

# Clan of the Whitebark Pine

Fighting for an Imperiled Forest



*Photo by Steven Gnam*

*by Louisa Willcox*

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## Fighting for an Imperiled Forest

by Louisa Willcox

*What a joy to be alive on a fall morning in the Beartooth Mountains, when sinewy whitebark pine lead an orchestra of Clarks Nutcrackers and red squirrels clamoring for their fatty seeds!*

*Perched on some of the continent's most inhospitable terrain, these ancient whitebark pine are bent by gale-force winds, broken by avalanches, and scarred black by lightning strikes. Their battered limbs finger the white-capped Crazy, North Absaroka and Gallatin Mountains in the distance.*

*Around their feet are shrunken, frostbitten goldenrod and white asters, the epilogue to a brief alpine summer. Blond scats filled with pine seeds speak to the presence of grizzly bears that have been lured by squirrels' caches of whitebark pine seeds. These rich seeds make a world of difference to a pregnant grizzly that will soon give birth.*

*This happy din reminds us that nutcracker, squirrel, grizzly and whitebark pine evolved together, comingling for millennia with native peoples who also depended on pine seeds.*

*For hundreds of thousands of years, whitebark pine have survived everything mother nature can throw at them – that is, until humans unleashed a lethal brew of warming temperatures and a nonnative disease.*

Below the high peaks of the Beartooth Mountains, boisterous nutcrackers and angry squirrels announce the presence of [whitebark pine](#) (*Pinus albicaulis*). This year, a record crop of hefty purple-black cones bedecks the crowns of the trees, offering a feast for birds, squirrels and grizzly bears that flourish in Yellowstone's austere high country.

A cone drops to the forest floor, followed by another... and another. A squirrel is furiously clipping cones from the topmost branches of a whitebark pine before they fall prey to nutcrackers -- not even bothering to cache the precious cones below ground in a frenzied rush to beat the aerial competition.

None of this is lost on a grizzly bear, whose fresh blond scats bespeak a meal of fatty whitebark pine seeds. The squirrel has just done her the favor of dropping dinner almost into her mouth. And how convenient, because full-grown grizzlies hardly ever climb trees.

I had not expected to see the entire ecosystem, replete with nutcrackers, squirrels and grizzly bears, still vibrant and intact, as it had been for thousands of years. Nearby -- and throughout much of whitebark pine's range -- entire forests are now silent grey ghosts, ravaged by disease and mountain pine beetles.

Indeed, the precipitous collapse of whitebark pine throughout North America, driven in part by a warming climate, persuaded the US Fish and Wildlife Service in 2020 to propose that this tree be provided with Endangered Species Act protections<sup>1</sup>. A final decision is expected sometime during 2022.

This momentous proposal brought back a flood of memories for me of the remarkable people and their largely unsung efforts that created this watershed moment – along with the campaign we created out of mutual respect, shared passion, and a desire to make positive change in the world. My reflections impressed upon me once again some seminal lessons for those seeking to protect our Earth's fellow inhabitants at this critical juncture in our shared journey.

## **Whitebark Pine Gets its Due**

A federal safety net for whitebark pine could not have come at a more critical time. According to the latest government appraisal<sup>2</sup>, over 50% of the whitebark pine forests in the US have died as a result of the ravages caused by a nonnative fungal pathogen and an unprecedented outbreak of native predatory insects unleashed by warming temperatures. Some climate models project that we could lose over 70% of the environments cold enough to sustain whitebark pine by the end of this century<sup>3</sup>. Other models project even bleaker scenarios. With the loss of whitebark pine, the high mountain ecosystems that they sustain will unravel. Goodbye grizzlies, nutcrackers and more.

I was astonished that the Trump administration – hostile to everything the Endangered Species Act stands for – threw a lifeline to whitebark pine. The administration had steadfastly refused to protect better known charismatic species such as the wolverine. I thought the chances of whitebark pine being granted protections were slim indeed.

As Senior Wildlife Advocate for Natural Resources Defense Council, I had helped draft a petition to the US Fish and Wildlife Service requesting that whitebark pine be listed under the ESA<sup>4</sup>. I also helped lead an innovative effort during the late 2000s to assess the havoc caused by a novel outbreak of native mountain pine beetles in the Greater

## A Sea of Red



*Beetle-killed whitebark pine in Greater Yellowstone: Union Pass, Gros Ventres Mountains, Wyoming Range, 2009. Landscape Assessment System Project photos.*

Yellowstone ecosystem – an outbreak that had turned healthy forests into an ocean of red dying trees in the blink of an eye. We found that about 80% of Yellowstone’s mature whitebark pine trees had been killed in a mere seven years<sup>5</sup>.

In 2011 the Fish and Wildlife Service responded to our petition by concluding that whitebark pine deserved endangered species protections<sup>6</sup>. But the agency dodged formally listing the species, claiming that the agency’s limited resources needed to be prioritized for protecting other more critically imperiled species. A decade later, after updating their analysis and expanding upon our earlier work, the Fish and Wildlife Service agreed with our initial assessment that the tree was in urgent need of protection.

I am not alone in praying that endangered species protections have not come too late for these forests and the ecosystems they sustain. There is much we can yet do if we commit to tackling the complex challenges facing this iconic species and the web of life that depends on it.

And to me, this campaign for whitebark pine has broader implications for how conservation can happen.

Here is the story of that campaign. But first, a little background.

## Grandmother Trees and Their Ecological Family

I confess to a long love affair with the whitebark pine forests that define high peaks of the Northern Rockies. From their alpine summits, mountains recede to the horizon, hinting at the curvature of the earth. Here, whitebark pine feed and shelter species large and small, from 600-pound grizzlies to tiny voles. Since time immemorial, whitebark pine have nourished humans too – and our imagination.

I am not alone in imagining whitebark pine as part human, stooped like an old man, or seductively draped across an alpine ridge. In the Mission Mountains of Montana, the Salish Kootenai's name for one ancient whitebark is "Great Great Great Grandparent<sup>7</sup>." A 500-year-old whitebark in Oregon's Crater Lake Park is lovingly called the "Grandmother Tree<sup>8</sup>."

In the Absaroka Mountains, I once stumbled upon the remains of an ancient Indian camp in the midst of a whitebark pine forest. People had almost certainly camped there to harvest pine seeds, gather medicinal plants, and hunt bighorn sheep. They did not need scientists to explain how the lives of trees, birds, bears, squirrels and people were interconnected.

Grandmother Whitebark



*Grandmother Tree, over 500 years old, in Crater Lake National Park. Credit: National Park Service.*

But over the years scientists have deepened our appreciation of how whitebark pine functions as the lifeblood of an ecosystem. These trees play a surprisingly vital role in the hydrology of watersheds by shading the snowpack, slowing the melt of snow, reducing soil erosion and regulating stream flows<sup>9</sup>. They sustain the region's world-class trout fishery, farms in the valleys below, and the human communities that depend on both.

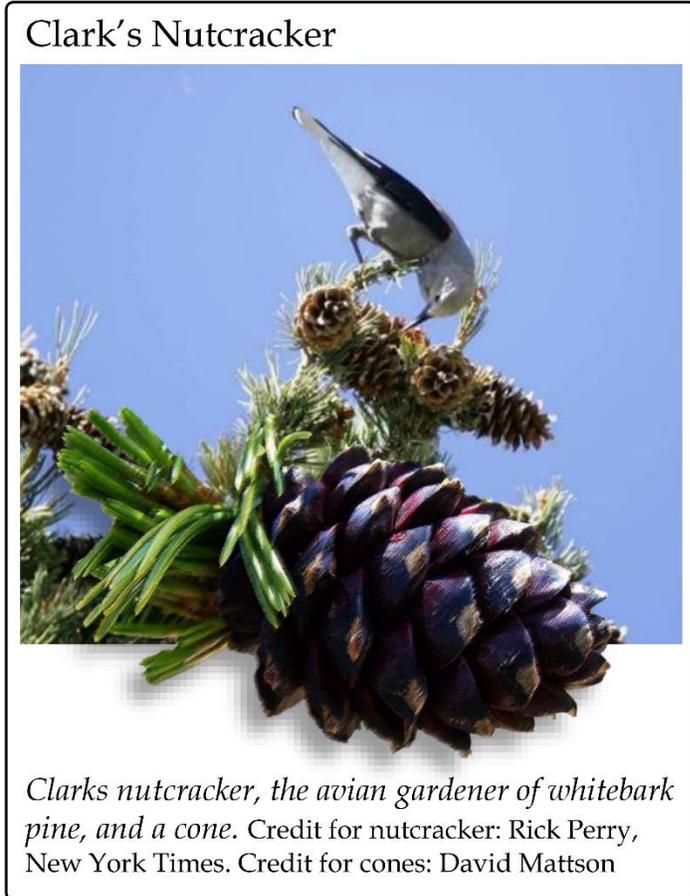
## Creating Ecosystems

### The Web of Grizzly, Nutcracker, and Squirrel

Scientists have long been fascinated with whitebark pine that cling to wind-scoured outcrops at the highest elevations of any tree in the Northern Rockies, Sierra Nevada, Cascades, and much of interior Alberta and British Columbia. They endure bitter cold,

icy winds, lightning strikes and poor soils – even as they create conditions within which other tree species and plants can flourish.

Whitebark pine prefers the high country, almost all on public lands, in part because it does not compete well with species such as lodgepole pine and Douglas-fir that grow at



lower elevations. Whitebark pine are part of a loose-knit group of [five-needled stone pines](#) that grow in Europe and Asia. All stone pines produce singularly large nutritious seeds beloved by diverse species, notably bears. Stone pines also share a remarkable ability to endure conditions that would kill most other trees. Indeed, this is the stone pine's evolutionary advantage.

Whitebark pine are considered the pioneers and engineers of alpine ecosystems. They can grow literally out of the rock, with roots strong enough to break apart stones. Their needles provide scarce organic matter that builds soil and enables other plants, such as spruce, mosses and grass, to begin to eke out a living, in turn allowing other species to flourish.

The connections between whitebark pine and nutcrackers, as well as red squirrels and grizzly bears, underscore how ecosystems are built on a complex web of life.

Because whitebark pine seeds do not disperse well in the wind, the Clark's nutcracker, a relative of the crow, has evolved to do the tree a favor by dispersing their seeds for them<sup>10</sup>. These handsome and gregarious grey birds have a unique and mutually beneficial relationship with whitebark pine. The seeds of whitebark pine – and all stone pines – are so large and the cones so resistant to opening that dispersal and germination would not likely happen without the help of nutcrackers.

## Whitebark Pine Cone



## From Cone to Bear

### Red Squirrel



### Squirrel Midden



### Grizzly Bear



Photo by The Cornell Lab of Ornithology

### Bear Scat



*The intertwined history of whitebark pine, red squirrels and grizzly bears – or, how red squirrels help grizzly bears fatten on whitebark pine seeds. The cones of whitebark pine grow at the top of the trees, but adult grizzly bears aren't good climbers. Squirrels cache the cones in middens that they rely on during winter. During fall, grizzlies raid the middens to eat seeds from the cached cones. Female grizzlies that have fattened on whitebark pine seeds have more cubs than other females. Credits: from top left to bottom right, David Mattson, Jeff Henry, Kate Kendall, The Cornell Lab of Ornithology, and David Mattson.*

Nutcrackers descend on whitebark pine trees in the fall, break the still-intact cones open, and pluck out their ripening seeds. Each bird is capable of stashing 100 seeds at a time in its throat that it then caches a few centimeters in the ground. As part of their survival strategy, they store many times more seeds than they need to survive – and in the process leave numerous caches that benefit other animals and whitebark pine itself.

Whitebark pine seeds readily germinate in nutcrackers' neglected caches. These avian gardeners thereby ensure future generations of whitebark as well as the survival of their own species. Today you can see clusters of massive trees, typically numbering four to six, that began life centuries ago as a single, forgotten nutcracker cache.

Among the many hungry consumers of whitebark seeds are red squirrels and grizzlies. But grizzly bears are ill-equipped to climb trees to compete head-to-head with other seed predators. Enter the red squirrel. Squirrels cache thousands of cones containing seeds that will tide them through winter, often expanding on the decomposing caches of their ancestors<sup>11</sup>. Grizzly bears merely need to listen for the chatter of a squirrel defending its hoard of cones – and voila: a hundred Big Macs worth of calories can be had with minimal exertion.

As the naturalist John Muir wisely observed: "When we try to pick out anything by itself, we find it hitched to everything else in the Universe<sup>12</sup>."

And Muir discovered something else. A weather-beaten whitebark high in California's Sierra Nevada, with a trunk just six inches across was, to his astonishment, roughly 426 years old.

In the zone of dwarfed trees at timberline called Krummholz, where whitebark hunker down to avoid ferocious icy winds, a ten-inch tree can easily be a century old.

## Grizzly Cassandras

Because they live so long, whitebark pine trees and their relatives in the bristlecone family tell the story of past climates and warn, like Homer's Cassandra, of the future. Tree rings of bristlecone pine together with other proxies were first used by scientists such as [Michael Mann](#) to assemble the famous – and terrifying – hockey stick graph showing the escalation of planetary warming<sup>13</sup>.

Over the course of thousands of years, whitebark forests have migrated from valley floors during the ice ages to their current stronghold on mountain tops<sup>14</sup>. But with the blistering pace of human-caused climate warming, scientists fear there may be no more mountain to retreat to<sup>15</sup> – and, with the loss of whitebark pine, a number of other species will follow. Loss of whitebark has already severely impacted a host of species, including Yellowstone grizzlies that have historically depended on whitebark pine seeds to fatten before the winter famine of hibernation<sup>16</sup>.

