Valuing the Forest for the Trees: Willingness to Pay for White Pine Blister Rust Management

Extended Abstract

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Abstract—The nearly two million acres of high elevation forests in the Western United States are not an important source of timber or any other market products. However, that does not mean that the forests are not highly valuable. Visitors and nonvisitors alike value the unique five-needle pine trees found in these high elevation ecosystems. In this study, we estimate the nonmarket benefits of preserving high elevation forests in the Western United States from the threat of white pine blister rust (WPBR), a non-native pathogen. A contingent valuation survey collected information about attitudes, behaviors, and economic preferences related to high elevation forests and the threat posed by WPBR. The estimated values suggest high-elevation forests in the Western United States provide the public with significant nonmarket benefits. The magnitude of the estimated nonmarket benefits and responses to attitudinal measures reflect survey respondents' concern about the continued existence of healthy high-elevation forests. Attitude and behavior data demonstrate varied motivations for nonmarket values. The majority of the survey respondents had visited a high-elevation forest in the past, yet recreation was rated the least important feature of high elevation forests. Results of this study can be used in benefit-cost or other types of analysis to improve management efficiency of high elevation white pine ecosystems.

Introduction

High-elevation forests are home to native five-needle pine species including foxtail pine (*Pinus balfourniana* Grev. and Balf.), Great Basin bristlecone pine (*P. longaeva* Bailey), limber pine (*P. flexilis* James), Rocky Mountain bristlecone pine (*P. aristata* Engelm.), and whitebark pine (*P. albicaulis* Engelm.). Most of the high-elevation forests are found on public lands where they are valued for their beauty, uniqueness, or role in recreation (Burns and others 2008; Logan and Powell 2001; Samman and others 2003). However, these forests are threatened by the invasive disease white pine blister rust (WPBR). Caused by the non-native fungus *Cronartium ribicola*, WPBR first invaded the high-elevation forests of North America in the early 20th century and has slowly, but continually, spread across much of their range (Burns and others 2008; Liebhold and others 1995). This fungus threatens the sustainability of these forests by causing mortality at all stages of the trees' lifecycles, disrupting the forests' regeneration cycle (Burns and others 2008). In addition, the fungus's complex lifecycle, which involves multiple hosts and an airborne spread, makes either eradication or containment of the disease difficult, if not impossible (Burns and others 2008; Liebhold and others 1995; Maloy 1997).

Typical strategies for managing invasive species in forests involve a combination of prevention, eradication, and containment as a first stage, followed by mitigation of impacts and restoration of degraded areas if that first stage proves unsuccessful (Liebhold and others 1995; Schoettle and Sniezko 2007). Historically, widespread attempts at controlling WPBR may have slowed the spread but have not successfully eradicated the disease (Maloy 1997). Therefore, current research suggests the most viable approach to managing WPBR is to increase the frequency of the genetic resistance to rust naturally occurring at low levels across the range of the forests. This can be done either by planting seedlings screened for genetic resistance or by encouraging more seedlings than would be established naturally, through techniques such as prescribed burning and thinning of competitor species (Burns and others 2008; Samman and others 2003; Schoettle and Sniezko 2007; Schwandt 2006). Although invasive species management often occurs only after the infection of an area, this disease has not yet spread throughout the entire range of the high-elevation forests in the Western United States. This presents a potential for proactive management, which refers to the application of these treatments prior to an area's infection, to lessen the impacts of future WPBR invasions (Schoettle and Sniezko 2007).

While proactive treatment of WPBR seems promising, it is not clear whether the public will support intervening in forests that are not yet infested, as proactive treatments would lead to a potentially costly loss of benefits through the disturbance of healthy forests, referred to as "management externalities" (Bond and others 2010). A study of public attitudes toward managing the mountain pine beetle infestation in Canada found support for management, but not when measures were proactive (McFarlane and others 2006). In addition, proactive management techniques might prove quite costly in terms of management expenditures (Burns and others 2008; Schoettle and Sniezko 2007). When timber values are high, the economic rationale for management can be self-apparent despite the possibility of management externalities. However, where there are few if any market benefits, as with high-elevation forests, the optimal approach to management often is less straightforward (Holmes and others 2009). In such cases, the associated nonmarket benefits for the protection of a resource can be elicited through a variety of techniques, including the contingent valuation

In: Keane, Robert E.; Tomback, Diana F.; Murray, Michael P.; and Smith, Cyndi M., eds. 2011. **The future of high-elevation, five-needle white pines in Western North America: Proceedings of the High Five Symposium.** 28-30 June 2010; Missoula, MT. Proceedings RMRS-P-63. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 376 p. Online at http://www.fs.fed.us/rm/pubs/rmrs_p063.html

method (Carson and others 2001). To date, these methods have not been utilized to elicit the nonmarket benefits associated with treating high-elevation forests for WPBR.

