

Appendix: Survey Instrument

Note: Actual survey administered online; formatting appeared differently for online viewing, but all content matched that provided in this paper-version reproduction.

High-Elevation Forests *and* White Pine Blister Rust

This survey was developed by researchers at the Department of Agricultural and Resource Economics at Colorado State University. It asks what you think about a current threat to high-elevation forests. You do not need any special knowledge about forests to complete this survey. We will provide the information you need.

Foxtail Pine



White Pine



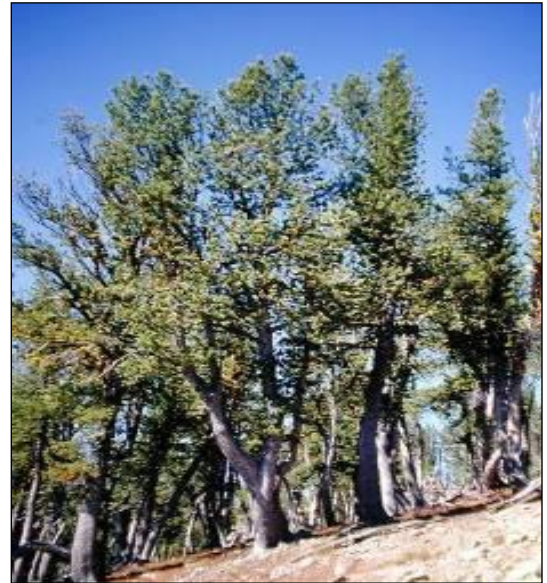
Bristlecone Pine

High-elevation forests

High-elevation forests include the trees that are collectively known as *white pines* or *five-needled pines*:



