was indeed a champion of Limber Pine and a friend to all five needled pines. Bob touched the lives of everyone he met. We know that his passing will leave a void in the hearts of all who knew him and our thoughts and prayers go out to his wife and children.

RESTORING WHITEBARK PINE
ONE PROJECT AT A TIME

NOW LIVE! "Restoring Whitebark Pine—One Project at a Time":

A partnership between the US Forest Service Forest Health Protection and the Whitebark Pine Ecosystem Foundation

The WPEF is pleased to announce our newly launched webpages and database Restoring Whitebark Pine—One Project at a Time (http://database.whitebarkfound.org/). This website provides important information about whitebark pine restoration projects funded by the US Forest Service Forest Health Protection (FHP) Whitebark Pine Restoration Program, from the inception of the program in 2007 to the present (2014 reports in progress).

The categories of projects funded by the program include:

1) assessing health—surveying and monitoring;
2) operational cone collections;
3) harnessing rust resistance;
4) enhancing regeneration & reducing competing vegetation;
5) special projects; and
6) education/outreach/technology transfer.

Restoration is key to maintaining whitebark pine as an important component of high elevation ecosystems for the foreseeable future, given multiple threats to the species' survival, including the spread of non-native white pine blister rust, mountain pine beetle outbreaks, fire suppression in some regions, and climate change.

The Whitebark Pine Restoration Program is the only federal agency program with dedicated funding for whitebark pine. The "landing page" of our website provides a short history of the program's development under former FHP Director Robert Mangold and WPEF's early role, and the total funding leveraged for restoration since the inception of this program. John Schwandt was the first to administer the Whitebark Pine Restoration Fund, with Sandra Kegley taking the lead after John's retirement.

The WPEF restoration website design and development were funded by FHP through Region 1. In the process of developing these webpages, the WPEF worked with FHP on a new final report format for funded projects, which provides a concise synopsis of the work accomplished. All project reports include methods and outcome, and provide contact information for follow-up. Agencies and organizations contemplating whitebark pine restoration work will find this resource extremely helpful; they can examine past projects for objectives, work accomplished, and scale and cost. We would like to expand the reporting in these pages to whitebark pine restoration projects funded through other sources or implemented by other agencies. We are looking for volunteers to help us with this expansion.

These webpages have been in development since January 2013 in cooperation with FHP Region 1 and with the help of Gregg DeNitto, Sandra Kegley, and John Schwandt. We thank Solédad Diaz, director of the project, and WPEF webmaster JoAnn Grant for their dedicated work.

The webpages may also be accessed through the WPEF home page at http://whitebarkfound.org/ by clicking on the green "Whitebark pine restoration website button."

www.database.whitebarkfound.org

"Members" Area of the WPEF Website is a Source of Exclusive Information

By Bryan Donner

WPEF Membership and Outreach Chairperson

The "Members" area is a common feature of many society, club, or foundation web sites. Currently, access to this area on the WPEF home page (www.whitebarkfound.org) is on the MEMBERS tab on the far right of the top banner. The Members area can only be accessed using a pass code that is supplied to our members upon joining the foundation or whenever the pass code is changed. The most recent pass code change was July 2013. All members will be notified via email or a letter if the pass code changes. If you forget the username or pass code information, please contact me or Bob Keane via email and we'll get that information to you.

Access to the Members area is an important benefit of membership in the WPEF that you may not be taking advantage of. The following list shows some attributes of our Members area:

- You can only reference the most recent edition of the Foundation's newsletter Nutcracker Notes in the Members area. There is also a link to all past versions that resides outside the Members area. Adobe Acrobat versions of all past Nutcracker Notes dating back to 1993 are available. Also available is an index of all past articles in an Excel spreadsheet. There are currently 383 articles in this index.
- A page labeled "Board Business" contains several links of interest to WPEF members. Of particular interest is the WPEF Bylaws and our three year Strategic Plan. The current treasurer's report is here as well as several documents regarding federal tax status for our 501(c)(3) organization. Lastly, this page contains the minutes to Board meetings for the past 15 years.
- The WPEF BOD Handbook 2013 page contains a large amount of information about how the WPEF Board of Directors operates. This is a good resource for members to see what committees are available for volunteers. The Handbook also describes the duties of each of the Board of Directors positions; an excellent resource for those who are considering running for one of the BOD positions. Election procedures are also outlined.
- A nomination form for the current or most recent Board of Directors election is provided.
- A link to a brief PDF list of those current members as of the spring of each year is at the bottom of the page, called Members List 2015. This list provides limited information about who is a member of WPEF.

Please let me know if there is other Members Only information that you would like to see posted in this exclusive part of the WPEF web site.

Other Membership information: The current total membership for the foundation stands at 179 spread across our various membership categories. The membership total includes 36 members who reside in Canada. This is the greatest amount of members for this time of year in our history. Overall, membership has increased steadily over the years; even through the recent economic recession that saw membership in similar organizations decline. As membership increases, the Board of Directors are able to fund our restoration and education efforts to a greater degree.

THANK YOU, Members, for all of your support!

Pint Night for Whitebark Pine

If you missed it, you missed a good time! For the second year, WPEF was featured at the KettleHouse Brewing Company's Community Unite in Missoula on March 18. KettleHouse donated a portion of beer sales that night to WPEF for our critical education and restoration projects. We had a great time, with frequent whitebark pine swag raffles, merchandise sales, WPEF information and membership, all while enjoying great beer. Our thanks to KettleHouse for their donation, and to the community for coming out to support whitebark pine.

KETTLE HOUSE BREWING CO. MISSOULA MONTANA

ELECTION NEWS

By Cyndi Smith and Melissa Jenkins
Nomination and Election Committee

The Foundation recently held its first ever web-based election for the Board of Directors (BOD). Our web guru, JoAnn Grant, researched the options and set up a secure page on the Foundation's website for member voting. We then sent an e-mail to each member with instructions on how to vote. We also sent paper ballots to those members who have difficulty accessing the internet.

While there was only one candidate running for each vacant position – the Membership/Outreach Coordinator and one general board member – bylaw E.f.1 requires that acclamations must be ratified by a majority of members voting. This is in the bylaws so that the BOD is held accountable to the membership to run an election. The Nominating Committee tries hard to get multiple candidates for each position, but this is often difficult … as most of you know who are involved with small organizations!

Now… the results! We had 74 ballots cast from a possible 176 eligible members, for a 42% participation rate. When we mailed out paper ballots only, the participation rate varied from 53% to 67%. Thank you to those who participated in the new web-based election process. The BOD will be exploring ways to increase voter participation in future web-based elections. Remember to always read emails with the "@whitebarkfound.org" address and "Vote" in the subject line!

Bryan Donner was re-elected as Membership/Outreach Coordinator, and Shawn McKinney was re-elected as a general board member. We thank Bryan and Shawn for serving again. This will be their final terms in these positions, as the bylaws (F.a.2) only allow three 3-year terms in any given position.

As of September we will have two board-appointed general board member vacancies. We are looking for individuals willing to step up and be active in the Foundation … please forward any suggestions to me at cyndi.smith@whitebarkfound.org. These passionate, environmentally-minded people do not need to be working in the resource management field, as we need all kinds of expertise on the Board.

If you have any comments on the running of this web-based election, please let either Cyndi or Melissa (mmjenkins@fs.fed.us) know.

TREASURY REPORT December 31, 2014

Beginning BALANCE (Checking & Savings) 1/1/2014: $28,243.61

EXPENSES	
Accountant fee ($200 Donation Below)	$300.00
Advertising	$400.00
Annual meeting	$324.47
Annual State Registration	$15.00
Bank fees	$115.33
Grant Research Contract	$510.00
Mailing/operating expenses	$329.17
Membership expenses	$239.76
Nutcracker Notes	$864.64
P.O. Box fee - Yearly	$92.00
PayPal fees	$110.88
Symposium Support	$1,000.00
Travel - Plane fares and lodging	$3,013.33
Web site Mtnce WPEF	$1,803.88
Web UC Denver/USFS	$10,223.75
Total Expenses	**$19,342.21**

INCOME	
Calendars	$51.00
Donations	$1,149.00
Flight Reimbursement	$502.00
Interest Earned	$16.15
Membership Direct Checks & PayPal	$6,109.59
State Annual Registration Donation	$15.00
Symposium/Annual Mtg/Merchandise	$6,529.86
Web Reimbursement USFS	$24,990.54
Total Income	**$39,363.14**
Ending BALANCE 12/31/2014:	***$48,264.54***

Respectfully submitted,
Vick Applegate - Treasurer

Whitebark Pine in Northwest California

Ash Creek Butte, California

By Michael Kaufmann

Whitebark pine (*Pinus albicaulis*) is a long-lived and slow-growing tree found in upper montane to subalpine forests of southwestern Canada and the western United States. It regularly defines upper treeline and co-occurs with other conifers. Of the approximately 250,000 acres where whitebark pine (wbp) forms pure stands in California, >95% is on public land, often in remote wilderness settings on National Forest and Park lands; however, the acreage of the pine's presence in mixed-stands across the state is much greater.