In recent years, independent-minded ecologists and climate researchers have found themselves playing Cassandra too, pointing to the demise of whitebark pine as a

## David Mattson



*David Mattson, field researcher with Interagency Grizzly Bear Study Team, documenting grizzly bear excavation of a squirrel midden, 1979.*

warning of the desperate future facing us all. I have been blessed to learn from some of them. Indeed, one is my husband.

[Dr. David Mattson](#) fell in love with grizzlies and whitebark pine long before me. I first met him when I worked for the Greater Yellowstone Coalition and grizzlies were part of my beat. Then as now, in the world of Yellowstone grizzlies all paths led to David. At the time he worked for the Interagency Grizzly Bear Study Team, logging thousands of miles on foot following grizzlies to find out what they ate and how they lived. Blond, wiry and curious, David tasted pretty much everything grizzlies ate – worms, ants, dirt, and of course whitebark pine seeds. Except for the worms, I have too.

David is the scientist who put together how dependent Yellowstone grizzlies were on whitebark pine – a story that cast a long shadow over the controversies that followed. In his research, David found that female grizzlies were three-times more likely to produce triplets (as opposed to singletons or twins) when and where they had access to abundant whitebark pine seeds<sup>17</sup>. That boost matters because grizzlies have one of the lowest reproductive rates of any terrestrial mammal, exacerbated by cub mortality as high as 60-70%. David also found that the availability of abundant whitebark pine helps reduce human-caused mortality by attracting grizzly bears to remote high-elevation areas – away from people and thus out of harm's way during their fall feeding frenzy<sup>18</sup>.

Conversely, he found that when pine seed crops are poor, grizzly bears died at about twice the rate as when seed crops are good, which resulted in an average 5% rate of population increase following good seed crops versus an average 7% rate of decrease when crops were poor<sup>19</sup>. During years with poor whitebark pine seed crops, grizzly bears ranged during late summer and fall nearer people, consuming foods such as livestock and elk, often with deadly results. These years of pine seed scarcity were especially hard on females because they put their cubs in danger any time they foraged heavily on meat, primarily because cubs ended up being killed more often by the male grizzlies that tend to dominate carcasses<sup>20</sup>.

These problematic dynamics have been amplified by the widespread loss of whitebark pine. Barring areas where our few remaining healthy whitebark forests survive, every year is a bad year for the animals that once depended on pine seeds.

David was also one of the first scientists to flag the threats posed by climate change to grizzlies in a 1991 paper published in *Conservation Biology*<sup>21</sup> – threats that have since been realized. The official response of his government employers was to call him “chicken little” – a warning of punishments<sup>22</sup> to come for raising the alarm over climate change, loss of whitebark pine, and the damage caused by excessive logging and roadbuilding.

History would prove out David’s concerns, but as Homer reminds us, Cassandras are rarely rewarded.

## Diana Tomback Pursues a Bird into a Threatened Forest

Diana Tomback



*Diana Tomback, champion of whitebark pine and teacher extraordinaire.* Credit: Rick Egan

You cannot be a fan of whitebark pine for long without meeting [Dr. Diana Tomback](#), one of its premiere experts and advocates. A gifted teacher with the graceful bearing of a swan, Diana, not surprisingly, began her career studying birds. Falling in love with the Clark’s nutcracker as a graduate student, Diana wrote her PhD on its connection with whitebark pine. Her research shed new light on the bird’s role as the primary disperser of whitebark pine seeds<sup>23</sup>. The connection between nutcrackers and whitebark is now considered a textbook example of mutualism, an ecological interaction between two or more species where each species gains something from the interaction.

A professor and associate chair with the Department of Integrative Biology at the University of Colorado Denver,

Diana has studied nutcrackers and whitebark pine across the West, but especially in Yellowstone, which is where I met her years ago in the Beartooth Mountains

surrounded by a gaggle of enthusiastic graduate students. They were painstakingly measuring the health of whitebark pine by tracking the telltale white cankers and caked brown needles on whitebark pine that signify the deadly white pine blister rust.

Blister rust (*Cronartium ribicola*) is a non-native fungus that was introduced from Asia to North America around the turn of the 20th century. Entering trees through the stoma or breathing holes in the needles, the fungus disrupts the pines' circulatory system, slowly killing its victims<sup>24</sup>. Starting from where it had been introduced along the Pacific coast, the fungus began killing five-needled pines, including white and whitebark pines, both of which have little natural immunity.

With spores capable of traveling on the wind hundreds of miles, blister rust eventually reached the Northern Rockies, where the fungus had clobbered most of the whitebark in the environs around Glacier Park by the 1960s. Wafting on to dryer forests, by the early 2000s rust had infected about 20% of whitebark pine in the Greater Yellowstone area<sup>25</sup>. And because rust infects trees of all ages, entire forests were vulnerable – including the wild animals that depended on them<sup>26</sup>.

For decades, Diana has been a crusader for whitebark ecosystems, sounding the alarm about blister rust, and giving flight to young ecologists who share her devotion to these forests. Watching her hold forth before rapt students, I am reminded of a different Diana: the guardian of the forests in the Greek pantheon.

Like Diana, Dr. Jesse Logan was another Cassandra whose warnings came true far sooner than he imagined.

MUG SHOT: White Pine Blister Rust (*Cronartium ribicola*)

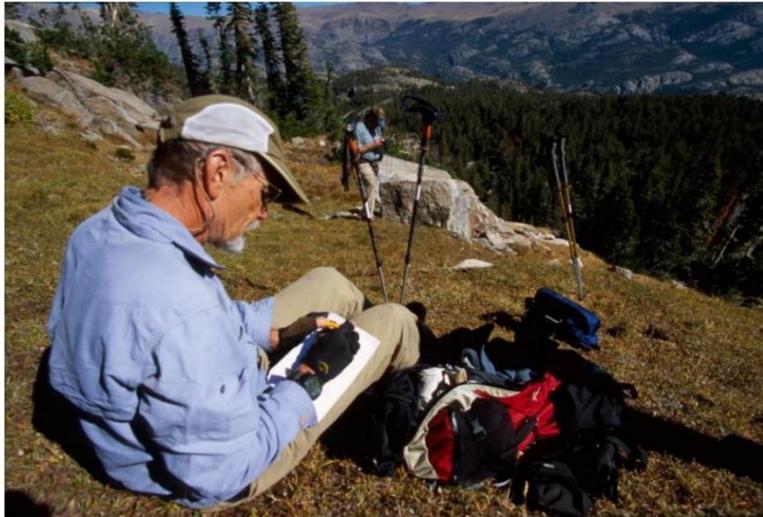


Deadly cankers of blister rust. Blister rust kills whitebark pine by damaging its circulation.

## Red Flags Over Yellowstone A Climate Scientist's Fears Come True

Fit, grey, and upbeat, [Jesse Logan](#) hardly appears the embattled veteran of climate politics that he is. One of the world's experts on relations between temperature and insects, Jesse had predicted that mountain pine beetles would storm whitebark pine ecosystems with warming temperatures. Tragically, he was right.

Jesse Logan



Jesse Logan in the Wind River Mountains, in his new-found freedom from the Forest Service, 2006. Credit: Ed George.

Native [mountain pine beetles](#) (*Dendroctonus ponderosae*) have co-evolved with lodgepole pine in forests of the West. The size of a grain of rice, the mountain pine beetle is deadly because it attacks a tree in swarms numbering in the thousands. The beetle reproduces in a host tree that it recently killed by boring through the bark, feeding on the nutritious phloem below, and then laying its eggs in a web of galleries that girdle the trunk of its victim<sup>27</sup>. A new brood hatches the

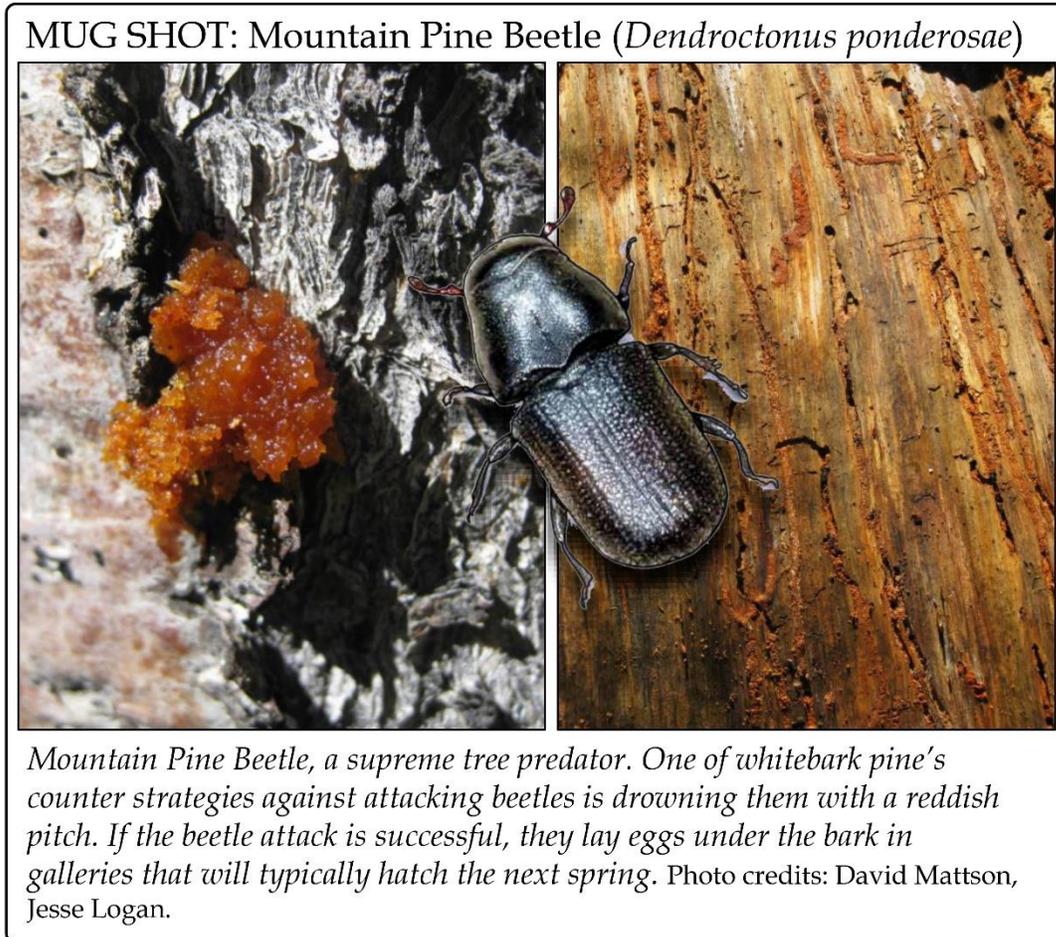
following year, roaring through the forest, attacking new trees and emitting pheromones to attract other recently emerged beetles to attack targeted trees. If enough beetles attack, the tree dies, but the cycle of the beetle continues.

For thousands of years, beetles and trees such as lodgepole pine have been engaged in a strategic arms race<sup>28</sup>. An attack begins when a female drills into a pine. If she finds plenty of sugary phloem, she ingests it and synthesizes a pheromone that signals to other beetles that she has found a feast. If enough beetles gather, they kill the tree. But the tree tries to defend itself by releasing a beetle-killing chemical brew. If only a few beetles attack, the tree typically wins. If an army of thousands invade, the tree succumbs, especially if it is already weakened by drought or other factors.

Although frigid alpine temperatures had tended to keep high-elevation whitebark pine free of beetles, recent warming winters have allowed them to flourish amongst whitebark pine forests<sup>29</sup>. And, tragically for whitebark pine, it did not evolve with

beetles and lacks adequate physiological defenses or a reproductive strategy capable of weathering the beetle's attacks.

Whitebark pine were sitting ducks.



In a groundbreaking study in Idaho's Sawtooth Mountains<sup>30</sup>, Jesse saw his worst fears realized. Beetles pummeled whitebark pine in a fraction of the time he had predicted. Not only were beetles surviving at higher elevations, they reproduced more quickly – as if on steroids – completing their life cycle in as little as a single year.

Jesse feared that beetles might amplify or even outstrip the threat posed to whitebark pine by blister rust. In 2001, Jesse and James Powell published a paper entitled "Ghost Forests, Global Warming, and the Mountain Pine Beetle<sup>31</sup>," forewarning a danger to whitebark pine throughout its range.

As if on cue, during the next few years we began to see seas of red and dying whitebark pine along the eastern flank of the Absaroka Mountains in Yellowstone Park and adjacent National Forests. This devastation was far greater than any that had happened

during the 1930s and 1950s<sup>32</sup>, when mountain pine beetles surged into Greater Yellowstone's whitebark pine forests during brief warming spells. Now, with sustained warming, beetles were ripping through whitebark pine like a red inferno.