Rocky Mountain Bristlecone Pine



Whitebark Pine



Bristlecone Pine

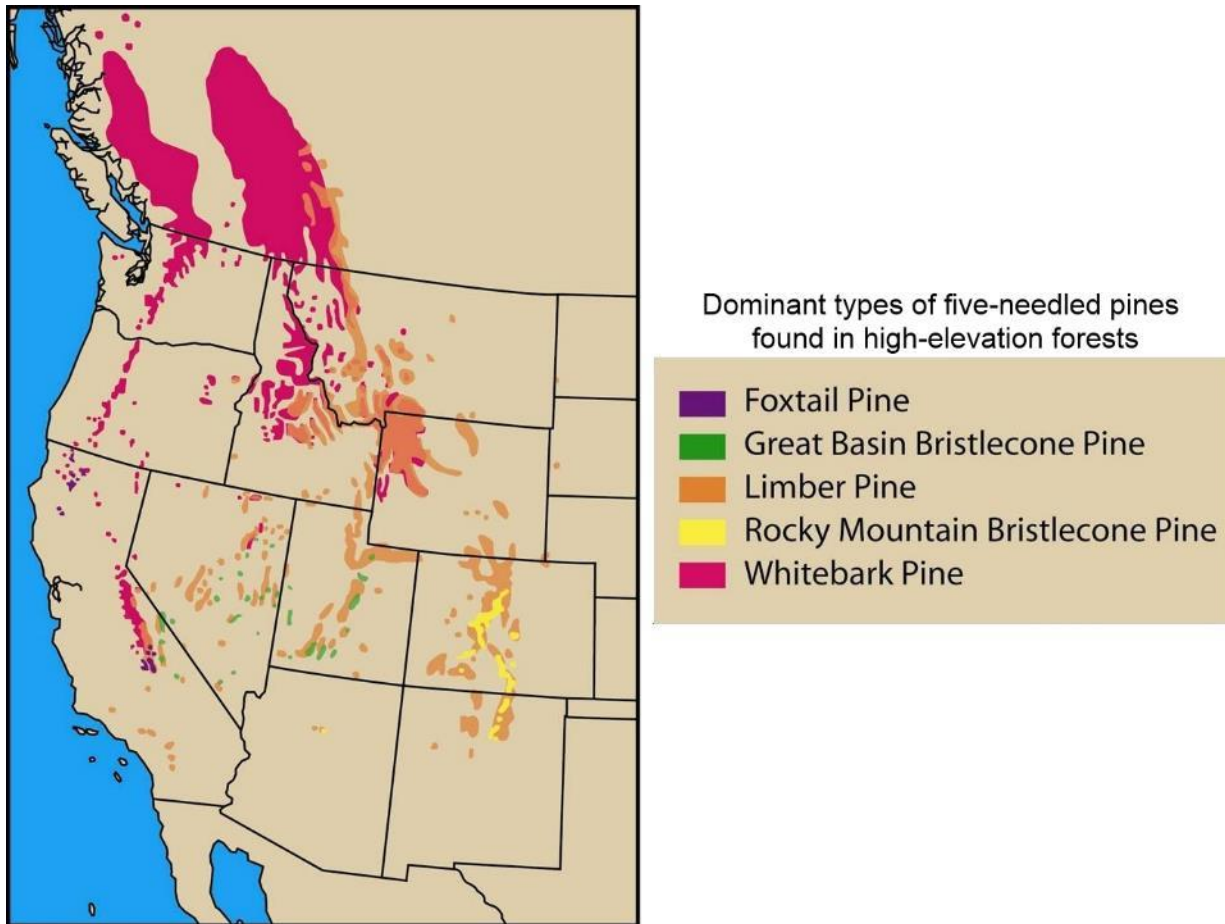


Foxtail Pine



Limber Pine at Treeline

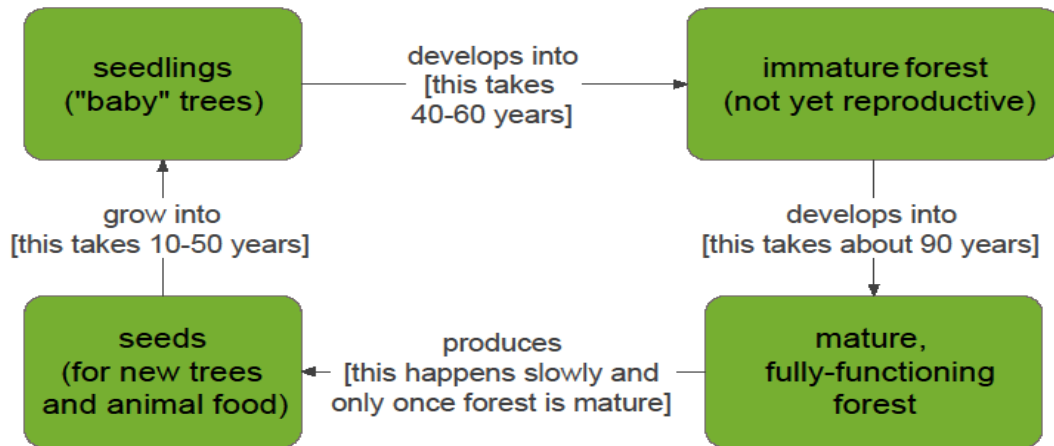
High-elevation forests are found in the Western United States above about 5000 feet in elevation, near the tops of mountains and at the upper limits of where trees are able to grow. In total, there are about 2 million acres of *high-elevation forests* in the Western United States. The map below shows where these forests can be found.



Q1. Please tell us about your previous knowledge and experience of the *high-elevation forests* by answering the following questions. There are no right or wrong answers to these questions.

Before taking this survey, had you ever heard of any of the <i>five-needled pine trees</i> , such as the Bristlecone Pine or the Whitebark Pine?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Before taking this survey, had you ever heard of a <i>high-elevation forest</i> ?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Have you ever been to a <i>high-elevation forest</i> in the Western United States?	Yes <input type="checkbox"/>	No <input type="checkbox"/>

The basic life-cycle of *five-needled pines* is shown below.