Across the state, the species is found from 1,830 – 4,240m (6,000'-13,899') in the Sierra Nevada, Cascade, Warner, and Klamath mountains where it is an outlier of a much broader range (Arno et al. 1989, Murray 2005) from the more contiguous Rocky Mountains and Cascades in western North America. Within this range, the species prefers cold, windy, snowy, and generally moist zones. In the moist areas of the Klamath and Cascades, it is most abundant on the warmer and drier sites. In the more arid Warner Mountains and in the Sierra Nevada, the species prefers the cooler north-face slopes and more mesic regions.

The Klamath Mountains of northwest California and southwest Oregon are unique compared to other temperate mountain ranges in western North America. The region nurtures one of the most biodiverse temperate coniferous forests in the world. The species richness is possible because of a range of climates, varied topography, and complex geology. The region's climate is generally Mediterranean with dry, hot summers and cool, wet winters. Topography is often steep, with swift rivers cutting big-shouldered canyons with snow-covered summits crowning the mountain tops.

Geology is complex with an unusual combination of rock types created by frequent tectonic uplift. Lastly, the Klamath Mountains have a central location, and continuity within, other mountain ranges along the Pacific Slope. This nurtures a mosaic of habitats at a crossroads of five biotic regions that includes the Cascades, Coast Range, Great Basin, Central Valley, and Sierra Nevada.

Because of the interaction of these abiotic factors, the Klamath Mountain's flora holds long-enduring lineages that have survived here for millions of years. Botanists have documented over 3,000 kinds of plants including 100 tree species, with 39 conifers and 22 oaks. This includes 4 of 6 five-needle pine species in California (foxtail, sugar, western white, and whitebark pines).

Conifer associates within this region include white fir (*Abies concolor*), Shasta fir (*Abies magnifica var. shastensis*), mountain hemlock (*Tsuga mertensiana*), Lodgepole pine (*Pinus contorta*), western white pine (*Pinus monticola*). The Klamath endemic foxtail pine (*Pinus balfouriana*) which are nearly synonymous with WBP, and rarely Brewer spruce (*Picea breweriana*), subalpine fir (*Abies lasiocarpa*), Douglas-fir (*Pseudotsuga menziesii*), and Pacific yew (*Taxus brevifolia*) are also associates. When present, white and Shasta fir along with mountain hemlock

NorCal continued next page

are typically young recruits that appear to be pioneering habitat (encroaching) upon stands of whitebark pine.

Whitebark pine is a species of concern in the state of California. Region 5 of the U.S. Forest Service has listed this species as Sensitive, requiring management to prevent its federal listing as Threatened or Endangered. In this vast region populations survive on isolated mountaintop, often in wilderness, where they are subject to the effects of a changing climate, bark beetle infestations and blister rust invasions.

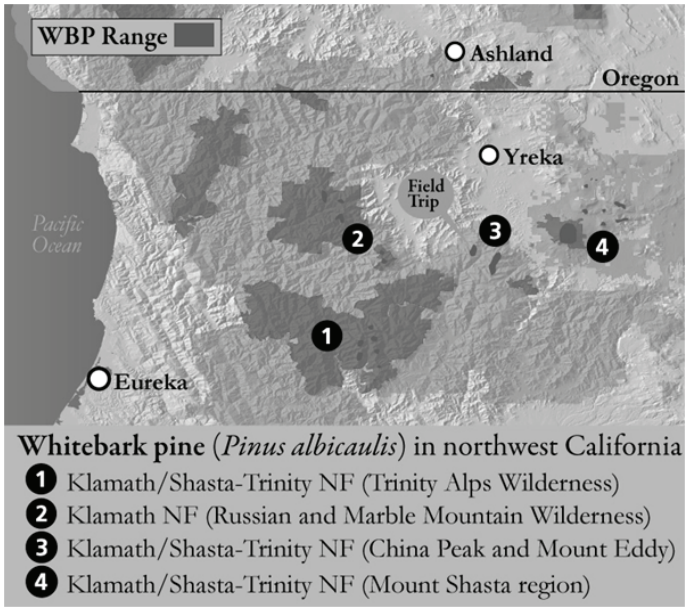
Fire has been a rare occurrence in whitebark pine stands the past 100 years in the Klamath Mountains but in the summer of 2014 multiple fires occurred, some burning stands of whitebark pine in the Russian and Marble Mountain Wilderness areas.

In the summer of 2013, I surveyed for whitebark pine across northern California including stands in the Klamath, Shasta-Trinity, Modoc and Lassen national forest where they inhabits a variety of ecological niches based on climate, geography, geology, and the synergistic effects of competition from other species. All of these niches, created primarily by elevation, are often "sky islands" that provide small-scale, isolated habitats for WBP across these forests (see fig. 1).

The first generalizable habitat type is in the Cascades (east of I-5) where whitebark has been found between 1,980-2,590m (6,500-8,500ft). The upper elevation for the species (outside of the flanks of Mount Shasta) is limited by the height of the peaks themselves. On Mount Shasta, where nearly half of the habitat in the Shasta-Trinity occurs, the trees range from 2,135-3,000m (7,000-10,000ft). Here, the species may be expanding upslope and are also on a parasitic satellite cone called Black Butte at 1,920m (6,300ft) (Griffin and Critchfield 1976).

In the Klamath Mountains (west of I-5), the range of elevations is slightly broader at 1,825-2,743m (6,000-9,000ft) but is again limited as the highest peaks including Thompson Peak and Mount Eddy, at 2,750m (9,023ft). WBP prefers granite in the Klamath but are occasionally found on mafic and ultramafic soils.

What follows is a summary of the most northerly populations of whitebark pine in California, including within the Crater Creek Research Natural Area, where one of the fieldtrips are scheduled in conjunction with the 2015 WPEF workshop.



Whitebark pine (*Pinus albicaulis*) in northwest California

1. Klamath/Shasta-Trinity NF (Trinity Alps Wilderness)
2. Klamath NF (Russian and Marble Mountain Wilderness)
3. Klamath/Shasta-Trinity NF (China Peak and Mount Eddy)
4. Klamath/Shasta-Trinity NF (Mount Shasta region)

Figure 1- Range of whitebark pine in Northwest California

1. Shasta-Trinity National Forest: Big Bar Ranger District - the Klamath Mountains

Whitebark pine sparsely inhabits the highest elevations of the Trinity Alps wilderness along the boulder-laden granitic ridgelines above Canyon Creek and northward to Caribou Mountain and surrounding high-elevation landmasses.

Seemingly suitable high elevation habitat (>7,500') exists in the Red Mountain, Middle Peak, Granite Peak, and Gibson Peak region as well as the mountains around Foster and Lion lakes but, while numerous western white and foxtail pine inhabit this landscape, WBP are not found. The absence of the species here is probably due to the serpentine substrate as well as increased competition from other conifers like firs, hemlocks, western white and foxtail pines.

The only survey of the granitic high country was done around Mount Hilton and, while blister was present in low percentages (~5%), individual trees were overall healthy. It appeared that these trees are, on average, too small and often too isolated to invoke large-scale mountain pine beetle infestations in all but a few areas. The most contiguous habitat in the granitic White Alps is found on the ridgelines south of Papoose Lake and the south-facing flanks of Thompson Peak and Caribou Mountain. These stands should be monitored because they hold larger specimens that would be more susceptible to MPB attack.

NorCal continued next page

NorCal continued from page 8

2. Klamath National Forest: Scott River Ranger District - the Klamath Mountains

Though time in the Marble Mountains was limited by weather, extensive ground-truthing around Boulder Peak was done. This high table-land is one of the most important habitats for WBP in all of the Klamath Mountains. I estimated the overall mortality of five-needle pines to average 5% for whitebark (MPB) and 10% for foxtail pine (MPB). Other enriched montane forest associates between Upper Wright Lake and Boulder Peak include white fir (*Abies concolor*), Shasta fir (*Abies magnifica var. shastensis*), subalpine fir (*Abies lasiocarpa*), and mountain hemlock (*Tsuga mertensiana*). These associates do not occur together in this combination anywhere else in the world! This population must be the main feeder for all the other meta-populations isolated on nearby mountaintops and ridgelines across the northern Marble Mountains. Due to the fecundity (at least historically) and extensive size of this population center, Clark's nutcracker were common and must consistently spread seeds to nearby, lower elevation mountain tops, thus sustaining isolated microsites where trees eke out an existence on the last remaining sky island habitats. Box Camp Mountain is a fine example of this phenomenon.