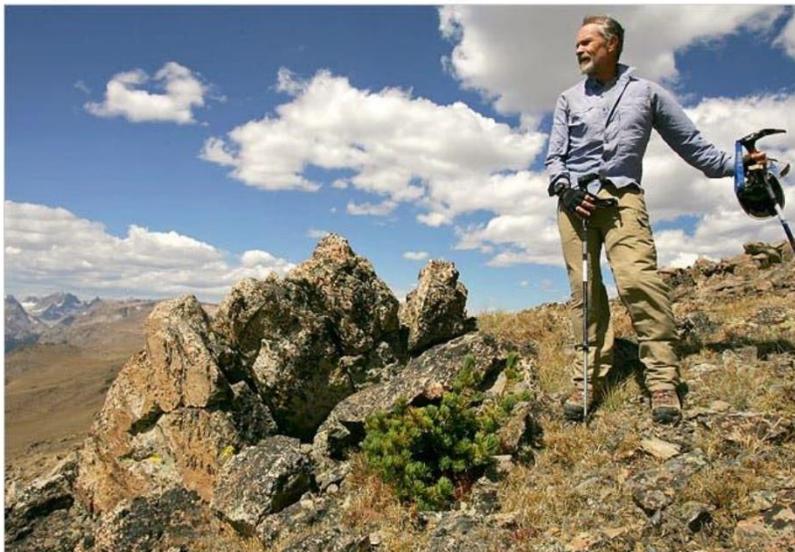
I began talking to Jesse at his office at the Rocky Mountain Research Station in Logan, Utah, about the problem, but he was facing his own difficulties. A climate scientist in the climate-denying G. W. Bush administration, he was having to resort to ever more inventive ways to get his message out, once outskiing his government media handlers to speak frankly to an environmental reporter who, fortunately, was a good skier too. (The article by Jesse's ski companion, Michelle Nijhuis, remains one of the best popular accounts of the connections between climate change, mountain pine beetles and whitebark pine.<sup>33</sup>)

I was not surprised when, in 2005, he told me he was retiring early, but rejoiced when he and his wife Catherine moved nearby in Montana's Paradise Valley.

I had an idea.

## Into the Heart of the Winds

Top of the Wind River Range



*Jesse Logan with Krummholz whitebark pine that are many decades old, if not older, Wind River Mountains, 2006. Credit: Rick Perry, New York Times*

I proposed that we take a trip into Wyoming's Wind River Range, the highest mountains in Greater Yellowstone where Jesse thought whitebark pine might find refuge. When Jesse told me that he had not seen the rugged heart of the Winds, I had to introduce him, for this range was my sanctuary, the place where I had found refuge as a teenager fleeing the fenced-in farm country of Pennsylvania.

It was a casual trip of friends, including Jesse and some of his colleagues – up until Charles Petit, a science writer for the New York Times, caught wind of our adventure and asked to tag along with a photographer. To reach a whitebark pine forest that we

thought might be a climate Shangri La, I had already planned the route into country so rugged and remote that a rescue would be extremely difficult. I had my doubts when Petit told me that the last camping trip he had been on was a weekend in the Sierras with his grandkids.

In the end, a Shoshone Indian friend brought Petit in by horseback to meet us after we had traversed the most treacherous terrain. An avuncular figure with a childlike curiosity about the forests, Petit surprised us all. He was a great sport with a droll sense of humor. His 2007 stories in the New York Times ([here](#) and [here](#)) featured a newly liberated Jesse Logan and sparked national interest in this little-known forest ecosystem. They also documented the birth of what would become the Clan of the Whitebark Warriors.

Jesse also brought [Jacque Regniere](#) and [Wally Macfarlane](#) along on the trip. Jacque was a modeler and mathematician who had worked with him on his Sawtooths' research. Jesse's friend Wally was a geographer and GIS whiz. Strapping and blond, Wally is a veteran mountaineer with the kind of cool you want around in a crisis. Not that ours were anything beyond the normal blisters and gear breakdowns – but the upshot was that Wally and I packed nearly our body weight of other people's gear out of the mountains.

## **A Rag Tag Army Unites Around Whitebark**

The storms and river crossings of that Wind River trip bonded all of us in ways that emails and meetings never could. Over campfires, we joked and argued about what was happening to whitebark and what to do next.

We had to figure out how widespread the beetle epidemic was, and we had to engage other experts and decisionmakers with the unfolding crisis. But we were quickly reminded that government agencies had few resources to do much of anything with a tree that has little economic value, as is the case with whitebark pine.

We also needed to better understand the synergistic relationships among beetles, white pine blister rust, and even wildfires. We knew that beetles kill the larger trees, but blister rust kills trees of all ages. And we knew that blister rust weakens trees, making them more susceptible to beetles<sup>34</sup>. But there was much we did not know.

Making matters worse, increasingly frequent and massive wildfires were killing whitebark pine faster than they could reproduce<sup>35</sup>. Meanwhile, paradoxically, in some parts of the Northern Rockies, whitebark were being crowded out by other conifers following decades of misguided fire suppression<sup>36</sup>. With so many harmful forces at play, an ecological disaster was unfolding before our eyes.

## Whitebark Pine Warriors



*From left to right, Wally Macfarlane, Louisa Willcox, Jacques Regniere, Jesse Logan.*

Given the pace of the beetle outbreak, we had to act quickly because assessing the cause of a tree's death, whether by drought, rust, or beetles, is far more difficult a year or two after needles drop off and bark begins to sluff from a dead tree. And the cause of death matters to shaping effective conservation and management strategies.

As we thought about next steps, funding limitations loomed large. Government agencies with jurisdiction over whitebark pine habitats had few resources. We were on our own.

But what we lacked in money we made up for in passion, ideas, and personal connections.

## Family of the Whitebark Women

Jesse began by tapping his many connections in the scientific world, experts such as climate guru and International Panel on Climate Change member [Steve Running](#), entomologist [Ken Raffa](#), Forest Service researcher [Barbara Bentz](#), and [Jeff Hicke](#), a genius who studies the interaction of climate and forests.

Through Jesse, I met [Dr. Diana Six](#), a former biker chick turned body builder and forest entomologist, now a professor at the University of Montana. She brought unique expertise in forest adaptation to her research on climate change and bark beetle ecology. She even took her quirky interests so far as to brew beer using the fungi that beetles carry around with them in what she calls "fungal suitcases." Beetles use the fungi to nourish the larva they lay underneath the bark of trees. Diana uses it to fuel her Six-Legged Ale. With a keen sense of humor, political astuteness, and superb

## Diana Six & Steve Running



*Diana Six and Steve Running on Natural Resources Defense Council media tour, 2010.*

communication skills, Diana offered a fresh voice and “out of the box” perspectives that were uncommon at the time.

And I also met kindred spirits among government biologists involved in the Greater Yellowstone Ecosystem Whitebark Pine Working Group. To me, this group was a welcome break from the testosterone-fueled government committees at the center of managing highly politicized species such as grizzly bears and wolves. Without money, careers or political agendas at play, the whitebark pine group tended to attract people who were genuinely curious and who cared about the organism that brought them together in the first place.

To my delight, I was welcomed as a professional who had something to offer, not dismissed as a troublemaker threatening to disturb the status quo. Not surprisingly, the group included a large number of women, including silviculturalist [Liz Davy](#) of the Bridger Teton Forest, [Melissa Jenkins](#) of the Targhee Forest, and ecologist [Nancy Bockino](#) of Grand Teton Park. Of course, plenty of men were around, like the ever-cheerful [Dan Reinhart](#) of Yellowstone Park whose path to whitebark began with studying grizzly bears, and Custer Gallatin National Forest’s [Dan Tyers](#), who found ingenious low-cost ways to monitor whitebark pine health. But the dominant voices were female – undoubtedly contributing to the group’s inclusive, can-do spirit.

Many of the committee’s members and leaders were also engaged in the [Whitebark Pine Ecosystem Foundation](#), an advocacy group comprised of academics and managers that Diana Tombeck had helped launch. Unlike government committees that typically limit their focus to research and management, the Foundation worked to marry research and advocacy. This union was easier in the case of whitebark pine than for more contentious species, primarily because advocating for the conservation and protection of whitebark did not threaten powerful interests invested in perpetuating the exploitation of natural resources. But that did not mean that the Foundation was content with business as usual.

Early on, the committee was focused on the threat posed by blister rust and the collection of seeds from trees that showed genetic resistance to the fungal disease. Seeds from these rust-resistant parents were then cultivated and planted to help propagate forests of less vulnerable trees<sup>37</sup>. Encouragingly, planted seedlings proved to be two to five times more resistant to rust than trees without natural immunity.

Because whitebark pine forests are so remote, assessing blister rust infection is time-consuming and expensive. The planting programs have proven to be yet more costly and labor intensive. Moreover, the narrow focus of this strategy did not promise to address threats that were rapidly multiplying across the range of whitebark pine.

The threat posed by beetles is especially problematic. Spraying trees with chemicals such as [carbaryl](#) to kill beetles is far too expensive and otherwise impractical because these toxins kill many other insects as well. A more benign approach involves stapling [verbenone](#) pouches on individual trees. Verbenone contains specific pheromones that tell beetles that the tree is already fully occupied and cannot feed more beetles – and to go look for food somewhere else. But stapling pouches on millions of individual trees is impossible, plus pouches are only good for one season.

Gaby Chavarria



*Gaby Chavarria, then Science Director of Natural Resources Defense Council, and the Forest Service made the Landscape Assessment System survey of whitebark pine health possible. Credit: Denver Natural History Museum.*

By the mid-2000s the outbreak of beetles was escalating fast, killing whitebark pine forests in entire watersheds. But no one knew how big the outbreak was or how fast it was moving. Members of the Whitebark Pine Working Group agitated for resources to assess the problem, but the tree was hardly a priority for ladder-climbing bureaucrats at the top of the Forest Service who were preoccupied with logging commercially valuable trees.

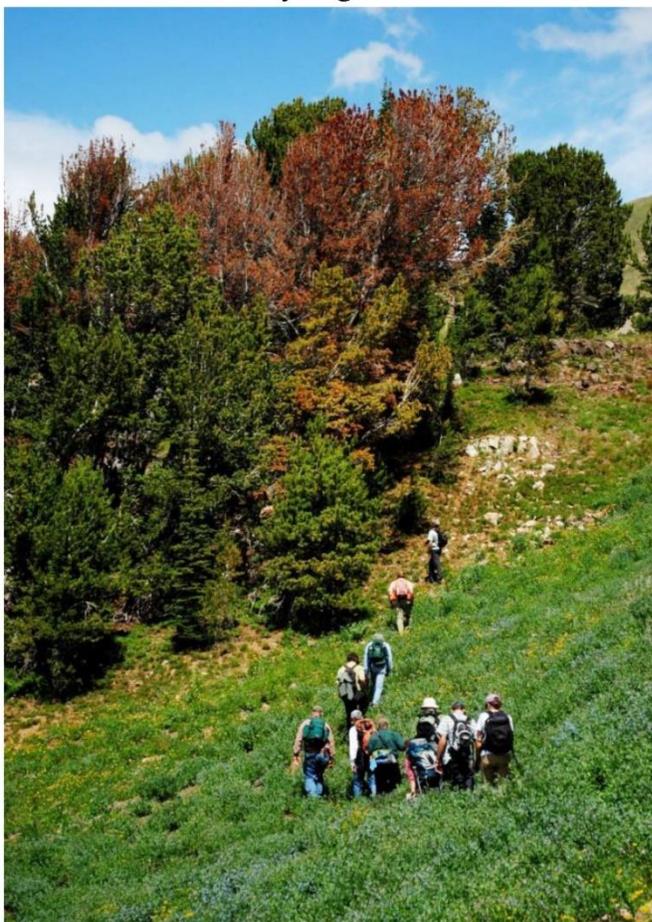
Meanwhile, as more of Yellowstone's high mountain country turned red with dead and dying whitebark, the public was largely unaware of what was happening – or why the loss of whitebark even mattered.

Frustrated, I contacted [Gaby Chavarria](#), the head of Natural Resources Defense Council's Science

Program. Originally from Mexico, Gaby was no ordinary scientist, but a rare visionary and an innovator who could integrate science and policy. In this, she followed in the footsteps of her mentor E.O. Wilson, one of the most famous biologists in the world. With her PhD at Harvard on tropical bumblebees, Gaby would prove a quick study on the complexities of mountain pine beetles, blister rust, and climate change.

Gaby jumped at the invitation to come to Yellowstone, even though she juggled a massive science program. Gaby fell in with our gang right away, bravely slogging through deep snow to see grey victims of the beetle, and brainstorming with Jesse, Wally and me till the wee hours. She was in.

### Media Tour of Dying Whitebark Pine



*Members of the press looking at whitebark pine on a NRDC media tour, Beartooth Mountains, 2010.*

### Getting Up Close and Personal with Whitebark

With NRDC's support, we began to convene gatherings of journalists to tramp through whitebark pine forests with lead scientists from inside and outside the government. Our aim was to raise public awareness about the plight of whitebark pine and generate more resources to address the threats.

Fortunately, we could leverage other high-profile issues that were unfolding at the time. Climate change was emerging as big news – and the ecosystem that we featured was centered on our nation's oldest park. Plus, the connection between whitebark pine and grizzlies became a top concern during the runup to the government's controversial 2007 decision to strip federal protections for Yellowstone's grizzly bears and allow a sport hunt.<sup>38</sup>

We also provided reporters with flights over the growing seas of otherwise inaccessible red and dying whitebark pine forests in the Beartooth, Wind River, Absaroka, and Teton mountain ranges. Veteran pilot and friend [Bruce Gordon](#) of [Ecoflight](#) had long

before taught me that a birds' eye view is always the best way to provide a clear and compelling picture of a complicated and spatially extensive ecological problem.