The life-cycle of *five-needled pines* in a healthy *high-elevation forest*

- In a healthy *high-elevation forest*, all four stages of this life cycle occur at the same time.
- The time between the stages is long. If seedlings are planted today, they will become mature trees in 140 to 200 years.
- The time between the stages also varies with conditions. For example, seeds more commonly grow into seedlings after a disturbance that results in an opening in the forest, such as a fire or tree cutting.

Five-needled pines are among the few tree species that are able to survive in the intense cold, dryness, and strong winds found at high elevations. Some distinctive features of healthy *high-elevation forests* include:



Living *five-needled pines* often have twisted, exposed

Very Old Trees

As some of the oldest living trees in the world, many limber pines live more than 1,000 years and some bristlecone pines survive over 4,500 years.

Unique Appearance

High-elevation conditions cause some of the trees to become twisted and contorted (shown to the left), resulting in an appearance that is often considered interesting and visually pleasing.

Protection of Soil

High-elevation forests hold soil on steep slopes, reducing erosion and dust. This helps other plants establish in otherwise barren areas.



The *Clark's nutcracker* uses the seeds of *five-needled pines* to survive

Water Provision

High-elevation forests trap and retain snowfall. This decreases the amount of water lost to evaporation and increases the availability of stream flows at lower elevations throughout the summer.

Habitat for Wildlife

High-elevation forests provide critical food and shelter for wildlife. Black bears, grizzly bears, squirrels, and birds such as Clark's nutcracker (shown to the right) consume the nutritious seeds of *five-needled pines*.

Scientific Value

Being among the earth's oldest living inhabitants, *five-needled pines* contribute to scientific understanding of many things, including historical climate conditions and processes that allow organisms to be long-lived.

Recreation Opportunities

High-elevation forests are a distinctive part of popular outdoor recreation sites. Many people enjoy hiking, camping, and other activities in the midst of the unique plants, animals, and landscapes.

Q2. Please tell us how important each of these features of high-elevation forests are to you by rating them from 1 'not at all important' to 5 'very important.'

Feature of <i>High-Elevation Forests</i>	Rating				
	1	2	3	4	5
	←—————→				
	Not at all Important		Somewhat Important		Very Important
Very Old Trees	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Unique Appearance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Protection of Soil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Water Provision	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Habitat for Wildlife	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Scientific Value	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Recreation Opportunities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

A threat to high-elevation forests: White Pine Blister Rust

Forests face many different threats. One major threat to *high-elevation forests* is *white pine blister rust (WPBR)*, a non-native, invasive disease that kills *five-needled pines*.



Close-ups of *white pine blister rust (WPBR)* on the bark of *five-needled pines*

WPBR (shown to the left) is caused by a fungus that spreads through the air. This spread cannot be stopped, and **in most cases, an infected tree will eventually die.**

However, a small proportion of *five-needled pines* has a natural, genetic resistance to *WPBR*. In other words, **some trees that are exposed to WPBR do not become infected or die.**

When trees in a *high-elevation forest* are killed, all of the distinctive features of a healthy *high-elevation forest* described previously are affected.



WPBR has killed the tree on the right. *WPBR* has killed branches in the tree on the left and the disease will likely kill this tree within several years.



The top of this young tree has been killed by *WPBR* and the tree will likely die in the next few years.

Some threats (such as Mountain Pine Beetles) are a natural part of the forest, with periods of high damage followed by periods where the forest can regenerate.

WPBR is different from other threats to *high-elevation forests*:

- *WPBR* is not native to high-elevation forests in the Western United States.
- *WPBR* infects trees at all ages and all stages of the life-cycle shown earlier.

As a result, the natural ability of the forest to recover from *WPBR* is limited.

WPBR was introduced near Vancouver, Canada, in 1910 and has since spread south into the Western United States. The spread is not likely to stop until most *high-elevation forests* are infected. The map below shows the overall pattern of infection across the Western United States, but there are forests with low, moderate, and high infection levels within each area.

- **Low Infection Areas**

Some areas of *high-elevation forests* currently have very low to no *WPBR* infection. Most forests in these areas are healthy, but some stands may already be infected. These areas will likely become "Moderate Infection" over time.