3. Shasta-Trinity National Forest: Mount Shasta Ranger District (Mount Shasta, Mount Eddy region and China Mountain) – The Klamath Mountains

At just over 6,000 acres the subalpine landscape centered around Mount Eddy provides the most contiguous high-elevation habitat for whitebark in the Klamath Mountains. Here whitebark pine are found with other dry-site conifers such as lodgepole pine (*Pinus contorta ssp. murrayana*), western white pine (*Pinus monticola*), and foxtail pine (*Pinus balfouriana ssp. balfouriana)*. Because of the xeric nature of this habitat, WBP interacts with numerous pine species and there is an increased potential for the vectoring of pathogens—such as MPB and WPBR—into and across the high elevations of the Scott-Trinity Mountains. Because this is rare and fragile habitat, the Shasta-Trinity and Klamath national forests should explore securing wilderness designation for Mount Eddy and surrounding mountains. At the time of this writing, a permanent plot to monitor WBP has been set by Cynthia Snyder and Danny Cluck. Otherwise, no known permanent plots have been set up in the Klamath Mountains.

South China and China mountains (where the field trip will go) as well as Mount Eddy are composed of the oldest mafic and ultramafic soils in the Klamath Mountains. Because of the harsh soil type, WBP are surviving on less than ideal habitats. Unlike other regions of the north state where once vigorous trees are dying on the north slopes due to bark beetles, on serpentine trees are often restricted to the south-facing slopes. This habitat supports the most vigorous and healthy specimens away from the competition of other conifers like firs and hemlocks, which occur more commonly on north slopes. Mortality from MPB and infection from WPBR was found within the small, isolated population on the south slopes of South China Mountain. Both South China and

NorCal continued page 26

Trinity Alps Wilderness near the summit of Mount Hilton

Fox scat containing whitebark pine nuts.

Aerial photograph of Beartooth Butte at the center of the study area.

***Red Fox** continued from the front page*

Park have long noticed the lighter blond coat colors and gray underfur of its foxes living at high elevations compared to the rich red found at lower elevations*(2)*, and recent genetic studies have revealed significant differences between foxes across an elevational gradient within the ecosystem*(3)*. Suspecting that behavioral differences could be contributing to these observations, we wanted to compare genetic and habitat use patterns high in the Beartooths to those lower down in Yellowstone*(4)*, hoping to identify the mechanisms driving this diversity.

But as we skied closer, I noticed that there was something odd about this scat. It was not composed of the fine gray hair and tiny bones one would expect from a predator of small rodents; instead it prickled with rigid, angular, broken bits of brown shells. If it wasn't for its small size and its being found in the wrong season, it could have been mistaken for a late-summer grizzly bear scat. This fox scat was packed with crunched whitebark pine nuts.

Later, over beers at the Miners Saloon in Cooke City, Montana, we reported our discovery to Jesse Logan, an expert on the area's whitebark ecology as well as its trout fishing and powder skiing.

"I think you are on to something here," Jesse said, encouraging us to continue documenting this apparently novel behavior, which was easy to do since the whitebark pine nuts would have a major effect on fox activity throughout the rest of the winter.

In the following months, we found pine nuts in nearly half of the 30 scats collected across the territories of multiple foxes, often in large quantities accounting for most or all of the scat's content. And on several occassions, our snow tracking surveys even led us deep into the forests, far from the edge territory that foxes generally prefer, to the raided red squirrel middens that had yielded the nutritious food. The snow around these sites, which were usually at the base of a grand old spruce or whitebark, would be packed down from so many fox tracks and have cone bracts, bark, needles, and other debris from the excavated midden strewn all over its surface. There would also be short trails leading away from the midden to smaller packed down rest sites where the fox would carry a whole cone, pull off its waxy, purple bracts, pluck out the seeds, and drop the empty husk before returning to the midden for another. Surely this was a more effective way to obtain calories than by diving through the deep snow after a small, scurrying vole. And foxes were not the only carnivores enjoying pine nuts that winter: we also observed several American marten scats that were obviously loaded with pine nuts.

The following winter, we did not find any pine nuts in the fox scats collected, but this was expected since we had not heard as many raucous Clark's nutcrackers that summer, nor did we see the overloaded tree tops like we had the summer before. Whitebark pine often exhibit the cyclical reproduction strategy known as 'mast seeding' in which cone production is high in some years and low in others so as to discourage seed predators from settling in*(5)*. Although there is substantial variation in these cycles from whitebark stand to stand given their site-specific environmental conditions*(6)*, researchers from the Interagency Grizzly Bear Study Team conducting cone count transects throughout the ecosystem rated the first year of this study

Red Fox continued on page 11

***Red Fox** continued from page 10*

(2012-2013) a "generally good cone production year" for the ecosystem, while the following year was rated a "generally poor cone production year."*(7,8)* That second winter, the foxes consumed more snowshoe hare, which seems like a formidable advisary for a predator that, at about 9 lbs (4 kg), is no bigger than the average house cat: they may look bigger, but it is all fluff. Nevertheless, we recovered snowshoe hare remains from over 70% of fox scats that winter, compared to less than 25% the winter before. Also that winter's field tech, Jake Kay, and I both recorded numerous kill sites while snow tracking, yet neither of us found any excavated squirrel middens.

Almost everyone who has seen these foxes, or even just their tracks, in such an extreme environment has wondered, *What do they eat up here all winter?* And clearly the answer is whatever they can find. Surviving in the subalpine requires a fair deal of adaptability, which is something that the red fox, the most widely distributed terrestrial carnivore in the world*(9)*, excels at.

So it was not surprising when, at the completion of its metamorphosis from raw field data to spreadsheets to statistical analyses, we found significant variance in the food items consumed between the two winters of this study. But we were surprised when we likewise analyzed the habitats used between the two winters and again found statistically significant variance. During the first winter when whitebark seeds were available, there was a significant spike in the usage of mature spruce-fir cover types, while the following winter saw a more even distribution of habitat useage as the spike in mature spruce-fir leveled off and more mid-successional forest stages were used. To understand why, we turn to red squirrel ecology.

Because of interannual variance in whitebark cone production due to mast seeding, pure whitebark stands are generally considered poor squirrel habitat since they lack the diversity of food types needed to sustain squirrels during low cone production years*(10, 11)*. And where there are no squirrels, there are no squirrel middens. Spruce-fir cover types, on the other hand, often have a significant whitebark component in addition to more consistent but less nutritious food sources*(12)*. This makes them better squirrel habitat and the most likely places where whitebark seeds would be available to foxes, thus explaining the significant spike in spruce-fir habitat use corresponding with the significant spike in whitebark pine nut consumption.

Ever since we found that first nutty scat high on the Beartooth Plateau, we were excited since it was, to the best of our knowledge, the first time foxes were recorded using whitebark pine nuts, adding them to the long list of animals that directly benefit from whitebark pine*(13)*. But the combined results of these statistical analyses are far more profound since they suggest that, beyond simply using this novel food source, the foxes were actually changing their habitat use behavior in response to its availability. Perhaps this is a clue pointing to why these high elevation foxes are distinct; perhaps they have evolved in this landscape where whitebark pine play such an important role; perhaps the foxes themselves, like the Clark's nutcrackers, red squirrels, and grizzly bears, play an interactive role in this particular system. In reality, these findings do more to raise new questions than they do to answer our original questions, which may just be the result of good science, but we can be confident that whitebark pine nuts are an important resource facilitating the persistence of this fox population in such an extreme environment.

Red Fox continued on the next page

Red squirrel midden excavated by red foxes on the Beartooth Plateau.

Closeup of excavated red squirrel midden.

Should the Beartooth Plateau experience the dire whitebark declines that have happened in other parts of the Greater Yellowstone Ecosystem, the adaptability of its remarkable population of red foxes will be put to the test.

Another photo of Beartooth Butte, this one from the ground and framed by the silhouete of one of my favorite whitebarks in the area.

This past spring, I met up with Jesse again at the Miners, and this time he had questions for me: how cold did it get up there last winter? what is the snowpack like right now? did you see any blood red brood trees infested with mountain pine beetles? When he later returned from a day of bark chipping on the Beartooth Plateau in the very area where the fox-excavated squirrel middens were located, his report was grim: wriggling beetle larvae were thriving in those high forests unaccustomed to the epidemic pest. Should the Beartooth Plateau experience the dire whitebark declines that have happened in other parts of the Greater Yellowstone Ecosystem*(14)*, the adaptability of its remarkable population of red foxes will be put to the test.

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Chainsaws & Fire for Restoring Whitebark Pine: Lessons Learned

Ignition of slash in Burn Block 1.

Carly Aniballi - ***Silviculture Forester, Lolo National Forest***
Bruce Erickson - ***Silviculturist, Lolo National Forest***
Robert Keane - ***Research Ecologist, Rocky Mountain Research Station***
Nancy Sturdevant - ***Entomologist, USFS, Forest Health Protection***

After nearly a century of being ignored, Mink Peak is seeing more than its fair share of attention. Beginning in 2010, the whitebark pine stand at Mink Peak on the Superior Ranger District of the Lolo National Forest has seen a flurry of activity.

The 6,863-foot elevation Mink Peak, located about 12 air miles southwest of Superior, Monana, is home to a 150 acre stand of 90-year old whitebark pine. The whitebark pine 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.

The stand is host to a mix of projects, all focusing on whitebark pine restoration. The projects include:

- Three rust-free trees selected as plus trees in the Tree Improvement breeding program for blister rust-resistant whitebark pine.