Staging most tours from a ranch owned by a friend in Tom Miner Basin north of Yellowstone Park, we walked through incipient outbreaks of beetles in the Gallatin Range that predictably killed larger and larger swaths of whitebark each year. Roughly five years after we began the tours, most of the bigger trees that a few years earlier had been vital and green were silent, grey ghosts – sans squirrels, nutcrackers, and grizzlies. The lesson was hard to miss.

NRDC assisted in many ways, including by sending out talented communications experts such as Josh Mogerman, whose job it was to help experts speak English, not scientese. But the logistics of hosting these tours was backbreaking for our overworked three-person office in Livingston. Every year, as I drove wearily home from Tom Miner, I vowed we would never do it again – until the stories, often powerful and insightful, rolled out from PBS, NPR, Denver Post, Salt Lake Tribune, LA Times, Seattle Post Intelligencer and more.

And then the phones rang off the hook from people sharing new ideas and offering to help. We had more to do.

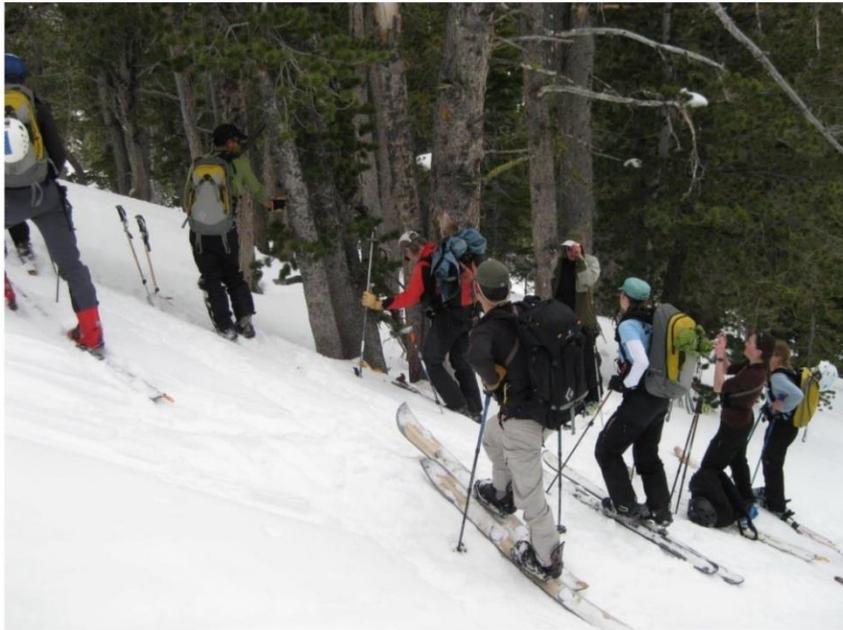
## **Harnessing the Passion of Citizen Scientists**

The calls and emails came from both coasts and from the heart of Yellowstone country, sometimes accompanied by photos of dead and dying whitebark. From outfitters alarmed about the loss of forest cover for elk; from mountaineers, skiers and guides. From fishermen fearing the end of a trout fishery dependent on cold water. From ranchers who saw the connection between loss of whitebark pine and loss of water for irrigation. And from citizens in love with the iconic lands of Yellowstone, some who had never stepped foot in the Park but dreamt of going someday.

Organically, people who would later be known as “citizen scientists” banded together to collect data on the health of whitebark pine. Equipped with cameras, strong legs, and a sense of adventure, people who were often not trained as scientists created an informal citizen science initiative to collect and share information. But I soon learned that coordinating the collection of uniform and useful data from diverse individuals across a rugged 26-million-acre ecosystem was no mean feat.

Again, Gaby came to the rescue, committing NRDC funds to formalize the work and ensure scientific rigor. With this support, Jesse and Wally designed the methodology for assessing whitebark health, while David Mattson helped shape how data were collected about wildlife.

## Citizen Scientists

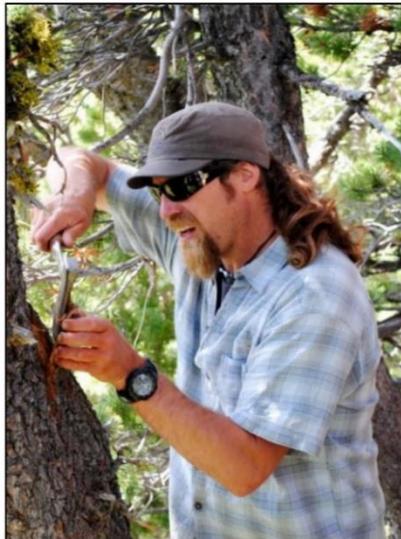


*Citizen scientists examine whitebark pine with Jesse Logan.*

Wally cleared his plate so that he could oversee the collection of data and training of citizen scientists. Encouraging and upbeat, with proficiency in Google Earth and ESRI GIS software, Wally was perfectly suited to the challenging task.

But the demands of training citizen scientists quickly overwhelmed us, leading Wally to bring in his wingman, Willie Kern, to help with logistics and training. Willie was a gifted teacher and skilled outdoorsman and naturalist—a perfect addition to Team Whitebark.

## Whitney Leonard & Willie Kern



*NRDC intern Whitney Leonard and consultant Willie Kern assisted the Landscape Assessment System survey of whitebark pine health, as well as the citizen science work, in incalculable ways.*

So was Whitney Leonard, who I hired at NRDC as an intern. Astute beyond her years, Whitney proved a capable field organizer for the training workshops, some conducted on skis. With patience and a winning smile, Whitney coached fledgling citizen scientists, showing them how to collect data, use a GPS, and record field observations.

Dena Adler, Capri Gillam, Colin Peacock, David Gonzales



*Whitebark Pine's Citizen Scientists, left to right: Dena Adler, Capri Gillam, Colin Peacock, David Gonzales*

Some citizen scientists specialized in places close to home, returning year after year to document the spread of blister rust and the outbreak of beetles. Chuck Neal, a retired ecologist with the Bureau of Land Management, recorded the outbreak near its origin, the east slopes of the Absaroka Mountains. Robert Hoskins and outfitters Tory and Meredith Taylor took on the southern Absarokas and northern Wind Rivers. David Gonzales, writer, filmmaker and backcountry junkie, tackled the Gros Ventre and Teton Ranges, eventually starting his own citizen science group, Treefight. John Gookin at the National Outdoor Leadership School trained instructors to collect data in the Wind Rivers. Gregg Trennish, founder of Adventurers and Scientists

for Conservation, organized a citizen science project in the Centennial Range along the Montana and Idaho border. And Colin Peacock, son of iconic grizzly bear champion Doug Peacock, brought students from Round River Conservation to monitor whitebark pine and wildlife in numerous parts of Greater Yellowstone.

One part of our citizen science experience involved deep listening. In addition to looking for tracks and sign, volunteers would stop at intervals to record what they heard – squirrels and nutcrackers of course, but many reported ravens, redtail hawks, and chipmunks and more. A number commented on how the experience of truly listening – not being distracted by smart phones or music or friends – was particularly powerful. So too was collecting data in groups.

I started writing down things people said at our training workshops:

Capri Gillam, Adventurer: “Hiking through a whitebark pine forest will never be the same again... This work requires learning together and a diversity of skills. There are the good hikers, those who know plants and those who know animal sign. There is always something to be learned no matter how skilled you are.”

Colin Peacock: “We experienced climate change viscerally and personally in an area I got to know and went back to year after year. I saw forests that had been around for about 1,000 years, but then the entire canopy was wiped out in the space of about three years. It’s scary and humbling watching ecosystems being snuffed out... But I’m not giving up.”

David Gonzales: “It’s so hard to watch these trees turn red, delivering their final blood-curdling shout to the world, saying that what’s happening to me is what is going to happen to you, because we are all on the same trajectory as these trees. This work has given me a new purpose -- and it’s ruined my life at the same time.”

Dena Adler: “One time, we stood in a grove of trees and we could hear the beetles actually chew the trees. We kept finding what we thought to be green trees, but looking closer, the beetles had found them already. It makes you feel like you’re part of the battle. If you find a green healthy tree, it’s a victory...”

Clearly, our citizen science work entailed more than simply recording data about a forest ecosystem. As I wrote in a 2011 publication of the Whitebark Pine Ecosystem Foundation<sup>39</sup>, we were learning that the work was changing lives.

## **Mystery Photo Reveals the Shocking Scale of Pine Death**

Bruce Gordon and his partner, Jane Pargiter, also a pilot, became invested in the citizen science work as well. He recounted: “Flying over forests that were green a few years ago and watching them turn red and then grey — it’s like a cancer on the forest, spreading so quickly. What a wake-up call about climate change.”

In July 2007, Bruce and Jane were flying from one of our media tours back to their home in Aspen, Colorado, when they looked out the window at a sea of red and dying whitebark pine larger than any they had seen before. Jane snapped a photo but later could not recall where she took it.

She sent the shot to Jesse, Wally and me, and we sent it to everyone we thought might be able to pin down the location. The photo was examined by dozens of astonished friends and colleagues, when out of the blue a remote sensing specialist with the Forest Service in Salt Lake City identified the location as being near Angle Mountain. He included a Google Earth image showing a green and healthy whitebark pine forest just two years before Jane took the post-mortem photo.

### Jane Pargiter and The Sea of Red



*In 2007, Jane Pargiter of Ecoflight shot the photo at right of red, dying whitebark pine near Angle Mountain on the Bridger Teton National Forest. The Google Earth image at left shows the forest just two years before when it was green and healthy.*

Not long after, the government began to use the image in official documents as the face of this unfolding tragedy. Indeed, Jane's photo would make its way into the 2018 Fish and Wildlife Service's Species Status Assessment<sup>40</sup> that justified the recent move to protect whitebark pine.

## Appealing for Help

In 2008 NRDC filed a 60-page petition to the Fish and Wildlife Service requesting that the agency list whitebark pine as an endangered species and designate critical habitat under the Endangered Species Act<sup>41</sup>. This petition represented the most comprehensive synthesis of the science on threats to whitebark pine completed to date and made a compelling case for whitebark pine being threatened throughout its range. We did not think that the forests would wink out entirely, but we did anticipate that they would cease to serve their age-old ecological functions in the foreseeable future.

Predictably, the petition gave some of our hitherto allies in government agencies the jitters because listing under the ESA could potentially limit management interventions such as logging and controlled burning that they favored. True, we responded, but listing would raise the profile of the tree, its ecosystem, and the threats they faced – and bring needed resources for research and restoration, which we maintained were more important.

Although the Fish and Wildlife Service resisted listing whitebark at first, it began to dig deeper into the threats.

So did we.

## **A Big Idea Takes Flight**

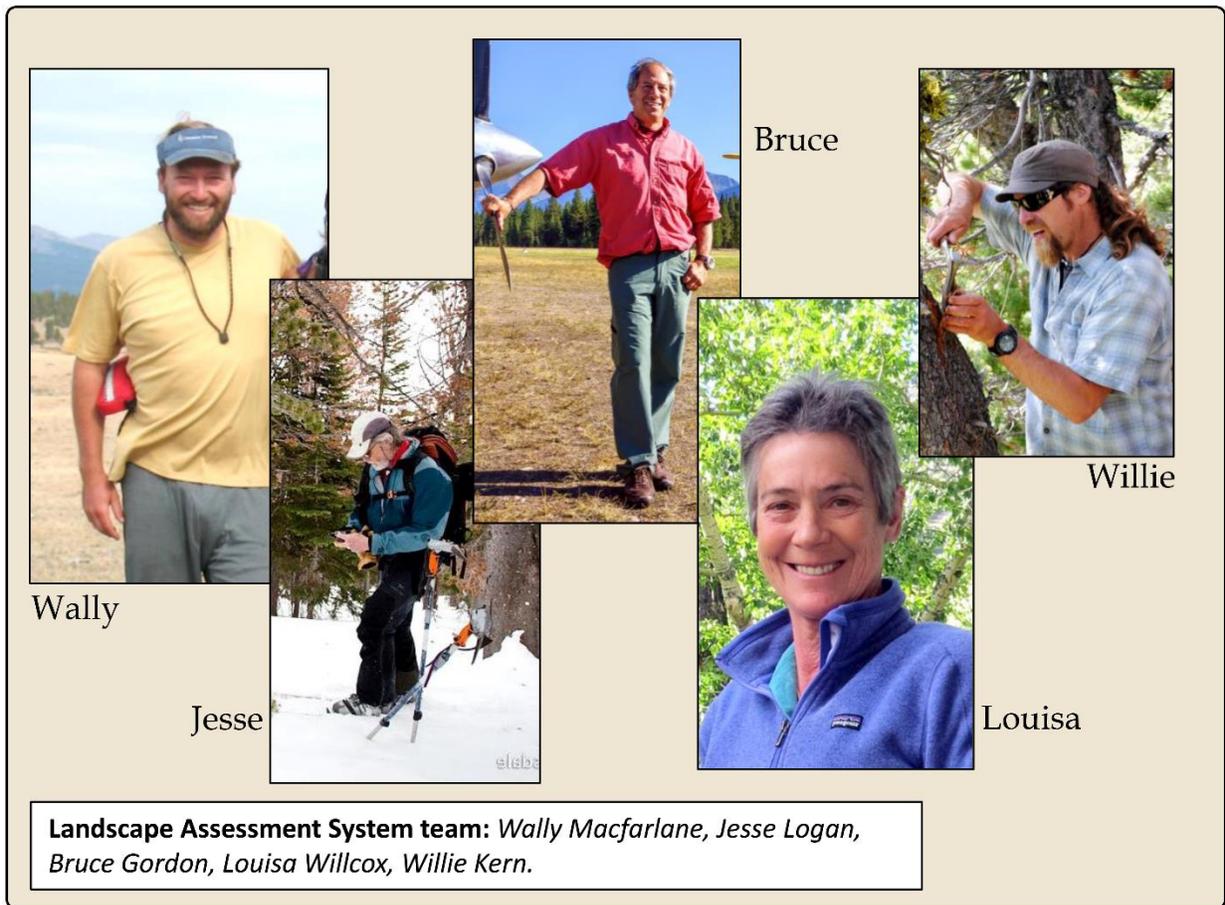
During the spring of 2009 I convened a public meeting in Jackson, Wyoming, that focused on the plight of whitebark pine. The meeting resulted from a fruitful collaboration between NRDC and the Teton Science School, an environmental education institution located in Grand Teton Park. We did not know it then, but the beetle outbreak was at its peak.