- **Moderate Infection Areas**

Some areas of *high-elevation forests* have *WPBR* infections that are established but not yet widespread. *WPBR* has infected about 25%-75% of the *five-needled pines* in these areas. These areas will likely become "High Infection" over time.

- **High Infection Areas**

Some areas of *high-elevation forests* are in an advanced state of *WPBR* infection. *WPBR* has infected over 75% of the *five-needled pines* in these areas. Some stands, however, may still be healthy.



Map showing stages of *WPBR* infection in regions of the Western United States

Q3. Prior to this survey, had you ever heard of white pine blister rust (WPBR)?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Q4. Have you ever seen any trees or forests infected by white pine blister rust (WPBR) in the Western United States?	Yes <input type="checkbox"/>	No <input type="checkbox"/>

Managing WPBR

The spread of *WPBR* cannot be stopped, and ***WPBR* cannot be eliminated once it is established in forests**. No chemicals or natural predators can stop *five-needled pines* from being infected by *WPBR*.

Depending on the forest, between 0 and 10% of the *five-needled pines* are naturally resistant to *WPBR*. This means that **at best, 1 out of 10 trees exposed to *WPBR* will not be affected**, possibly allowing for regeneration of the forest. In the worst case scenario, all of the *five-needled pines* in a forest could become infected and die, with little to no regeneration.

The only known way to improve the chances for a healthy forest over time is to increase the number of *five-needled pines* that are naturally resistant to *WPBR* through planting or encouraging natural regeneration.

Managers can choose any combination of the treatments described on the next page for dealing with *WPBR*, as well as when to treat and how much of an area to treat. Each treatment has different short-term effects, with the goal of increasing the number of resistant trees.

Treatments for managing WPBR

Treatment: Prescribed burning

- Prescribed burning involves setting fires in controlled situations that are intense enough to kill some mature trees, including healthy white pines, and create openings in the forest.
- The openings encourage establishment of more *five-needled pine* seedlings.
- Short term effects of burning include a small amount of smoke in the immediate area and dead, blackened trees left standing. Within a year, there is new undergrowth, including many wildflowers. Although unlikely, prescribed burns can spread beyond the planned burn area.

Treatment: Selective thinning

- Selective thinning involves removing healthy trees of other species in *high-elevation forests* to create openings in the forest.
- The openings encourage establishment of more *five-needled pine* seedlings.
- Short term effects of thinning include more open space between trees, small stumps and branches left behind, and less variation in tree types in the area. Depending on the area, either chainsaws or handsaws are used for selective thinning.



New whitebark pine growth at the base of a burned whitebark pine

Treatment: Planting WPBR resistant seedlings

- Seeds are collected from trees that were exposed to *WPBR* but did not become infected. These seeds are grown into seedlings and planted in the *high-elevation forests*.
- The plantings increase the total number of *WPBR* resistant trees in the forest.
- Short term effects of planting *WPBR* resistant seedlings include many seedlings a few inches tall growing in sheltered spots, such as near stumps or in clusters.

No Treatment

- *WPBR* will spread into more *high-elevation forests*, and if managers do not act, it will kill large proportions of the *five-needled pines*.
- If any trees in an infected forest have the natural resistance to *WPBR*, they will still grow and might reforest the area. However, few trees (0-10%) are resistant to *WPBR*, so full recovery with no treatment is unlikely in most stands.
- In other words, the forest will most likely be altered forever.

[CHOICE EXPERIMENT / CONTINGENT VALUATION (CV) SECTION]
PROGRAMMING: ASSIGN ORDER OF CHOICE/CV BASED ON xWPBR]
[IF CHOICE IS SHOWN IS SHOWN FIRST (xWPBR=1), SHOW INTRO1. IF CV IS SHOWN FIRST (xWPBR=2)
SHOW INTRO2]

[xWPBR=1]
[INTRO1]

The next eight questions ask about your preferences for treating *WPBR* in *high-elevation forests*. The first six questions are about **a single 1000-acre forest**, because management decisions are often made for forests of about that size. The forest is located on public land in the mountains of central Colorado. The last two questions are about **national-level programs** that might be used to manage **all** of the *high-elevation forests* in the Western United States. Please consider each of the questions separately.