- A long-term RMRS research study exploring the effects of various management treatments on growth and development of whitebark pine. Treatments include: (1) control, (2) daylight within 15 feet of selected whitebark pine trees and (2a) lopping and scattering slash or (2b) prescribed burning of the slash, and (3) prescribed underburning to reduce stocking of competing conifers.

- A short-term field study to explore the effectiveness of pruning whitebark pine to allow

***Lessons** continued on next page*

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 fuel accumulations and provide opportunities for whitebark pine regeneration.

The daylighting was completed in 2012 (see Nutcracker Notes Issue No. 24). The treatments for the pruning study were also completed in 2012 on thirty trees each of (1) controls, (2) daylight but unpruned, and (3) trees daylighted and pruned to at least 12 feet or ½ of total crown, which ever was less. All trees within the pruning study were selected randomly from mountain pine beetle-susceptible trees over seven inches in diameter that had no stem cankers.

So what happens when you burn whitebark pine stands? What if you thin them first? What if you pruned them? The intent of the Mink Peak burning was to burn the pockets of slash with as little mortality to the whitebark pine as possible and still achieve an understory burn that left a mosaic of at least 50% of the unit black. The goal was to achieve no more than 30% mortality in the whitebark pine with no mortality limit on any other species. To facilitate this, crews chose to burn in late September.

The underburning was completed in September 2014 and took place in two blocks. The first block completed burning in the daylight/underburn treatment area of the study. The following week, crews completed the second burn block that consisted of the underburn-only treatment area. Burning was monitored by District silviculture personnel and post-burn measurements were taken to assess scorch. Scorch was estimated as a percentage of: circumference of the root crown, circumference of the bole at breast height (d.b.h.), and total live crown.

Burn Block 1 – Daylight/Underburn

The daylight burn block experienced mixed fire severity, which appeared to be influenced by site topography and related temperatures and fuel moisture.

The north end of this treatment block is heavy to MEFE with a little bit of alder. While it was not expected to burn as well as the south end, this area acted as a heat sink for fire behavior. The fire did not carry well through the understory, despite adequate, dry slash. The burn in the north end of this treatment block resulted in a spotty, jackpot burn. This portion is predominately north-facing, and at the time of ignition, was still partially shaded.

The south end of Burn Block 1 is a different story. Here, the temperatures were notably higher as it receives sunlight for a greater portion of the day due to its southwest aspect, position closer to the ridge top, and open stand conditions as a result of slashing. The ignition resulted in a moderate to high burn severity, with an estimated 60-90% duff and fine fuel consumption.

Regardless of their location within the burn, whitebark pine that received both daylight and prune treatments more frequently experienced bole scorching. Pruning took place two years prior to burning. The pruning of live branches resulted in pitching from the wounds that streamed down onto the boles. Consequently, the pitch increased the likelihood of bole scorch as a result of burning. Sixty-four percent of pruned whitebark pine had some level of bole scorch compared to 40% of daylighted whitebark pine.

Lessons *continued page 15*

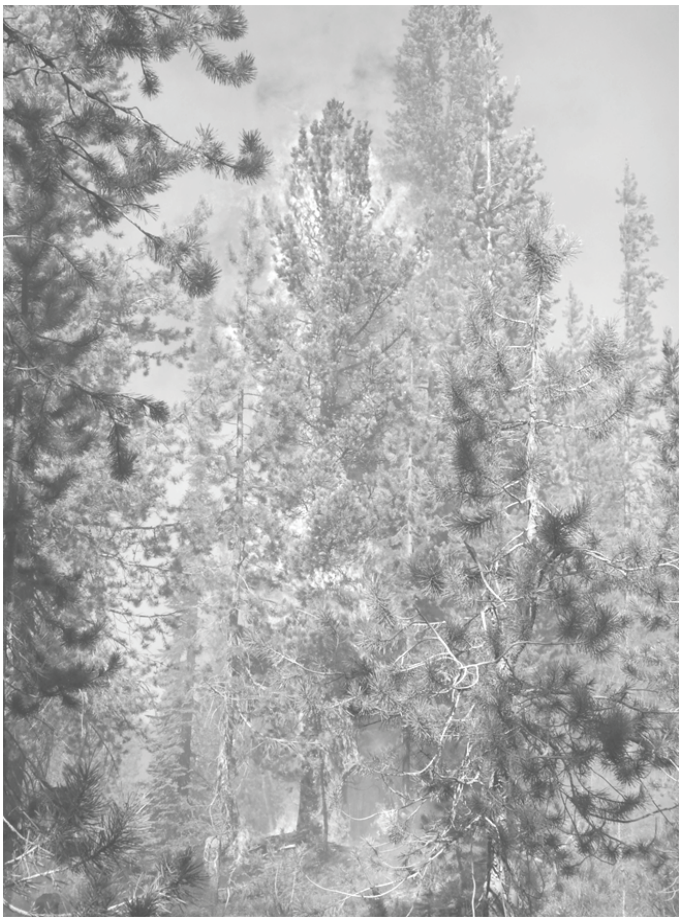
Table 1.

Treatment -- % of Trees:	w/Root Crown Scorch	w/ Bole Scorch	w/ Crown Scorch
Daylight/Underburn	80%	40%	100%
Daylight/Underburn/Prune	82%	64%	91%
Underburn Only	95%	41%	77%

Table 2.

Treatment	Average Root Crown Scorch	Average Bole Scorch	Average Crown Scorch
Daylight/Underburn	68%	30.5%	44%
Daylight/Underburn/Prune	70%	29.5%	43.6%
Underburn Only	82.7%	27.3%	22.9%

So what happens when you burn whitebark pine stands? What if you thin them first? What if you pruned them?



Whitebark pine tree torching in Burn Block 1.

***Lessons** continued from page 14*

Burn Block 2 – Burn Only
More uniform in aspect and slope position, Burn Block 2 experienced a low to moderate severity burn across the entire unit. Squarely north-facing, the burn block is a spotty, jackpot burn very similar to the northeastern half of Burn Block 1. Despite the similarity in burn severity and surface fuel consumption (20-35%), the whitebark pine in Burn Block 2 experienced more frequent scorch, with 21 of 22 trees receiving some level of scorch. During burning, adjacent conifers frequently acted as ladder fuels and avenues for the fire to reach the whitebark pine.

Lessons Learned:

(1) Burning without slashing results in jackpot burning with a wide range of root crown, bole, and canopy scorch.

(2) Slashing prior to burning results in a good underburn with fairly high scorch.

(3) Slashing and pruning prior to burning almost guarantees high rates of bole scorch.

In order to achieve effective burns in whitebark pine that provide openings for regeneration, most whitebark pine stands will likely need to receive mechanical treatment, i.e. slashing, before burning. Additionally, slashing can reduce ladder fuels to alter fire behavior, and slashing can reduce stand density to increase growing space and reduce bark beetle hazard.

If burning is planned for fall, consideration should be given to slash treatment after felling. Typically, slash is lopped and scattered to facilitate drying and prevent Ips spp. population build-up and the resulting fuel bed tends to be compact. However, leaving the fuel loose and choosing not to lop and scatter may enable fuels to dry out faster due to increased air flow following precipitation. In the case of Mink Peak, the compact fuel bed, fuel moistures following rain in September, the dry time needed, and shorter days greatly affected crews' ability to burn. Fuel crews were left with a very narrow burn window in which to achieve the objectives of the burn. The depth and compactness of the fuel bed had relatively little influence over burn severity.

While pruning whitebark pine has shown to be effective in reducing susceptibility to mountain pine beetle attacks, it exposes the thin-bark to more frequent bole scorch. This could increase potential mortality and susceptibility to bark beetles. We will be monitoring mortality this coming summer to access any subsequent bark beetle activity and scorch-related mortality in the whitebark pine.

Protecting & Restoring Whitebark Pine at Grouse Mountain

Karl Buermeyer
Zone Vegetation Manager, USDA Forest Service

The Grouse Mountain Whitebark Pine Restoration Project (Grouse Mt) is located approximately fifteen miles southeast of Moran Junction in northwestern Wyoming, on the Blackrock Ranger District of the Bridger-Teton National Forest. The project area encompasses 2,000 acres on the western slope of 10,337-foot Grouse Mountain (Figure 1).

The goal of the project is to conduct vegetation management activities to restore whitebark pine to functional and self–sustaining stands following decades of fire suppression and competition from other tree species, as well as a particularly severe mountain pine beetle outbreak. Taking advantage of advanced regeneration, promoting natural regeneration, protecting as many existing whitebark pines as possible from mountain pine beetle and fire damage, and promoting crown development will aid in this recovery. This project, in partnership with the Rocky Mountain Research Station in Missoula, Montana (RMRS), provides an opportunity to demonstrate and investigate techniques applicable to whitebark pine restoration projects in other areas. It is a "sister project" to the Mink Peak study, also described in this issue, as part of the Daylite Study headed by Bob Keane at the RMRS.