The packed meeting featured some of the usual suspects, including Jesse, Diana Tomback, myself and Bruce Gordon, the last of whom offered overflights to participants. Liz Davy of the Bridger-Teton National Forest took Bruce up on his offer. She was stunned. It was one thing to be on foot looking across at a ridge of dying trees, but quite another to fly over an entire dying forest.

With Liz, we hatched an idea that built on a proposal that Jesse had previously submitted to the Forest Service to assess the damage across the ecosystem from the air. But was Bruce and his Cessna up to such a huge task? And more fundamentally, was it even possible to assess the health of an entire species while flying at 13,000 feet and 100 miles per hour?

The tree offered some unique traits to work with. Most important, whitebark has a distinctive shape, more like a deciduous tree than a conifer, which makes it easy to differentiate from spruce, fir, and lodgepole pine, even from the air. Whitebark also turns a brilliant red the summer after succumbing to beetles – so dying trees are easy to identify even while flying 100 mph at 1,000 feet. Yes, we thought it could work. But who had the time, the expertise – and especially the money?

Theoretically, the Forest Service might be able to do the job, but it would probably take the agency years and cost hundreds of thousands of dollars. But we knew that forests of little commercial value would never qualify as a priority for the agency.



Even so, we hoped that the Forest Service could contribute some funds if we found the rest. On the back of an envelope, Bruce came up with some numbers for how much it would cost to fly all 22 mountain ranges of the Greater Yellowstone Ecosystem. Wally, Jesse and Willie fleshed out a system to evaluate whitebark health from the air on a watershed-by-watershed basis, dubbed the “Landscape Assessment System<sup>42</sup>.”

Gaby was confident that NRDC could help fund the work if the Forest Service were willing to match these funds. Liz went on to convince her boss, Forest Supervisor Kniffy Hamilton, and others in the Forest Service to commit to a joint survey project surprisingly quickly. Just a month after Liz’s flight with Bruce, we had secured commitments for matching funds from NRDC and the Forest Service.

## NRDC, Forest Service Team Up to Survey the Damage

In an arrangement none of us could have predicted, we developed a plan virtually overnight to assess the health of whitebark in Greater Yellowstone that summer. This plan included the Forest Service, Park Service, Bruce Gordon and Jane Pargiter from

EcoFlight, Wally, Willie and Jesse, and Natural Resources Defense Council. We would measure beetle-caused damage in mature whitebark on a subwatershed basis using geo-tagged aerial photography. Beetle-caused mortality would be assessed photo-by-photo using a numeric rating based on a previously developed schematic used to assess mountain pine beetle-caused mortality in other forest systems<sup>43</sup>.

But collecting data systematically for an entire ecosystem in only a few months was a daunting challenge. It was too late for the Forest Service or Park Service to commit staff that year. And I couldn't realistically serve as an aerial observer because I had thrown up in Bruce's plane too many times before.

Enter Colin Peacock and his girlfriend Dena Adler, who were by then experienced whitebark citizen scientists. On short notice, they jumped into the data collection, along with Willie Kern who oversaw the day-to-day operations. With a drive that only the young and possessed can muster, they got up with Bruce at the crack of dawn when the air was calm, and day-after-day flew until the turbulence made flying too hazardous – and then processed the day's data, often till late in the evening.

In a gracious gesture, The Murie Center in Grand Teton Park provided a basecamp of operations at modest cost. The place was fitting and close to my heart, as it had been home to renowned biologists and conservation icons [Olaus](#) and [Adophe Murie](#). Olaus' widow [Mardy](#), herself a famous environmentalist and author, had been a mentor to me. Near her old log cabin at the foot of the stunning Tetons, I felt like I was home again.

Things started to feel a little mystical, as if some force, maybe the tree itself, was calling the shots and pulling us together.

## Of Spinning Plates and Maxing Out Credit Cards

I describe my role in this work as that of spinning plates, but reporters often called me NRDC's whitebark pine "point person". But I was not really in charge. This was a free-thinking bunch that would not readily take orders, even if I wanted to give them. My job was to try keep an eye on the plates in the air and keep them from falling to the ground and shattering. Citizen science trainings, media workshops, overflights, and scientific presentations, plus coordination with agencies, staff at NRDC, other conservation groups, and lawyers all had to be attended to.

The first big road bump involved money as we racked up expenses for the summer survey work before the funding came through months later. But our hair was on fire. We were racing to catch up with the beetles. In hindsight, I am bemused by the fact that Wally and I did not hesitate to max out our personal credit cards to tide us over.

Louisa Willcox



*Louisa Willcox slacking off during a whitebark pine expedition in the Wind River Mountains...thanks to portable solar panel.*

Now that I look back, my career in conservation involved spinning multiple plates and making connections –not only ecological connections such as the one among tree, nutcracker, squirrel, and bear, but also connections with people who seemed different on the surface but nonetheless shared common goals – as well as connections between science, law, policy, and politics.

And here I found the connections that others were making to be most inspiring of all – citizen scientists with themselves and with high mountain ecosystems; experts inside and outside government; gonzo skiers with outfitters. Like raucous nutcrackers careening among whitebark pine trees during the fall, everyone was part of the action. And out of the chaos emerged a certain coherence and direction.

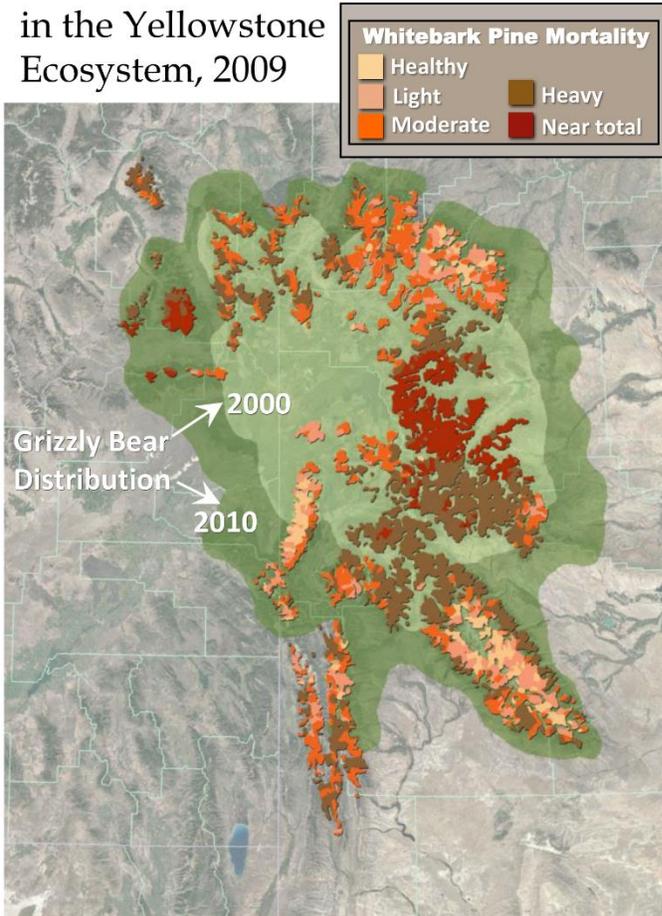
## **Grizzly News**

### **Few Whitebark Spared, But Findings Save Grizzlies**

By the end of 2009, Team Whitebark had taken five thousand aerial photos in 2,500 sub-watersheds throughout Greater Yellowstone. A grim picture snapped into focus.

We estimated that less than 20% of mature whitebark pine in Greater Yellowstone were healthy or nearly so – and only about 5% were completely untouched by beetles<sup>44</sup>. Importantly, about 80% of subwatersheds had suffered medium to high levels of beetle-caused mortality<sup>45</sup>. But the silver lining – if there was one – was that the assessment method held up under scientific peer review and rigorous scrutiny. The cost, moreover,

## Loss of Whitebark Pine in the Yellowstone Ecosystem, 2009



*LAS results: This map shows the damage to Greater Yellowstone's whitebark pine forests from mountain pine beetle in the outbreak that occurred between the early 2000s and 2009. Burgundy red shows dead whitebark pine. Dark brown shows forests that largely succumbed to massive beetle attacks. Orange denotes medium levels of damage. Beige shows where reasonably healthy whitebark pine forests remained. The lightest shade of beige shows healthy forests, untouched by beetles, in the highest mountains of the ecosystem. About 80% of the forests had suffered medium to high levels of damage, while only 5% of the forests were unscathed by beetles. Light green shows grizzly bear distribution as of the 1990s. Dark green shows grizzly bear distribution around 2010.*

came in at \$120,000, not including the time invested by volunteers and interns. It would have cost the Forest Service far more, if indeed the agency could have or would have responded on such short notice.

With only a few exceptions, people in the Forest Service embraced the project's results for good reason. This was the first ever aerial assessment of how climate change was impacting a tree species at an ecosystem scale. The low cost but reliable method also had implications for efforts to assess impacts of climate change far beyond the Greater Yellowstone<sup>46</sup>. It was no surprise that the subsequent publication on the work has since been cited as the gold standard on the topic.

With Gaby's help, Jesse, Wally, Willie, and I would move to get the results published, but before that glacial process could be completed, we had to put our work to the test in defending Yellowstone's grizzly bears.

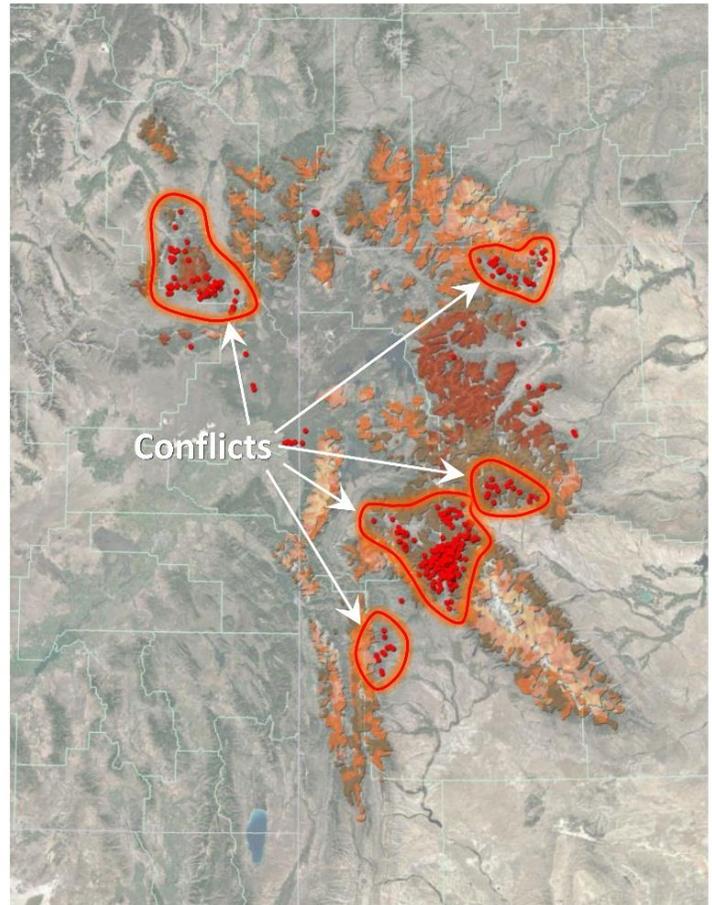
In 2007 the Fish and Wildlife Service stripped endangered species protections from Yellowstone's grizzly bears<sup>47</sup>, partly on the grounds that whitebark pine was doing fine and would continue to sustain the population. Flogged by the states of Idaho, Wyoming and Montana, eager to wrest control over grizzly bear management from the federal government, the agency

had chosen to rely on the [Forest Service's Aerial Detection Survey](#) system to assess whitebark pine health, knowing full well that the method was inadequate for detecting beetle damage, and that its claim of 16% mortality from beetles was outdated and a gross underestimate of the deadly truth. The Fish and Wildlife Service went so far as to argue that even if mortality was higher, whitebark pine didn't really matter to Yellowstone grizzlies – an assertion that contradicted all of the agency's own science.