[xWPBR=2]
[INTRO2]

The next eight questions ask about your preferences for treating *WPBR* in *high-elevation forests*. The first two questions are about **national-level programs** that might be used to manage **all** of the *high-elevation forests* in the Western United States. The last six questions are about **a single 1000-acre forest**, because management decisions are often made for forests of about that size. The forest is located on public land in the mountains of central Colorado. Please consider each of the questions separately.

[SHOW BETWEEN CHOICE SECTIONS]

We now shift to a different scale of management. **Please assume that no treatment plan from the first section will be implemented, resulting in no cost to your household.**

[CHOICE SECTION]

In this section, you will be presented with choices about options to manage **a single 1000-acre forest** in the mountains of central Colorado.

Each of the following questions will present three treatment plans for this forest. The characteristics of each plan, including the costs to your household, are different.

The characteristics of the treatment plans are:

Where treatment occurs

- The forest has areas with High Infection, Moderate Infection, and Low Infection of WPBR. Treatment would occur in the areas listed.

Type of treatment

- The forest can be treated by prescribed burning, selective thinning, planting resistant seedlings, or some combination of these. Not treating a forest is also an option. The type of treatment will determine the short-term impacts on the selected area and the long-term health of the forest.

Total one-time cost to your household

- The characteristics of the treatment plan affect how much the plan costs. The dollar amount is how much the project will cost **your household** in **unavoidable one-time taxes and fees**.

Chance of a healthy forest in 100 years

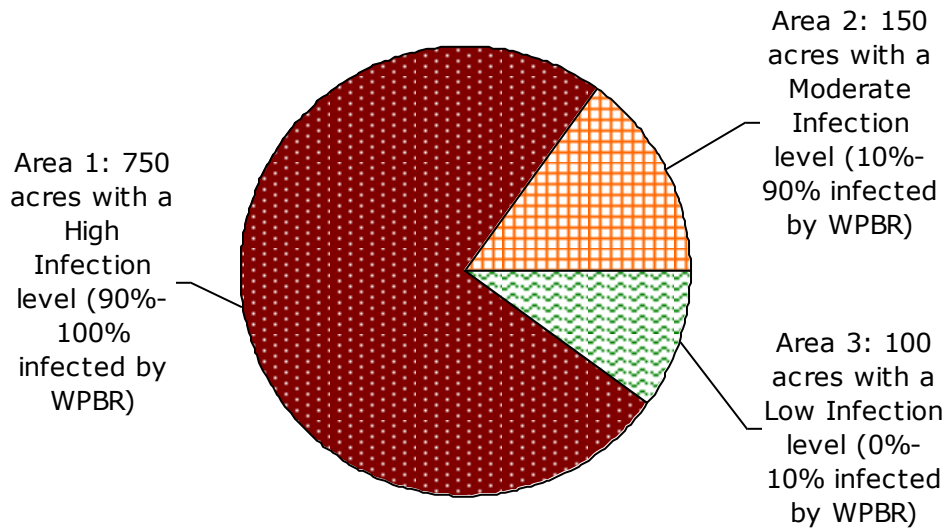
- The chance that the 1000-acre forest will be healthy, defined as natural continuation of all four stages of the life cycle (including forest regeneration) in 100 years. The chance of a healthy forest will be determined by the treatment plan's characteristics and other factors.

In each case, a "no treatment" plan is included where nothing would be done to the forest to manage WPBR, and there would be no charge to your household.

Choose the plan you prefer from each of the three options. There may be many reasons why you might choose one option over another, including the type and level of the characteristics, affordability of the program, and/or various other factors. There are no wrong answers.

Q5. Please tell us which treatment plan you prefer for the forest described below.