Treatments as part of the Grouse Mt. project include:

• Daylighting – This involves clearing 20-30 feet around sapling and mature whitebark pine trees to reduce competition and promote crown development, protect them from crown fires and severe scorching, increase sunlight to raise bole temperatures and discourage mountain pine beetle attack, and decrease relative humidity and susceptibility to white pine blister rust. This activity is being conducted in clearcuts harvested in 1973 that have been regenerated to primarily lodgepole pine, but contain a healthy component of naturally seeded whitebark pines, as well as in mature natural forest stands.

• Nutcracker openings – These are openings from ½ - 2 acres, created in mature forest stands to promote the caching of whitebark pine seeds by Clark's nutcracker and to provide a competition-reduced environment for the growth and development of whitebark pines. Any existing mature or understory whitebark pines are, of course, retained.

Grouse Mountain *continued on page 17*

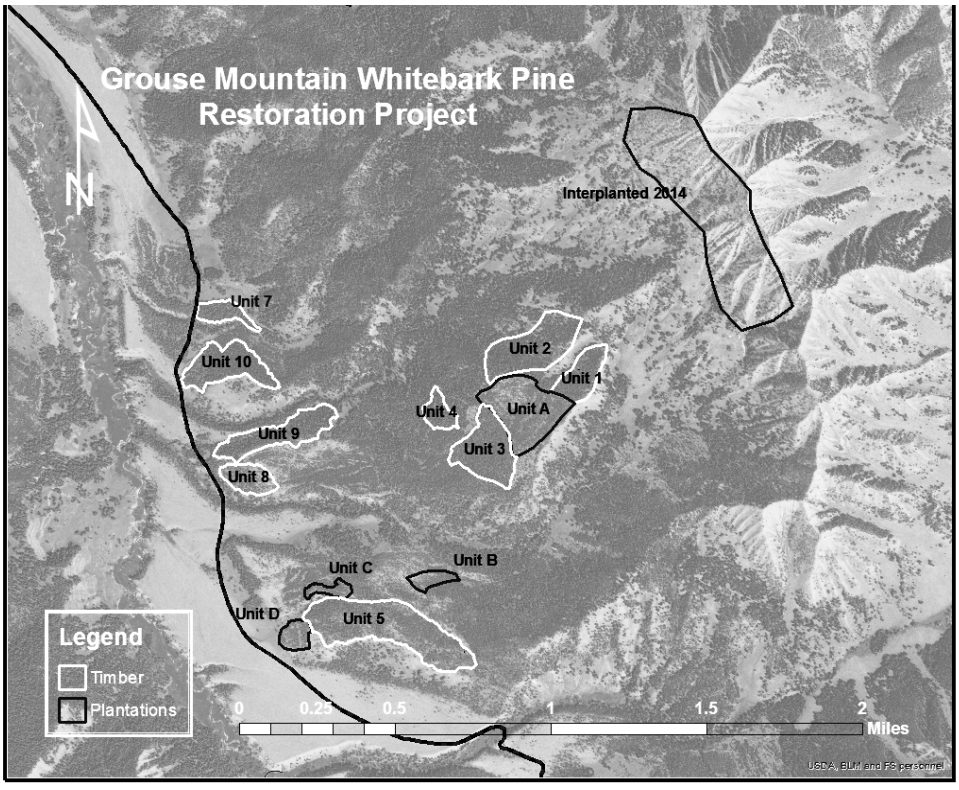


Figure 1: Activity units on Grouse Mountain

***Grouse Mountain** continued from page 16*

These treatments are prescribed in mature, mixed species stands totaling about 100 acres, and daylighting in lodgpole pine plantations totaling about 40 acres. In general, daylighting occurs where whitebark pines are mixed with other species, and nutcracker openings in portions of the stands where whitebark pine is largely absent.

• Underburn – Fire has been prescribed in Unit 1 (Figure 1) as a comparison to the mechanical treatments described above. An underburn would remove competing vegetation in the understory and kill more susceptible subalpine fir in the overstory. The prescribed burn is planned for fall 2015.

• Interplanting – Planting of two-year-old containerized whitebark pine seedlings was prescribed for the upper slopes of Grouse Mt. on the eastern side of the project area. These steep gravelly slopes contained nearly pure stands of whitebark pine with almost 100% mortality of trees greater than 6" in diameter due to mountain pine beetle around 2008 and 2009. Sparse advanced regeneration is present, so planting where dead trees and down logs provide microsites (shade and moisture retention) will help fill in areas where no young whitebark pine exist. Although mountain pine beetles have caused heavy mortality in lower-elevation stands as well, these stands either have whitebark pine in the understory already, or too much competition from subalpine fir to successfully plant without a significant investment in removing the competing vegetation.

• Clearcut with Reserve Trees – Two of the units had such heavy mortality in the overstory that it was decided to remove the overstory, reserving about 20% of the live mature trees for structural diversity. One of these units had a considerable component of whitebark pine in the understory. (Interestingly, it has no mature whitebark pines in the overstory.) While not included in the Daylite Study, the Forest will monitor to see how these seedlings and saplings respond to release, having been suppressed in the understory for up to 100 years (although many appear to be only several years old). One of the major unanswered questions concerning whitebark pine restoration is the ability of this moderately shade-tolerant species to recover from being suppressed in the understory for a number of years. Most of the second unit has no advanced

Daylight Unit 3

regeneration, and will be planted to whitebark pine.

The scheduled implementation of the Grouse Mt. project is behind that of the Mink Peak study. Planning and environmental documentation was completed in May of 2012 and the pre-treatment study plots installed that summer along with the marking and cruising of the treatment units. Obstacles to implementing the treatments have primarily centered around its remoteness, and the amount and quality of the timber products it has to offer. The nearest large lumber mill is 250 miles away, reducing the incentive for timber purchasers. The two clearcut units, being close to the main access road have been sold, but not yet harvested. While some of the nutcracker openings have high quality lodgepole pine to harvest, many contain a large component of subalpine fir, not a favored timber or firewood species. Attempts to accomplish the treatments through fuels management contracts and stewardship contracts (where the value of the timber is used to offset a portion of the cost of performing the work) have both failed to garner any bids, due apparently to the distance to travel and relatively small amount of work. In order to expedite the process of collecting data for the Daylite Study, those units that contain study plots have been treated by the local Forest Service Fuels Module; and daylighting in the plantations, with relatively smaller trees, was accomplished by a Wyoming Conservation Corp student crew in the summer of 2013.

Since these units are farthest from the main access road (Units 3 and A in Figure 1), one advantage is that it was unnecessary to reopen an old 1973 logging road; all work was accomplished by crews on foot. To minimize slash buildup, since none of the trees can be removed from the

***Grouse Mountain** continued on page 21*

American Forest's Endangered Western Forests Program highly involved in restoring whitebark pine ecosystems

American Forests is celebrating our 140th anniversary this year. Over those 140 years, we have been dedicated to the protection and restoration of threatened forests ecosystems both nationwide and globally. Planting nearly 50 million trees in all 50 states and in 45 countries is impressive, but I would argue our more focused work on some of the highest-valued forests — like the whitebark pine ecosystems — is where we have made the biggest impact.

American Forests first warned of the damage of blister rust in a 1917 edition of our magazine and tracked the issue for many years. We began supporting the planting of whitebark pines in 1999, and since our first whitebark planting project in the Targhee National Forest, American Forests has planted more than 245,000 whitebark pines.

From the beginning, American Forests' goal has been to support projects with the greatest impact on the health of threatened ecosystems — and whitebark pine will most certainly remain at the top of our list. We look forward to watching this majestic species recover and thrive.

Though we had recognized the threats to and importance of the whitebark pine, it wasn't until after we submitted our comments on the addition of whitebark pine to the endangered species list that American Forests began developing a more targeted campaign. In early 2012, we developed our Endangered Western Forests program, which is dedicated to the protection and restoration of the whitebark pine.

Over the last three years, our Endangered Western Forests program has worked with the Whitebark Pine Ecosystem Foundation and the Greater Yellowstone Coordinating Committee's subcommittee on whitebark pine to determine high-priority projects within the Greater Yellowstone Area. Through these partnerships, American Forests has had the opportunity to support incredible on-the ground work.

In addition to the thousands of disease-resistant whitebark pines we've helped plant, we've supported the update of the Greater Yellowstone Whitebark Pine Strategy and the purchase and distribution of more than 15,500 pheromone patches. We supplied the materials for the irrigation system at the Little Bear Nursery and provided crews with useful supplies and equipment to make their jobs safer and more efficient. In addition, we have supported the study of water availability at whitebark planting sites, surveyed the survival rate of direct-seeding projects, and gauged the rate of natural regeneration on state lands. For 2015, American Forests is working to support high-priority cone collection, distribution of SPLAT (a new beetle protection option), and modeling climate change within whitebark pine ecosystems.

As this program moves forward, American Forests plans to not only expand our Endangered Western Forests program beyond the boundaries of the Greater Yellowstone Area, but to replicate it in other ecosystems as well. As we update our strategic plan, we will look to our partners to help identify high-priority projects within the whitebark pine ecosystem.