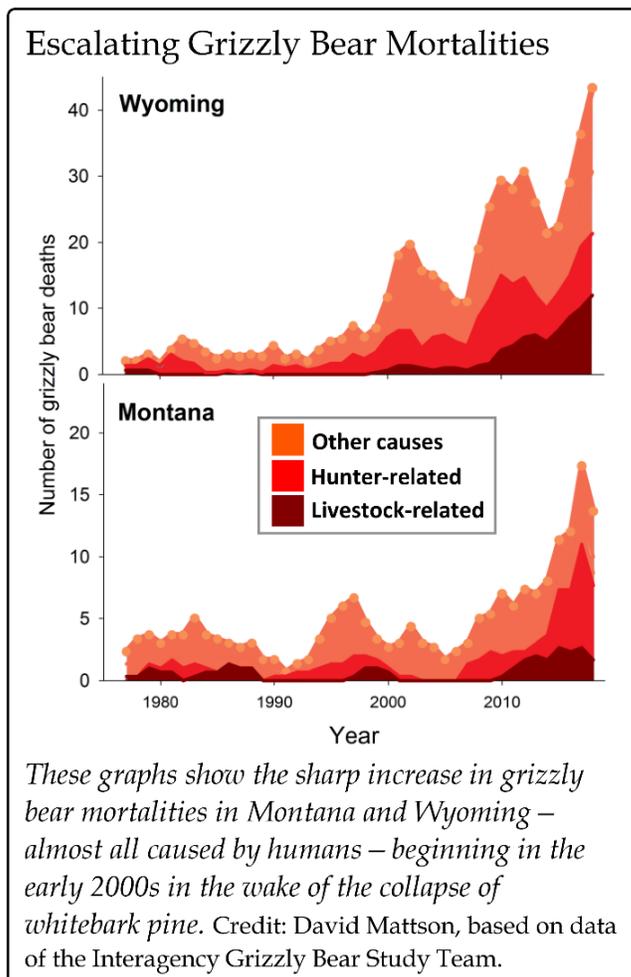
After our work during the summer of 2009, we were confident we had a much better estimate of whitebark pine mortality. Doug Honnold of Earthjustice filed an affidavit by Jesse in support of the case to restore protections for Yellowstone's grizzlies. Missoula-based federal Judge Donald Molloy heard the case that fall. In a decision that reinforced the power of science and the rule of law, he ordered the restoration of protections for grizzlies<sup>48</sup>, partly due to threats to whitebark pine and the significance of whitebark pine seeds to grizzlies, especially females.

Two years later, the ruling was upheld by the 9<sup>th</sup> Circuit Court of Appeals<sup>49</sup>. Setting the tone of the hearing, the Honorable Susan Graber asked why mother grizzlies are so dependent on abundant whitebark pine seed crops. The government attorney did not know the answer, but Doug did.

## Whitebark Pine Loss & Escalating Grizzly Bear-Livestock Conflicts



*This map shows grizzly bear-livestock conflicts 2002-2010 as red dots, most of which are concentrated in areas where mountain pine beetles have decimated whitebark pine. Following the collapse of whitebark pine, grizzly bears increasingly sought out meat from livestock and big game carcasses, resulting in conflicts with livestock operators and hunters. The consequences have been deadly for the involved bears. Credit: David Mattson, based on data of the Interagency Grizzly Bear Study Team*



Parenthetically, the government would go on to spend many thousands of taxpayer dollars to find a way around the court ruling – even as the evidence mounted that loss of whitebark pine was driving an unsustainable spike in human-caused grizzly bear deaths resulting from bears foraging nearer people on foods that often readily brought them into conflict with people<sup>50</sup>.

As a result of the lawsuit, the politically fraught debate over the grizzly bear threatened to bleed into the otherwise amicable whitebark pine arena. Some of our allies supported delisting, especially those in the Forest Service who bridled at our use of data that we had collected together. Indeed, some Forest Service staff tried to prevent publication of our work – without success.

In the end, our fears that litigation might poison our relations with the community of whitebark pine advocates were not, thankfully, realized. For the most part, shared concerns about whitebark pine overrode different views about management of grizzlies.

Meanwhile Wally took his collaboration with the Forest Service to the next level.

## Tracking a “Sneaky, Slow Burn”

Ever the Whitebark Warrior, Wally went on to work as a consultant for the Forest Service, leading a massive effort to update the 2009 survey to cover the period 2013 to the present. Overcoming logistical hurdles created by COVID, he and his team found that the out-of-control onslaught of beetles had waned, largely because an October cold snap during 2009 caught beetles unequipped with the antifreeze they produce for surviving winter. Most beetles in the high mountains died.

But the outbreak continues to simmer – not manifest as in-your-face seas-of-red, but instead as a slow deadly burn that adds up to more terrible news. And even the highest and coldest whitebark forests have not been spared. In 2009 about 5% of whitebark forests were untouched by beetles, but today none are free from the insect’s deadly kiss<sup>51</sup>.

Wally Macfarlane



*Wally Macfarlane, ever the Whitebark Warrior, continues to track the health of these forests as a consultant to the Forest Service.*

And with drought and warm temperatures, whitebark pine are severely stressed, making them even more susceptible to beetles – and potentially another massive outbreak<sup>52</sup>. But without vistas of red and dying whitebark, Wally fears that agencies and the public could relax into complacency, even as small armies of beetles continue to chew their way through remaining healthy whitebark pine.

Undaunted, Wally and Jesse are bringing a younger generation of eager ecologists into the whitebark clan. Last summer, Wally fielded a crew to ground-truth the new aerial surveys and collect additional data on wildlife use of whitebark pine forests. With the “all in” attitude that has characterized the whitebark clan from the start, Wally offered his summer seasonal staff the use of his personal truck if there was a bottleneck in the funding, proclaiming: “We are never going to stop fighting for these trees<sup>53</sup>.”

And when whitebark pine is finally listed, the Fish and Wildlife Service will officially be in the fight.

## Whither Whitebark?

Mounting scientific evidence shows that the fate of whitebark pine and the ecosystems it supports hangs in the balance. By midcentury – and maybe before – conditions will be ripe for another tsunami of beetles. Meanwhile, blister rust continues to reach its deadly fungal fingers into the circulatory systems of ever more whitebark pine – even in habitats previously thought to be inhospitable – while making survivors more vulnerable to beetle attacks<sup>54</sup>. Compounding this, blister rust infections are proving to be more severe and widespread than scientists had previously thought<sup>55</sup>.

But there is little doubt that climate change is the chief threat. As long as temperatures continue to warm, and as long as beetles can find food in the highest-elevation whitebark pine stands, all bets are off. As ecologists Bill Romme and Monica Turner wrote several in 2015, with the pace and extent of climate change, we have entered uncharted territory<sup>56</sup>.

As with Jesse’s previous predictions, current modelers are finding that their worst fears are coming true far more quickly than they imagined possible. The speed of these changes is the nemesis of slow-growing late-maturing whitebark pine trees. Indeed, the evolutionary traits that served the tree in the past may contribute to its downfall in today’s rapidly changing world. As Jesse, Wally, and I wrote, we need new research and strategies to respond to the crisis<sup>57</sup>.

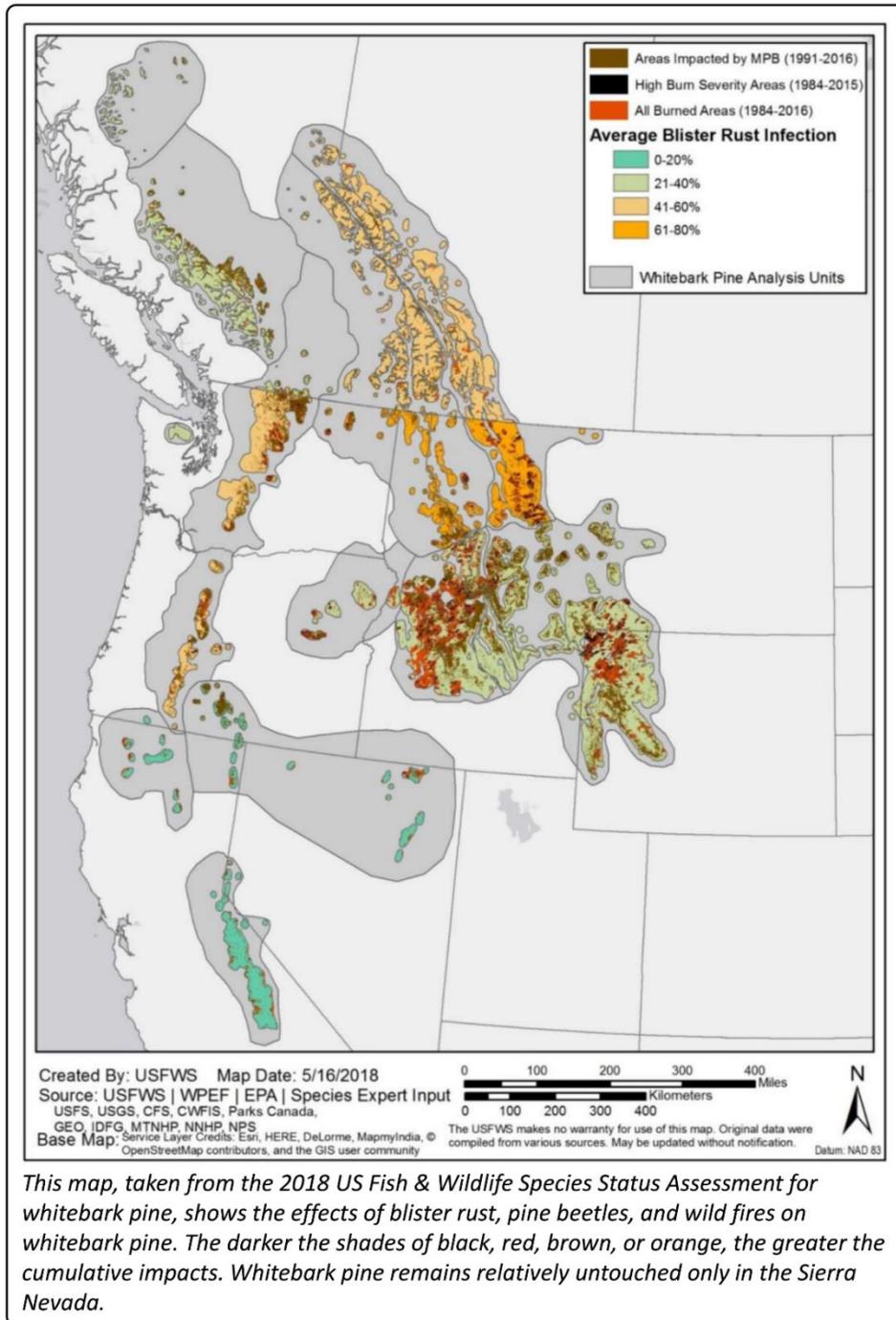
Not only is climate change shrinking suitable habitat for whitebark pine, it is increasing the threat of catastrophic fires<sup>58</sup>. Higher temperatures, lower rainfall, and earlier snowmelt are contributing to higher frequency, higher intensity, and larger scale fires<sup>59</sup>. Despite the fact that low-intensity smaller-scale wildfires can benefit whitebark pine by reducing competition from shade-tolerant competitors such as subalpine fir, whitebark pine can be devastated by massive fires such as occurred in Yellowstone during 1988<sup>60</sup>. Hotter fires kill mature whitebark pine, and nutcrackers respond poorly to large burns. Nutcrackers will abandon extensively burned areas because there is nothing to eat. Regeneration of whitebark pine is hindered, largely because the gardener it depends on has left<sup>61</sup>. This gives an advantage to other conifers that have wind-born seeds.

Overall, changing fire regimes driven by a warming climate will favor more fire-adapted conifers such as lodgepole pine and Douglas-fir, while at the same time accelerating the displacement of whitebark to ever higher elevations – a trend that has been afoot since the Pleistocene<sup>62</sup>. The problem is that whitebark are running out of mountain-tops.

Experts such as Diana Six and Jesse Logan are especially worried about the problematic, complex, and often nonlinear synergies among blister rust, climate change and beetles that can be enormously hard to predict<sup>63</sup>. Along these lines, in the listing proposal the

Fish and Wildlife Service questioned the pine’s ability to persist over the next 100 years in light of the combined effects of altered fire regimes, climate change, and blister rust<sup>64</sup>.

The scale and complexity of these threats raise questions about the wisdom of relying so heavily on the two approaches that have dominated whitebark pine conservation so far: planting rust-resistant whitebark seedlings, and burning to free whitebark pine from tree competitors.



## Silver Linings?

Fortunately, whitebark pine have some things going for them. They enjoy a wide distribution across the West – meaning that not all our eggs are in one basket. Whitebark pine also has high levels of genetic diversity and a number of locally adapted genotypes that Diana Six, Cathy Whitlock and others believe may confer the ability to adapt to threats<sup>65 66</sup> – but only up to a point.

For example, Six has documented monster whitebark pine trees untouched by beetles in some stands that have otherwise entirely succumbed, suggesting that some whitebark have higher concentrations of resin compounds toxic to beetles and/or lower concentrations of the sugary phloem that beetles look for<sup>67</sup>. That would be good news indeed.



*A classic elven or krummholz form of whitebark pine growing at upper treeline in the Warner Mountains of northeastern California. Credit: David Mattson*

And as Jesse Logan emphasizes, whitebark pine is widely distributed in the highest subalpine zones as a Krummholz growth form hugging the ground. These Krummholz trees can assume upright growth forms if conditions are favorable, which allows them to grow taller than competing conifers encroaching into higher elevations<sup>68</sup> – at least for a time, and maybe long enough for us to turn the thermostat down on Earth's temperature.