1000 acre high-elevation forest with different levels of WPBR infection, as shown at right



	Treatment Plan 1	Treatment Plan 2	No Treatment
Where treatment occurs	[Where1]	[Where2]	No treatment in any areas of the 1000 acre forest
Type of treatment	[Type1]	[Type2]	
Total one time cost to your household	[PROGRAMMING: Multiply Cost1 by Where1]	[PROGRAMMING: Multiply Cost2 by Where2]	\$0
Chance that this 1000 acre high-elevation forest is healthy in 100 years	[Chance1] % chance of a healthy forest in 100 years	[Chance2] % chance of a healthy forest in 100 years	[xCHANCE]% chance of a healthy forest in 100 years
Choose Your Preferred Option:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

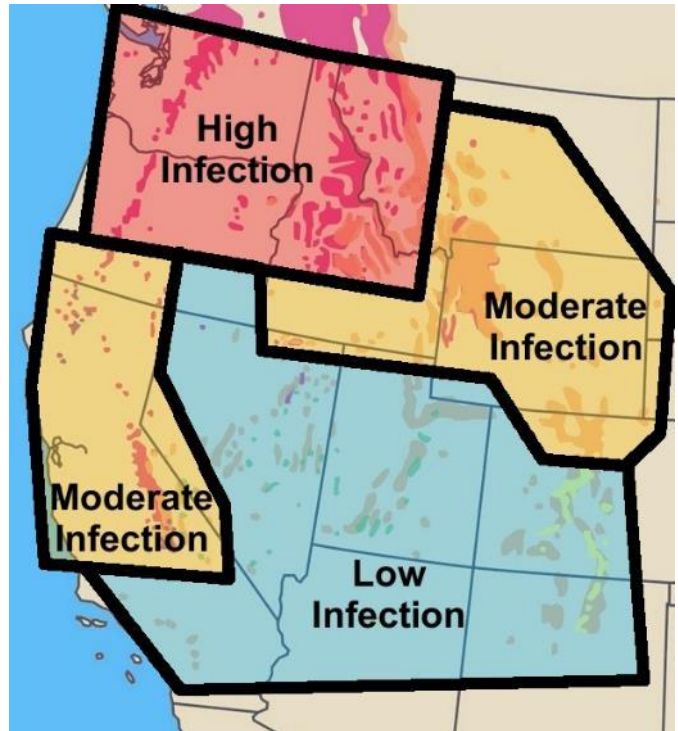
[CV SECTION]

In this section, you will be presented with two choices about a program to manage **all of the high-elevation forests in the Western United States.**

One option to treat forests under threat of WPBR throughout the Western United States is the establishment of a special White Pine Blister Rust Management trust. This national program would allow combinations of prescribed burning, selective thinning, and planting resistant seedlings, and would require additional funding to establish. Funding for the program would come from some combination of individual donations, increased fees to visitors of high-elevation forests, and tax increases.

Remember, WPBR will spread over time. This means that in untreated areas, WPBR will kill large proportions of the *five-needled pines*, and the forests in these areas will most likely be altered forever. Areas that are treated have improved chances of being healthy in 100 years.

There may be many reasons why you might choose "yes" or "no" in the questions below, including support for the program, affordability of the program, and/or various other factors. Keep in mind that there are no wrong answers to these questions.



Map showing stages of WPBR infection in regions of the Western United States

<p>Q6. Suppose managers treat [xQUANT]% of the high-elevation forests in the Western United States. As a result, these acres will be healthy in 100 years from now. The remainder of the acreage would not be treated. Would your household be willing to pay a one time cost of \$[xBID1] to fund this program?</p>	<p>Yes <input type="checkbox"/></p>	<p>No <input type="checkbox"/></p>
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<p>Q7. Now suppose the managers treat [xQUANT]% of the high-elevation forests in the Western United States, and as a result of these actions, there is a [xUNCRT]% chance that these acres will be healthy in 100 years from now. The remainder of the acreage would not be treated. Would your household be willing to pay a one time cost of \$[bid amount2] to fund this program?</p>	<p>Yes <input type="checkbox"/></p>	<p>No <input type="checkbox"/></p>
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