From the beginning, American Forests' goal has been to support projects with the greatest impact on the health of threatened ecosystems — and whitebark pine will most certainly remain at the top of our list. We look forward to watching this majestic species recover and thrive.

Jami Westerhold, Senior Director of Forest Restoration
American Forests 202-370-4516
jwesterhold@americanforests.org | americanforests.org

Whitebark & Limber Pine Experience and Outreach in the Canadian Rocky Mountain National Parks

By Brenda Shepherd
on behalf of the Whitebark and Limber Pine Network for the Mountain National Parks

"No one will protect what they don't care about. And no one will care about what they have never experienced."

- David Attenborough

The author, Brenda Shepherd, atop a whitebark pine...in awe.

Five-needle Pines: Not Just for Nerds

Let me tell you a story. I was in Banff last February for my daughter's ski race and I met up with a long-time friend who is also a biologist. As we sat quietly in the corner of the restaurant catching up, a guy left his buddy sitting at the bar to chat with us, helped possibly by liquid-courage. Within one minute we knew his story: he drives a party-bus every weekend from Edmonton to Banff, promising young 20-somethings an "epic" ski trip on a licenced bus. From there our conversation turned to whitebark pine. No…really, and he started it, not me.

When he discovered we were biologists he asked, completely out of the blue, "So can you tell me if those are limber or whitebark pine growing along the road from Rocky Mountain House?"

For the next half-hour we talked about five-needle pines. When he drove the bus trips past those stands, he talked about "his" trees to the party-goers, so he was pretty happy to be able to get the species right now; they are his favourite trees. My point is this: I am surprised again and again at how these trees move people once they make a connection to them. If effective conservation is enabled through a large constituency of caring people, then we are lucky, because we work on species that easily stir people to care.

Outreach and Education – Does it make a difference to Conservation?

At its best, experience and outreach create both a connection for people and turn those connections into tangible support for conservation. Research demonstrates that contact with nature is essential in developing values and attitudes that support conservation; people care about what has meaning in their lives (Thompson, et al. 2008, Cheng and Monroe 2012, Ipsos Reid. 2013). Just as many meaningful adult connections develop in early childhood (Wells and Lekies 2006), there is good evidence to support the notion that child-oriented environmental education influences knowledge, understanding and behaviour in adults (Damerell et al. 2013).

It is evident that connectedness to nature is an important predictor of environmentally responsible behaviour (Frantz and Mayer 2014), but is this enough to conserve species?

In one case, Trewhella et al. (2005) achieved conservation through environmental education for endangered bat populations. They found improved awareness, knowledge and policy led directly to a greater

***Outreach** continued on next page*

capacity to carry-out conservation manifested in reduced hunting losses. In contrast, Howe (2009) measured the behavioural intention of people as a practical measure of conservation success. She found that both formal and informal conservation education had an effect on conservation success, but this was dependent upon the type and amount of education provided, and ultimately, funding.

There are a growing number of case studies that demonstrate that targeted behaviour-change campaigns in particular have successfully protected habitat, improved water quality and reduced harvesting (Veríssimo 2013). While environmental education and outreach has already had important conservation effects, there is a need for stronger empirical evaluation of conservation investments, including education and outreach (Salafsky et al. 2002, Ferraro and Pattanayak 2006, Veríssimo 2013).

Effective Conservation Outreach and Experience:
I ♥ whitebark pine

Outreach and education can be effective, but it depends on what it is and how it's done. A new approach to biodiversity communication suggests we need to radically change our messages to radically motivate action (Futurra Sustainability Communications 2010).

Their approach uses four themes; more love, less loss, target need, and add action. Based on the psychological and sociological responses to communication, this approach engages and inspires, rather than informs. It builds on awe and fascination for nature and the way it makes people feel.

Extinction messages, while important, aren't motivators for change while love messages work by reconnecting people to experiences in nature, even those from their childhood. Ultimately, people want to conserve nature because it makes them feel good. Messages that instil the need for conservation are important for policy makers and businesses but are less effective with the general public. Call to action messages are the clincher, especially as a way of delivering positive feelings back into people's lives, inspiring them to become supporters, funders, doers, and to change their behaviour.

Our Whitebark and Limber Pine Experiences and Outreach

The Canadian Rocky Mountain National Parks are working to restore whitebark and limber pine by building resistance to blister rust, planting seedlings and using prescribed fire. But this is not the message that inspires. We also need to build a constituency of whitebark and limber pine lovers and supporters. We focus our experiences on conjuring a sense of awe and wonder in people, creating the connections that count toward inspiring action.

1. The Nutcracker Sweeeet: A Street Theater

Once upon a time, a lonely tree fell in love with a beautiful bird, and their love grew into a mutualistic relationship that kept the bird fed, and the tree reproducing. But all was not well in the forest. Evil blister rust and mountain pine beetle lurked at the edges, threatening the existence of the tree, and all of her kin. Along with a diverse cast of characters, costumed park interpreters bring this emotional and tragic story to the streets of Jasper every summer day. The simple message is that love will conquer all. The intent is to connect thousands of visitors through their involvement in the play and the story to a tree. Perhaps this connection will inspire some to seek out the trees, explore the trails and spot the love-struck nutcrackers.

2. Geocache

Geocaching is a high-tech treasure hunting game played around the world by adventure seekers. The basic idea is to locate hidden containers, called geocaches, and then share experiences online. Anyone can use coordinates found on geocaching.com to find the caches by visiting whitebark stands where they decode the messages left by the supreme natural geocacher, our very own, Clarke's Nutcracker. Record the code word from at least four of these sites and earn a collectable coin.

3. Portable Exhibit

When people can't come to the park, we go to them where they live. We have designed a large interactive exhibit focused on whitebark pine, caribou and fire, for use in science centers, zoos, and festivals. Hosted by national park staff, the exhibit draws in visitors using videos, interactive props and games targeted to children and adults. It concludes with a puppet show stage where children connect to nutcracker, fire and grizzly bear puppets to act out the whitebark pine story.

4. Ski and See a Whitebark

Glacier National Park, Canada, is home to big power and whitebarks. Before skiers venture into the backcountry,

Geochache Coin

***Outreach** continued on next page*

***Outreach** continued from page 20*

permit holders take a quiz to ensure they comply with the permit system. While the quiz focuses on safety, skiers are also asked: "What should you do if you come across a whitebark pine skiing?" Optional responses are: Take a branch to show your friends, place your up-track close to the tree so that weaker skiers can use it for support, make a "kaka" sound to attract Clark's Nutcrackers or report the location to parks staff?" We engage new audiences and give them something they can do to help.

Will it Work?

We track our restoration work using Open Standards for the Practice of Conservation, a system to assess and communicate the effectiveness of conservation efforts (Conservation Measures Partnership 2007). Through this framework, we will share our stories about sitting atop whitebark trees, of nutcrackers pecking open cones, finding squirrel middens decimated by grizzly bears, and restoring fire.

A generation of conservationists has been inspired by Sir David Attenborough communicating his passion for nature through our televisions. Like him, and like my new friend the bus driver, we are inspired by whitebark and limber pines. We have learned that they may not persist without concerted action. We are convinced that among the most important actions we can take is to inspire others to connect to these wonderful creatures.

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***Grouse Mountain** continued from page 17*

site, lodgepole pines in the nutcracker openings were girdled, only fir and spruce were felled due to the potential for skirting (small branches near the base surviving and growing). Efforts are ongoing to find buyers for the remainder of the treatment units.

Tree planting on the upper slopes (from 9,600 – 10,000 ft. in elevation) was accomplished in late September of 2014. Eight thousand seedlings were packed in to the base of the planting unit (Figure 1) by Forest Service mule packers, and interplanted over 100 acres by a contract planting crew. Survival of the seedlings on this difficult site will be monitored by Forest Service crews after 1, 3 and 5 growing seasons.

The main lesson learned is that projects with limited scope and the remote locations characteristic of whitebark pine habitats may lack a critical mass of work or products to be attractive to a purchaser or contractor, so contingency plans should be made to accomplish the work. In the case of Grouse Mt, a summer student crew was employed to release whitebark pine in plantation situations, which has the advantage of adding flexibility to modify the scope and methods as opposed to a traditional contract. The disadvantage was that the seasonal students were not as proficient in chainsaw use and work production as a contract crew.

The mature stands that have been treated have been accomplished by the Fuels Treatment Module based on the Blackrock Ranger District. Again, working with Forest Service employees allows more flexibility in scheduling and modifications than a contractor. Disadvantages include the crew being unavailable a large percentage of the time during fire season, and being pulled away for higher priority projects. Since there is no mechanized equipment to remove the felled trees, girdling of lodgepole pine was incorporated to minimize an influx of slash. Several whitebark pines were inadvertently girdled in nutcracker openings despite being marked for retention. If girdling is planned, it is recommended that leave-tree paint be applied more heavily, and at the level that girdling will take place rather than at eye level as is normally done.

Since the prescribed burn treatment has not been implemented yet, we will be incorporating the lessons learned from the Mink Peak study.