In addition, alpine habitats in the lower 48 states and further north in Canada and Alaska might become suitable for whitebark to survive in as the climate warms. Given the changes underway, Jesse and others believe

that we should not limit our vision to where whitebark pine is living today, but consider where it might live in the foreseeable future<sup>69</sup>. In comments on the draft listing rule, numerous scientists recommended that both current and potentially suitable habitat should be designated as critical habitat under the ESA, and thereby given special consideration.

Given how much we have lost already and remaining scientific uncertainties, they also urged caution in managing whitebark pine.

## The Need for a Precautionary and Adaptive Approach



*The classic profile of whitebark pine, bared to the elements thanks to a massive avalanche that spared this cluster of trees.* Credit: David Mattson

The principle of precaution is built into the bones of the ESA – an admonition to carefully consider potentially unforeseeable consequences before leaping into action and making a bad situation worse. So is the principle of “do no harm.” Both are vital since we humans are notorious for mucking about with good intentions, while adding insult to injury. Both principles are critical to effectively recovering whitebark pine given current levels of uncertainty and the risk that those in charge might have blinders on.

Clearly, no one person or agency has all the answers to the problems facing whitebark pine. Like all people who work for government agencies, employees of the Fish and Wildlife Service are prone to living in an echo-chamber that reinforces their preconceptions and worldviews – an approach that has had problematic consequences for grizzlies and other endangered species. That would be a serious mistake here.

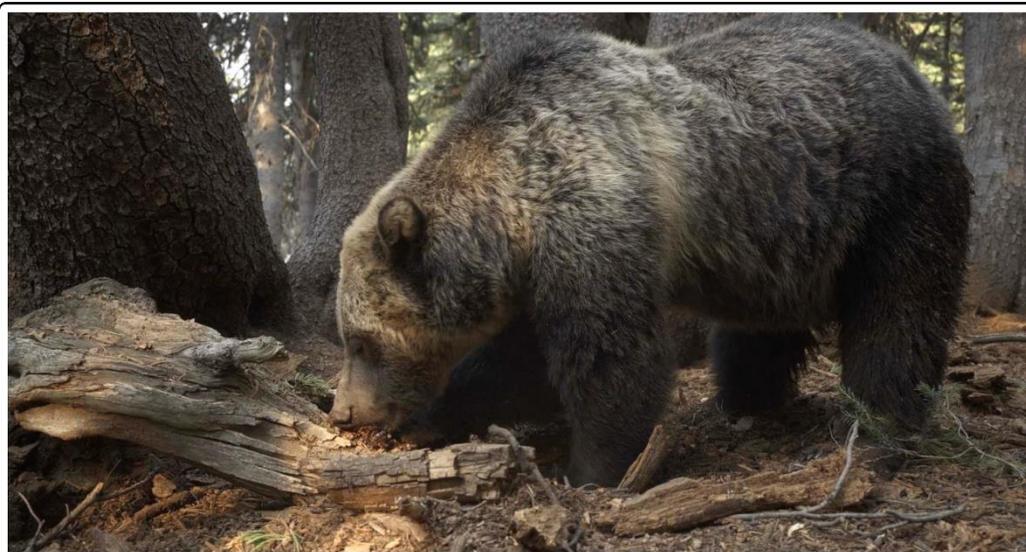
Management that relies on a broad-based collective of creative, smart people with different viewpoints – including a goodly representation of women – has almost certainly the best prospects of tackling what may seem like an intractable problem: recovering whitebark pine.

Here, the Fish and Wildlife Service would be wise to build on the collaborative work done so far by constituting a diverse whitebark pine recovery team, with experts in blister rust, beetles, climate change, and forest management from inside and outside government, perhaps also including people with less scientific expertise but a long-standing passion for the species. This is consistent with a recommendation made by a

number of experts associated with the Ecological Society of America that recovery teams for endangered species be diverse<sup>70</sup>.

This means broadening the government's current scope and perspective on the problems and solutions. So far, recovery efforts have understandably focused on planting blister rust-resistant whitebark pine seedlings<sup>71</sup>. But planting is hardly a panacea – especially given the diversity of threats and the fact that most current as well as potential future whitebark pine habitat is distributed in roadless areas with various degrees of federal protection.

Researchers such as Diana Six are also concerned that too much planting can reduce genetic diversity and even introduce locally maladaptive genes, while at the same time swamping prospectively positive adaptations of local trees<sup>72</sup>. If planting is done, cones ideally would be collected as close as possible to ensure that local genetic variants are favored. As a corollary, it makes little sense to expend scarce resources on planting trees where climate models show that habitat will not be suitable in the foreseeable future.



*This photo was taken with a remote camera deployed near Mud Lake on the Beartooth Plateau by researchers from The Cornell Lab of Ornithology. The bear is greedily consuming whitebark pine seeds from cones cached by a red squirrel. Photo by The Cornell Lab of Ornithology*

In comment letters on the Fish and Wildlife Service's draft listing rule, a number of scientists warned against focusing on one facet of the problem, such as blister rust, while ignoring other threats as well as the synergistic interactions among them. As Diana Six wrote: "This is a three-prong stool and fixing only one leg will not be sufficient. It will take a holistic and careful approach to save this tree and ensure that efforts to alleviate one problem do not exacerbate the others<sup>73</sup>."

As an example, several experts have observed that thinning or burning to “release” whitebark pine from competition with shade-tolerant trees such as spruce should be approached carefully because it could easily lead to unintended negative outcomes<sup>74</sup>. Slow-growing whitebark that have been spared by beetles may actually become more vulnerable after thinning when they start to grow more quickly and produce more beetle-enticing sugars. And, of particular relevance to thinning, whitebark pine is at risk of being edged out by more shade tolerant competitors in only a small part of its range.

As a bottom line, intrusive management has the potential of doing more harm than good, not only for whitebark pine, but also for animals such as grizzly bears that depend on high-elevation habitat for security. For bears, building roads into the remote haunts of whitebark pine is especially problematic because it prospectively increases access for humans, among whom will always be a handful of poachers<sup>75</sup>. And unwarranted heavy-handed management is a very real risk given predispositions built into the Forest Service’s technocratic culture centered on exploiting forests.

## What Losing Whitebark Pine Means to Ecosystems

### The Whitebark Pine Ecosystem



*The rich ecosystem of whitebark pine. Credit: Larry Eifert, [www.larryeifert.com](http://www.larryeifert.com)*

We also need to learn more about the consequences of losing whitebark pine for the ecosystems it sustains – ecosystems comprised of numerous species in addition to nutcrackers and grizzlies. Nutcracker experts are concerned, for example, that birds will simply abandon sites that have suffered widespread losses of mature whitebark pine<sup>76</sup>, making it harder for trees to regenerate even if conditions are suitable<sup>77</sup>. We are already seeing a shift in nutcracker foraging to lower elevation species such as Douglas-fir and limber pine.

Grizzly bear experts are deeply concerned that whitebark pine losses are forcing Yellowstone bears to forage ever closer to people and increasingly turn to killing livestock as a means of compensating for loss of a critical food<sup>78</sup>. Indeed, since the beginning of the beetle outbreak in the early 2000s, rates of human-caused deaths have skyrocketed to unsustainable levels<sup>79</sup>, threatening to reverse 40 plus years of hard-fought gains for the bruin<sup>80</sup>. But federal government officials have so far turned a blind eye to the problem for political reasons, foreshadowing the potential politicization of whitebark pine recovery efforts. Admitting the real consequences of losing whitebark pine would cast doubt on the wisdom of ongoing efforts to strip protections and institute a sport hunt on Yellowstone's grizzlies.

Importantly, rather than being an exception to the rule, this history of grizzly bear management is in fact the rule. Agency officials almost invariably entrench in the defense of past commitments and, in the process, exclude alternative perspectives. The hazards for whitebark pine management are clear.

A more complete and realistic understanding of costs and benefits, tempered by due regard for uncertainties, could help us envision policies for ameliorating losses. For example, experts on climate, grizzly bears, and whitebark pine such as Cathy Whitlock, David Mattson and Jesse Logan, believe we should be doing more to offset the inevitable loss of resilience in whitebark pine ecosystems by protecting more lands as Wilderness. Although not a silver bullet, increased protections provide not only security from intrusive human activities, but also a potential buffer at a time of unprecedented change.

Given the seriousness of the threats facing whitebark pine and all of the species that depend on it, ESA protections helps bring a much-needed spotlight for magnificent forests with enormous ecological importance to wild animals, watersheds – and us. Convening a diverse recovery team is, moreover, prospectively crucial for preventing well-intentioned but narrowly-focused people from making the current bad situation even worse.

## **Whitebark's Iconic Power**

I have thought long and hard about the larger prospective lessons that emerged from our campaign to protect whitebark pine. Although every situation is inescapably contingent and complex – even to the point of being a singularity – we need insights that will help us better pursue conservation at a time of unprecedented urgency.

We were blessed that an iconic and beautiful tree in one of our most symbolically potent landscapes was at the center of this debate. Yellowstone and the West are cultural touchstones. And for many, whitebark pine forests signify high mountain country, pristine streams, and the freedom of wild places.

Since time immemorial, trees have represented life, endurance, and a connection to the heavens. And whitebark pine forests have long been involved in a special relationship with humans. Indeed, ancient whitebark pine have witnessed the evolution of our world.

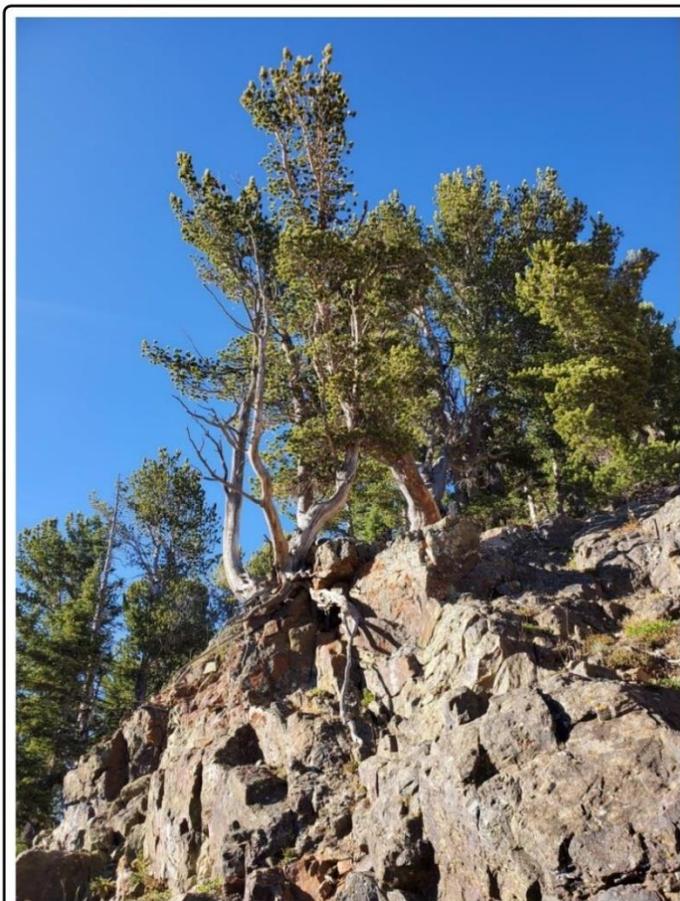
Flourishing long before Columbus' arrival, ancient whitebark pine trees seem to possess an incandescent power to bring people together. Managers, environmentalists, fishermen and others care about these iconic forests for a variety of reasons: ecological, aesthetic, and even spiritual. Here, shared values and shared passion facilitated fruitful collaboration.

The symbolic importance of a species or landscape is not critical to focusing public attention, but it sure helps.

## **Minimal Power and Wealth Stakes**

Because whitebark pine do not make good lumber and often grow in places devoid of commercial value, those seeking to perpetuate status quo exploitation of the environment have not apparently found it worthwhile to engage in the debate over these forests. This means less contention than is commonly the case in conservation, where those invested in profiting from extraction of natural resources often resist constraints.

The ideological stakes are also not as high, especially in contrast to the arenas organized around wolves and grizzlies. Plus, there is, as yet, no villain or hero. Whitebark Warriors understood that all of us who contribute to warming the planet are culprits, while at the same time those of us trying to understand the whitebark pine ecosystem and do something helpful are heroes as well. Alarmed by images of “seas of red,” we were basically on the same side trying to figure out what to do.



*This cluster of whitebark pine is emblematic of the harsh rocky habitats that this rugged species can colonize and survive in. Credit: Louisa Willcox*

At the opposite end of the spectrum are bruising battles over grizzlies and wolves where the ideological stakes are extreme, and the people invested in making money from exploiting nature are powerful. One side sees these large carnivores as symbols of beauty and wildness, whereas the other sees them as a constraint on business as usual and a threat to the ethos of domination. Opportunities for collaboration are rare and highly contingent.

If the whitebark debate had been framed entirely around grizzly bears or climate change – both divisive issues – it too might have become a toxic political cesspool. The lesson here is: look for ideological common ground, keep the power and wealth stakes as low as possible, and be strategic about navigating the backlash of those invested in exploitation.

## Shared Passion Inside and Outside Government

We were also blessed by the character of the leaders and volunteers who showed up, shouldering huge responsibilities, most without much if any financial reward. We were lucky too that talented and dedicated academics and agency officials shared a love of whitebark pine, often working on a shoestring. This contributed to a more inclusive and creative atmosphere and ultimately a better orientation to practical problems than is typical of conservation. The fact that a large environmental organization and the Forest Service were able to quickly collaborate on a large-scale survey was testimony to the commitment of those involved and their ability to move the institutions they worked for.