Does Fire Improve Conditions for Whitebark Pine Seedling Establishment?

Judy Perkins
Bureau of Land Management
Colorado River Valley Field Office
jlperkins@blm.gov
970-876-9054

One of the burned plots on Beaver Ridge.

Introduction

The association of fire with regeneration of whitebark pine forests is well known. These forests historically experienced mixed severity wildfires, with patches of stand-replacing fire interspersed with patches of ground surface fire. Stand-replacing fires remove the overstory canopy of more shade-tolerant tree species, and nutcrackers carry seeds to burned sites for caching, facilitating establishment of whitebark pine seedlings in recently burned sites. Whitebark pine is an early successional species, which thrives with the increased light availability following stand-replacing fire. Efforts to restore whitebark pine have included use of prescribed fire, or silvicultural treatments in place of fire, to remove shade-tolerant trees and create seed caching areas for nutcrackers.

As part of my PhD research at the University of Montana, 1999-2004, I studied the effects of fire on whitebark pine seedling establishment and growth. Using a portion of the Beaver Ridge study site (Clearwater National Forest, Idaho), part of the larger Restoring Whitebark Pine Ecosystems study by the RMRS-Fire Sciences Laboratory (Keane and Parsons 2010), I planted whitebark pine seeds in a prescribed high-severity burn area and in a nearby unburned area to study the effects of fire on whitebark pine seed germination and seedling survival.

Methods

I established 90 1-m2 plots on Beaver Ridge, 50 plots in the burned area and 40 plots in the unburned control area. The burned site was prescribed burned in September 1999 to mimic a wildfire, with trees felled pre-burn to increase fire severity. The control area had last burned in 1910, and had a mature forest overstory and well-developed understory vegetation. Plots were arranged in association with common understory plant species to also test for potential interactions between whitebark pine seedling establishment and growth with adjacent understory plant species. Within both the burned and unburned sites, I placed 10 plots each with grouse whortleberry (*Vaccinium scoparium*), beargrass (*Xerophyllum tenax*), elk sedge (*Carex geyeri*), and Hitchcock's smooth wood rush (*Luzula glabrata var. hitchcockii*). Within the burned site, I also established 10 plots in patches of bare ground. To keep small rodents from eating the whitebark pine seeds, hardware cloth exclosures were installed around all of the plots, following the design of McCaughey (1990).

Seeds for this study came from a 1999 collection at Union Pass, Shoshone National Forest, Wyoming, and were processed at the USFS-Coeur d'Alene nursery following the protocols of Burr et al. (2001). I provided the seeds with one warm stratification, followed by overwintering in cold storage, and then re-warming with a running water soak prior to planting. A total of 3330 seeds were planted on 27-28 June 2001, 37 seeds in each plot. Because of the severe fire season in 2000, the site could not be accessed for seeding at the more appropriate time in the fall, so seeding was delayed until the site

***Seedlings** continued on next page*

Seedlings *continued from page 22*

became accessible in spring 2001. To simulate the missed snowmelt, plots were hand-watered every three days for the first two weeks after seeding. Two one-gallon plastic water jugs were also placed at the upper edge of each plot, with pin-prick holes along their bottom edges, to allow slow water seepage onto the plots between hand-watering.

Since fire usually results in a pulse of increased soil nitrogen, and sometimes phosphorus, which could influence seedling establishment and growth, I installed ionic resin capsules in the soil within each of the plots. These resin capsules remained in the ground for one year, capturing soil nutrients to provide a more complete picture of soil nutrient levels than one-time soil core samples.

I monitored seedling emergence and survival throughout the 2001-2003 growing seasons. On 25 September 2003, I removed all of the surviving seedlings to measure total biomass, and to measure leaf nitrogen levels.

Results

Very little seed germination occurred during the first growing season, with only 13 germinants in the burned plots and 7 germinants in the unburned plots out of the total 3330 seeds planted. Germination during the second growing season was better, and by its end a total of 197 seedlings (12% of seeds) had emerged in the burned plots and 67 seedlings (7% of seeds) in the unburned plots. No additional seed germination occurred in the third growing season. By the end of the third growing season there were 50 surviving seedlings (25%) in the burned plots and 6 surviving seedlings (9%) in the unburned plots. Seedling biomass, both aboveground and belowground, was significantly greater for the burned plot seedlings than for the unburned plot seedlings.

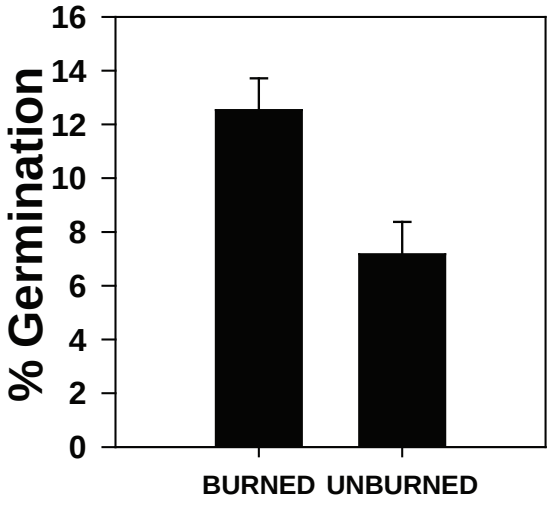
Plant association had no significant effect on either seed germination or seedling survival, but in the burned plots whitebark pine seedling biomass was significantly less when growing with either beargrass or elk sedge than when growing in bare ground. Because of the low seedling germination and survival in the unburned plots, no plant association effects could be determined for the unburned treatment.

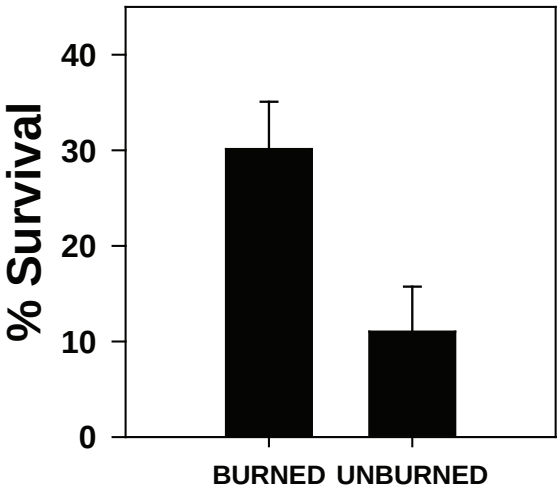
Mineral nutrient differences were seen, with higher soil nitrate and plant available phosphorus in the burned plots than the unburned plots. No difference was found for soil ammonium between the two treatments. Total leaf nitrogen was greater in seedlings in the burned plots, although the concentration of leaf nitrogen was greater in seedlings from the unburned plots. Insufficient leaf tissue was available to test for leaf phosphorus.

Summary and Conclusions

Whitebark pine seed germination, seedling survival, and seedling growth were all greater in the burned plots than in the unburned plots, suggesting that recent stand-replacing fire was beneficial for seedling establishment and growth. Increased soil nutrient availability following the fire is one potential reason for these differences, since both nitrogen and phosphorus levels showed a post-fire increase. However, nitrogen did not appear to be a limiting factor since seedlings in the unburned plots actually had greater leaf nitrogen

Seedlings *continued on next page*





Whitebark pine seed germination, seedling survival, and seedling growth were all greater in the burned plots than in the unburned plots, suggesting that recent stand-replacing fire was beneficial for seedling establishment and growth.

concentrations than did those in the burned plots. Increased phosphorus availability may be important, since this nutrient is important for root growth. Young whitebark pines must develop roots quickly during their first growing season in order to survive their first winter. Aboveground growth in the first year was generally limited to cotyledons only, with needle bundles not produced until the second growing season. Root growth appears to be much more important initially for whitebark pine seedlings.

Adequate soil moisture is also important for whitebark pine seed germination and young seedlings. The poor germination in 2001 relative to 2002 may have been influenced by the post-snowmelt seed planting and the relatively dry climate conditions in 2001. More precipitation occurred in 2002 than in 2001, and seedlings also benefited from the spring snowmelt that year.

Length of growing season is also important for subalpine conifer seedling establishment, since a longer growing season gives seedlings more time to establish and grow roots before their first winter. Snowmelt occurred in the burned plots approximately two weeks prior to snowmelt in the unburned plots. Greater sunlight exposure due to fire removal of the canopy influenced snowmelt, and likely also increased soil temperatures earlier in the growing season.

Any or all of the above factors may have contributed to the observed results of greater whitebark pine seedling germination, survival, and growth in the burned area. My results support the use of stand-replacing fire as a tool for restoration of whitebark pine forests.

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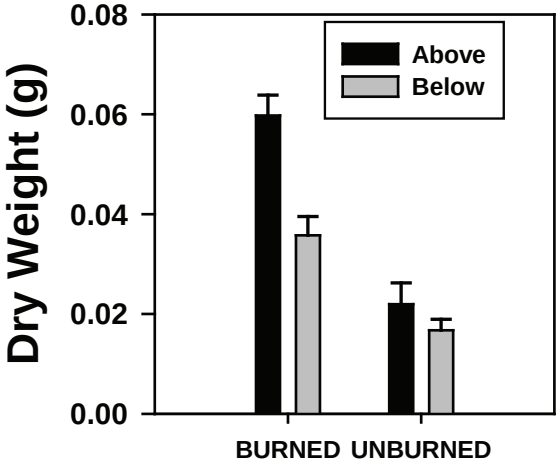

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winter minimum temperatures. Mountain pine beetles have killed cone-bearing whitebark pine across more than 190,000 hectares (470,000 acres) in the western U.S. since 1998. Whitebark pine range and elevational distribution are predicted to shift northwards and upwards as temperatures increase.

Whitebark pine restoration

These threats to whitebark pine do not stop at wilderness boundaries. They are destroying entire ecosystems in wilderness areas—something that the human activities specifically prohibited by the Wilderness Act could never do. These indirect threats are resulting in an existential crisis for whitebark pine across its range, with serious impacts on the species that evolved with it. We are, in real time, seeing a loss of important ecosystem services from whitebark pine that impact biodiversity, ecological function, indigenous cultural heritage, and even human well-being.

The experts acknowledge that the invasive pathogen *Cronartium ribicola*, the most serious threat to whitebark pine, is becoming "naturalized" in North America. After more than a century, the pathogen is well on its way across the range of all western five-needle white pines, and will likely spread south into Central America. We speculate that warming climates will accelerate its spread. Five-needle white pines, *Cronartium ribicola*, and its alternate hosts must be honestly acknowledged for what they now represent: a continent-wide pathosystem, with the potential for immense loss of biodiversity and unique products of biogeography and evolutionary history, including the iconic interaction between whitebark pine and Clark's nutcracker.

Ironically, we have tools and techniques that could restore whitebark pine communities within several human generations. Planting seedlings that have resistance to blister rust would increase the frequency of these genes in regional populations. This comprises one of the most important restoration tools for whitebark pine. It is key to the survival of whitebark pine communities through the extreme genetic and population bottleneck that the species is now experiencing. Other tools are more intrusive and include prescribed burns to reset advancing succession or thinning to increase the vigor of cone-bearing trees. Allowing fires to burn into wilderness could help recreate successional mosaics on the landscape that can reduce the hazard of future mountain pine beetle outbreaks.

Most federal wilderness experts state that the conventional interpretation of "trammeling" in wilderness prohibits the use of the restoration activities in our toolkit. We are told that planting seedlings, even those from seeds from trees in wilderness, constitutes unacceptable "trammeling." The problem is that 40% of whitebark pine is in wilderness, and that means that 40% of the species is off-limits for restoration.

Let's "untrammel"

It is time to revisit these interpretations. Let's acknowledge that human activities were responsible for the current plight of whitebark pine. What we did and are doing constitutes trammeling at a massive scale, threatening the future of a widespread keystone and foundation species. In particular, the pristine world that the architects of the Wilderness Act wanted to preserve no longer exists for wilderness areas with whitebark pine.

On behalf of the Whitebark Pine Ecosystem Foundation, I am asking that the federal stewardship agencies administering whitebark pine in wilderness—the U.S. Forest Service and the National Park Service—reevaluate their interpretation and begin the process of planting blister rust-resistant whitebark pine seedlings in their wilderness areas, and consider other restoration activities to save the species.

The expression is trite, but the sentiment is honest: "We broke it. We must fix it."

WPEF news

We are pleased to note the launch of a new addition to our website, the result of a partnership between the U.S. Forest Service Forest Health Protection (FHP) and the WPEF: "Restoring Whitebark Pine—One Project at a Time." These web pages make available information on completed whitebark pine restoration projects, from 2007 to 2013 (2014 in progress), funded by the FHP Whitebark Pine Restoration Fund. This is an important resource for any federal agency or organization planning to do restoration projects for whitebark pine. Please note the accompanying article in this issue of Nutcracker Notes. This year, the annual WPEF Whitebark Pine Science and Management Workshop will be held in Ashland, OR, September 17 to 20. Information is posted on our website http://whitebarkfound.org/?page_id=18. Our workshop theme is "Genetics and restoration of whitebark pine on the Pacific Coast." In addition to a great line-up of speakers, the organizers have planned three field trips: Crater Lake, a foxtail pine site, and Dorena Genetic Resource Center. This meeting promises to

Tomback continued on next page

NorCal continued from page 9

China mountains should be targeted for monitoring plots in the future.

4. Klamath/Shasta Trinity National Forest: Goosenest Ranger District - the Cascade Mountains to the north and east of Mount Shasta plus Mount Shasta – The Cascades

This area was a major focus of the 2013 summer field work based on the relative shortage of previously collected data. Several permanent plots have been set up in the northern part of this area, including on Ball Mountain and Goosenest, but other data for the southern Goosenest RD was absent. In addition to being quite remote, often only accessible with 4wd, the southern Goosenest is under heavy pressure by the logging industry. A checkerboard of private in-holdings mix with National Forest and logging was often either occurring or had recently occurred within whitebark pine habitat. Often, remnant whitebark pines were left with the completion of logging activities (which took hemlock, western white pine and lodgepole pine instead). There was also salvage logging of lodgepole pine that have been killed by mountain pine beetle in the Whaleback region.

On mountaintops and ridgelines, north-facing slopes were often decimated by mountain pine beetle. These stands were always a mix of lodgepole and whitebark pine with occasional Shasta fir and mountain hemlock. The common pattern is that low species diversity and smaller individual trees are invoked by mesic south-facing slopes with higher species diversity and most vigorous and larger trees inhabiting the mesic north-slopes. MPB are commonly infesting trees on north-slopes because they provide the most concentrated and exploitable resources. This pattern of mortality was found on the Whaleback, the unnamed ridge to the north of Antelope Creek Lakes (private property), as well as the ridgeline between Antelope Creek Lakes and Rainbow Mountain. These areas had mortality reaching and often exceeding 50%. To a lesser degree the Haight Mountain region was exhibiting this pattern but mortality was lower on average. The Ash Creek Butte region appears to be generally unaffected by rust or mountain pine beetles at the time of this writing but this may be due to most of the trees here being smaller and only surviving on the south-facing slopes with north-facing slopes being steep and generally uninhabitable.

5. Mount Shasta: Shasta-Trinity National Forest - The Cascades

The whitebark pine on Mount Shasta explore the highest elevation habitat for the species in California outside of the Sierra Nevada. The populations on Mount Shasta compose the second largest in northern California at almost 12,000 nearly contiguous acres. At the lower elevational limits around 2135m (7,000'), whitebark pines associate with mountain hemlocks (*Tsuga mertensiana*), western white pines (*Pinus monticola*), and Shasta firs (*Abies magnifica var. shastensis*). But just upslope at 2,600m (8,500ft) other species become less common and pure stands of whitebark pine become the norm on ridgelines above swales created by streams and avalanches. A shift in vegetation type is occurring in the swales which are being pioneered by whitebark pine because growing season lengthening and snowpack is decreasing. Conversely, along ridges in the Brewer Creek region, once Krummholz specimens are sending leaders skyward through ecological release but many of these leaders are dying back, most likely because of xerification. I recommend monitoring the extent of the WBP across the elevational spectrum on Mount Shasta, from the region of overlap with montane conifers to the current upper elevational limits.

Learn more and see full reports:
http://pacslope-conifers.com/conifers/pine/wbp

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be a major event. We are also looking for donations of items for auction. Please see the accompanying announcement in this issue of Nutcracker Notes. I look forward to seeing you there!

Transitions

It is somewhat shocking when long-term whitebark pine folks retire. Our good wishes go to Art Zack, Forest Silviculturist with the Idaho Panhandle National Forest, who is retiring as I write this message. Art has been a major supporter of the WPEF from its inception, attending many of our meetings, and has advocated for attention to whitebark pine. He has included whitebark pine in his work whenever he has the opportunity, and implemented restoration projects. After Art has had his fill of fun and leisure, we are hoping to recruit him to help with some of our projects!

WHITEBARK PINE
ECOSYSTEM FOUNDATION
PO Box 17943
Missoula, MT 59808
www.whitebarkfound.org

Clark's nutcracker with a walnut, by Dennis Witmer

SAVE THE DATE

Whitebark Pine Ecosystem Foundation's Annual Science & Management Meeting

Genetics & Restoration of Whitebark Pine on the Pacific Coast

Sep 17-20, 2015 - Southern Oregon University, Ashland, Oregon

Workshop Panels:
Restoration and Resistance Ecology
Inventory and Monitoring
Genomics and Landscapes

Field Trips:
Crater Lake National Park
Crater Creek Research Natural Area
Dorena Genetic Resource Center

Plus:
Evening Social
Silent Auction
& Poster Session

For more information and to pre-register, go to www.whitebarkfound.org

Vasiliki Ridge, Early Winters Creek in the North Cascades. By Cliff Schwab