The nature and orientation of those comprising the government's Whitebark Pine Working Group mattered enormously. The leaders of this arena were generally

friendly, curious, openminded, and respectful – and not accidentally, largely female. This could not have been more different from the arrogant, “us versus them,” behavior typified by the largely male silverbacks that populate agencies involved in managing grizzly bears. Such behavior exacerbates rather than alleviates conflicts.

In addition, funding shortages in the government and academia made collaboration with nonprofit groups outside government imperative. Because no one agency or entity had the resources to adequately address the crisis, we had strong incentives to work together. But the point is that collaboration here involved a pooling of brainpower and resources that yielded results that could not have been achieved otherwise.

One might ask, if the arena was so friendly, why did a formal listing petition need to be filed? The answers are straight-forward. For one, bureaucratic inertia in government is legendary. For another, whitebark pine is not a high-profile species with a vocal constituency, like grizzly bears or lynx. Making matters worse, the ESA is seen by many in government as a chain around their necks rather than a needed safety net. Compounding this, Washington DC agency leaders tend to be motivated by climbing the career ladder, dealing with Congress and the administration, and biggerring budgets – not addressing substantive problems or responding to pressure from underlings.

Our listing petition helped cut through the bureaucratic lethargy. Even so, FWS drug its heels and failed to produce the required 12 month finding in response to our petition for nearly three years – fulfilling its legal duty only because NRDC threatened to sue. Its 2011 finding that whitebark deserved to be listed (but was precluded by other priorities) meant that the agency had to continue investigating the problem – investigations that finally convinced it to listing the species.

As a bottom line, it helps to have a pointy stick -- here in the form of a legal petition -- even if the administration is basically supportive. Conservation advocates like myself ended up being friendly foes forcing agency higher-ups to act.

## **The Clan of the Whitebark Warrior**

Whitebark Warriors outside the government came together as a surprisingly powerful force for change, largely because the right people showed up at the right time with the right skills. Importantly, Warriors were on a level playing field insofar as power is concerned, with shared passion and willingness to show mutual respect.

It helped that no one organization was invested in being in control and appropriating credit for everything that happened. Decentralized authority and decision-making

meant that the work did not flounder on the shoals of organizational jealousies, bureaucracy, and rigid plans – scenarios I have seen too often.



*A classic open-grown whitebark pine on rocky wind-blasted substrate near the upper-elevation limits of where it can grow upright. Credit: Louisa Willcox*

Yes, NRDC was the group with the most resources and institutional skin in the game, but the work was shared. Better ideas emerged out of sometimes hilarious and chaotic discussions, where no idea was too nutty. This might suggest we had no strategy. We did, but we adapted it constantly.

Someone had to keep track of all the pieces, a task that fell to me. Unlike the many volunteers, at least I was on salary. I cannot say I was the best leader or manager – or the most organized – but others were not shy to jump in or straighten me out when I needed it. The fact was that someone had to be the juggler of plates.

No doubt, a few assholes or egomaniacs could have wrecked the whole thing. But instead, we had Gaby, Wally, Willie, Jesse, Bruce, Liz, and so many other talented, gung-ho, inspired, fun-loving people willing to make sacrifices for these forests. The spirit proved contagious.

Fun and inspiration may not seem critical in this serious-minded business, but they are. I recall often being at the end of my rope, but then someone would show up with a new idea or a fresh volunteer, and the work seemed doable again. Often the idea involved another excuse to get up into the high country and whitebark forests, look for elk and bear sign, listen to nutcrackers – and just be.

Truth be told, we were uplifted and unified by the forests, the challenges, and each other. Here and elsewhere, I have found that inspiration, persistence, and flexibility are rocket fuel for change.

## **Power of the Press**

I was astonished by level of interest among reporters in the plight of whitebark pine ecosystems. The media proved to be a powerful ally, helping to educate the regional and national public about the ecological roles of whitebark pine and threats to its

existence. As important, the media elevated the problem inside the federal government. I have no doubt that stories about the pine's peril helped convince Judge Donald Molloy to take a hard look at the threat posed to grizzly bears by loss of whitebark pine and inadequacies of the Forest Service's conventional methods for assessing mortality caused by bark beetles

We were lucky that, at the time of our work, reporters were digging into stories about real-world examples of climate change. It helped too that the drama around grizzly bear delisting was unfolding at the same time. Plus, during summer, readers are always hungry for stories about National Parks—none more beloved than our oldest. And here, the sight of entire mountain ranges of red, dying forests was hard to ignore.

Granted, most of our work took place before the recent media ice age that seems to have frozen out scientific evidence, and during the last gasp of the endangered environmental reporter who specializes in science and policy. Nonetheless, positive press about species such as whitebark pine—or any environmental issue for that matter—does not fall into your lap. You have to work at it.

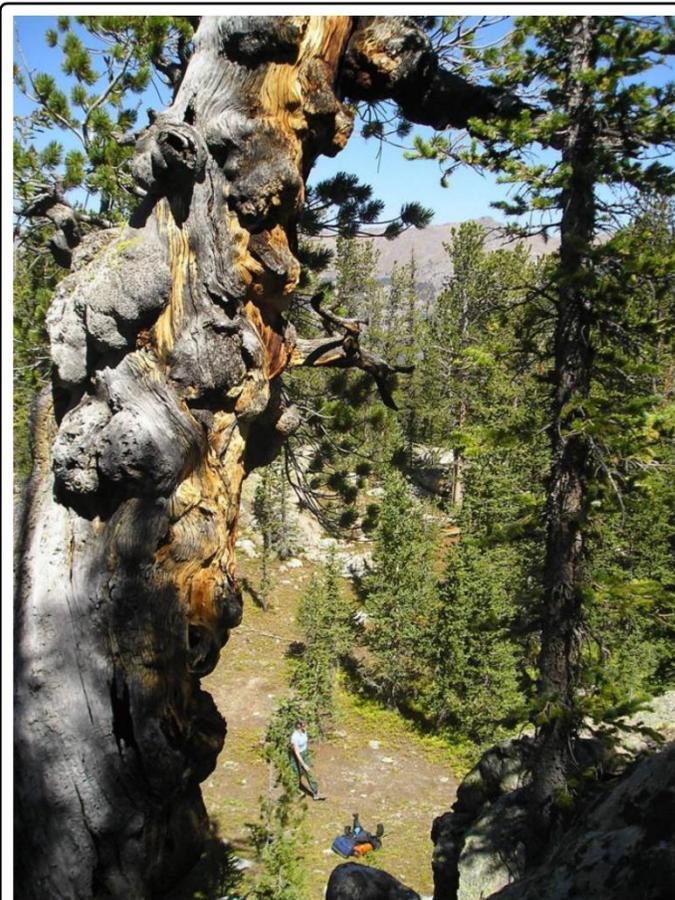
In this case, there was no substitute for bringing reporters out into these iconic forests in the company of articulate and informed experts. Overflights were especially powerful for showing the true scale of the disaster.

## **Ripple Effects of Citizen Science**

The impacts of our citizen science work on the involved individuals were profound, even though it only marginally improved our understanding of the problems facing whitebark pine. Since our field investigations, citizen science initiatives have exploded around the globe, becoming more ambitious, more rigorous and better integrated. And practitioners everywhere are learning, often the hard way, that some citizen science holds up better than others.

In our case, the scale of the problem—26 million acres of remote, rugged country—outstripped what any citizen science endeavor could have tackled. As it turned out, the aerial survey proved to be scientifically far more rigorous than the citizen science, but some of the work did add important localized knowledge about the health of whitebark pine forests.

For years after I moved on from NRDC, the citizen science work we inspired continued. David Gonzales and Treefight brought hundreds of volunteers into the Gros Ventre and Teton Ranges to staple verbenone pouches on whitebark pine trees, in the process opening the eyes of these volunteers to the value of these forests and the ecosystems that they embody.



*An ancient and gnarled survivor, hundreds of years old, in high elevation haunts of the Wind River Mountains. Credit: Ed George.*

Other citizen scientists took the warrior spirit into environmental careers. Dena Adler became an attorney devoted to promoting a meaningful response to climate change. Colin Peacock works on sustainable food systems in Alaska. Willie takes cancer survivors into the woods. Whitney, also an attorney now, works on behalf of Indians in Alaska. And Wally has some new summer interns from Utah State University working on whitebark pine research under Forest Service auspices. Meanwhile, Jesse Logan, at 77, continues to outski youngsters less than half his age, while advocating for wilderness and whitebark pine in his spare time.

Although it is impossible to definitively gauge the effects of this citizen science work on those involved, there is no doubt that it transformed lives.

## Of Alchemy and Moving Providence

I am not a believer in pixie dust, but we seemed to have our fair share blowing around. One person acted, inspiring another, and another, triggering an avalanche of complementary actions large and small. The people at the white-hot center of our little clan radiated passion and purpose that ignited others. Together, we were lightening in a bottle.

It almost felt like ancient whitebark pine had a hand.

I recalled what the Scottish mountaineer and wilderness advocate William H. Murray wrote on his way to climb Everest in 1951<sup>81</sup>:

“The moment one definitely commits oneself, then providence moves too. A whole stream of events issues from the decision, raising in one’s favor all manner of unforeseen incidents, meetings and material assistance, which no man could have dreamt would have come his way. I learned a deep respect for one of Goethe’s couplets: ‘Whatever you can do or dream you can, begin it. Boldness has genius, power and magic in it!’”

In decades of conservation work, I have rarely seen such collective boldness and so little of the kind of inertia, internecine conflict and goal inversion that plagues otherwise laudable environmental campaigns. I too felt I was part of an alchemical reaction, rare and spectacular as the northern lights.

The imminent listing of whitebark pine under the ESA opens a new chapter. It remains to be seen whether or not this bold spirit will continue in the face of the kind of bureaucratic and political traps that typically hamper endangered species recovery, including entrenched views, lack of vision, and turfiness over power and resources.

At this critical time, listing offers a lifeline to these forests – but action needs to be tempered with caution and humility. Because no one expert has all the answers, a sensible path involves giving climate experts, advocates, geneticists, ecologists, and entomologists – inside and out of the government alike – a meaningful seat at the table, including roles on a recovery team. Diverse perspectives and a democratic process are more likely to yield effective results than one agency operating in a silo.

To me, diversity and openness also promises to advance conservation more broadly in these highly uncertain and rapidly changing times, when the old ways of doing business are failing the earth and our society. At the very least it is worth a shot – for the sake of Grandmother whitebark and an extended ecological family that includes ourselves.

## Recommended Reading

These popular books offer a wonderful introduction to whitebark pine ecology and the threats that these tree face:

Lanner, Ronald, 1996. Made for Each Other: A Symbiosis of Birds and Pines. Oxford University Press.

Nikiforuk, Andrew, 2011. Empire of the Beetle: How Human Folly and a Tiny Bug Are Killing North America's Great Forests. David Suzuki Foundation Series.

Tomback, D.F., Arno; S.F., Keane, R.E., eds., 2001. Whitebark Pine Communities: Ecology and Restoration. Washington, DC: Island Press

David Mattson provides an excellent summary of whitebark pine ecology, paleoecology, importance to grizzlies, threats, and future prospects: <https://www.mostlynaturalgrizzlies.org/whitebark-pine> and <https://www.grizzlytimes.org/single-post/2017/07/29/The-Late-Great-Whitebark-Pine>

## Acknowledgements

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<sup>41</sup> Natural Resources Defense Council, 2008. A Petition to List the Whitebark Pine, *Pinus Albicaulis*, as an Endangered Species under the Endangered Species Act. The petition was written by top lawyers and scientists, including Melly Rueling, Sylvia Fallon, Susan Casey-Lefkowitz, Andrew Wetzler, Niel Lawrence and myself, and reviewed by experts such as Jesse Logan and Diana Tomback.

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<sup>44</sup> Macfarlane W. M., J. A. Logan, and W. R. Kern, 2013. An innovative aerial assessment of Greater Yellowstone Ecosystem mountain pine beetle-caused whitebark pine mortality. Ecological Applications 23:421–437.

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<sup>46</sup> Logan J. A., W. W. Macfarlane, and L. Willcox, 2009. Effective monitoring as a basis for adaptive management: A case history of mountain pine beetle in Greater Yellowstone Ecosystem whitebark pine iForest 2:19-22

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<sup>48</sup> Greater Yellowstone Coalition, Inc. Plaintiff, v. Christopher Servheen. 2009. United States District Court, D. Montana, Missoula Division 672 F. Supp. 2d 1105

<sup>49</sup> Greater Yellowstone Coalition, Inc. Plaintiff, v. Christopher Servheen. 2011. United States Ninth Circuit Court of Appeals, 665 F.3d, 1015, 1019.

<sup>50</sup> Mattson, David. 2019. Testimony to Natural Resources Committee Subcommittee on Water, Oceans, and Wildlife United States House of Representatives. Online: [https://ac0c4080-191f-4917-bc0f-9e80bf3a3892.filesusr.com/ugd/d2beb3\\_2fe7850814c04f6c900fd9d57336f83d.pdf](https://ac0c4080-191f-4917-bc0f-9e80bf3a3892.filesusr.com/ugd/d2beb3_2fe7850814c04f6c900fd9d57336f83d.pdf)

<sup>51</sup> Macfarlane, Wally, pers. comm. June, 2021.

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<sup>68</sup> Logan, Jesse. 2021. Comments submitted to Fish and Wildlife Service on Proposal to List Whitebark Pine under the Endangered Species Act.

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