Past studies on the native bark beetle epidemics highlight the subtleties involved in public preferences and attitudes regarding intervention in forests. Although residents living near Canadian national parks favored control of the beetles on average, respondents with more ecologically-oriented attitudes and greater knowledge of the beetles were less in favor of intervening with the natural processes driving the epidemics (McFarlane and others 2006). In contrast, tourists to a German national park favored non-intervention against that park's bark beetle infestation, with a suggested explanation of the difference being that the tourists accepted the German epidemic as more of a natural process (Muller and Job 2009). These studies suggest the importance of valuation that accommodates the different perspectives of respondents, as well as the distinction between natural ecological processes and disruptions caused by invasive species.

The present paper contributes to this general line of inquiry into attitudes and preferences for environmental benefits related to the protection of forests in two new directions. First, this research focuses on public preferences regarding a specific threat; namely, the fungus that causes WPBR. The invasive nature of this threat, and the novel proactive opportunities available for addressing it, make this application a unique case study, as well as one pertinent to contemporary policy decisions. Second, this research reports on a survey of a representative sample of the population of the entire Western United States. The survey elicited a variety of attitudes and preferences related to management of high-elevation forests. As such, it allows estimation of the benefits of managing high-elevation forests in response to the threat posed by white pine blister rust. Specifically, this paper addresses the following questions:

a) What attitudes do the public hold that might influence opinions of WPBR management?

b) What attributes of high-elevation forests are important to the public?

c) Does the public support the management of WPBR in high-elevation forests, and if so, what economic benefits are associated with this management?

Literature Review

There are many reasons to expect significant nonmarket benefits from the high-elevation five-needle pine forests. Bristlecone pines rank among the oldest living species on earth, sometimes exceeding 2500 years of life. All the five-needle pines are notable for contributing to the rugged natural beauty and scenic grandeur of important natural landmarks (Burns and others 2008; Logan and Powell 2001; Samman and others 2003; Schoettle and Sniezko 2007). Nonmarket valuation research on other tree species has used travel cost analysis to show that some recreationists value forests more highly as trees in the forests age, with upper range benefits of $152 and $478 per additional trail-mile through old-growth spruce/fir forests and lodgepole pine forests, respectively (Englin and others 2006). A contingent valuation study demonstrated high values for the high-elevation experience on Colorado's "14ers" (mountains with summits over 14,000 feet high) relative to those for other outdoor recreation, estimating average consumer surplus from a single 14er trip to be between $67, for respondents more willing to substitute to different mountains, and $397, for less flexible individuals (Loomis and Keske 2009). This result demonstrated a recreational preference for the type of terrain that often includes high-elevation forests.

Recreational use is just one of many possible sources of value related to support for protection-oriented management of forests. For decades, resource economists have recognized the benefits provided to the public through so-called "nonuse values" of resources, which cover demands for the option for future use, for the opportunity to offer resources as a bequest to future generations, and for the pure existence of the resource (Krutilla 1967; Walsh and others 1984). These benefits can be quite significant for the general population. For example, based on a contingent valuation study, Walsh and others (1990) estimated that nonuse values account for roughly three-quarters of the total value for protecting forest quality in public forests across Colorado, which averaged $47 per household per year. More recently, Kramer and others (2003) used follow-up questions to a contingent valuation exercise to decompose a total estimated per household willingness to pay (WTP) of $28.49 per year for protecting the high-elevation spruce-fir forest ecosystem in the Southern Appalachian Mountains into $16.24 for existence value, $8.55 for bequest, and $3.70 for use. More directly assessing existence value, Amirnejad and others (2006)'s contingent valuation study estimated a mean WTP for the existence of Iranian forests of $30.12 (in U.S. dollars) per Iranian household per year, even though most of the respondents do not visit the forests. Other contingent valuation studies about protecting large public forests from a variety of hazards found values for protection in the range of about $20 to $100 per household per year (Kramer and others 2003).

Additional indirect benefits contributing to these values for protection might relate to the ecological importance of forests. In the case of high-elevation forests, the five-needle pines occupy harsh habitats and facilitate the establishment of other high-elevation species, often defining treelines, initiating reforestation after large fires, and playing an important role in maintaining snowpack and protecting against soil erosion (Ellison and others 2005; Kearns and Jacobi 2007; Schoettle 2004). They provide habitat and an important dietary component for other species, including the Clark's nutcracker (*Nucifraga columbiana* Wilson), red squirrels (*Tamiasciurus hudsonicus* Ercleben), and grizzly bears (*Ursus arctos* L.) (Burns and others 2008; Logan and Powell 2001; Schoettle 2004).

Approach

The field of nonmarket valuation is well established, and it is often possible to transfer estimated values from one study to another if the goods being valued across studies are similar. However, in this study, it was necessary to develop a survey instrument and collect the requisite data, as no previous studies have estimated the benefits of managing high elevation forests for the threat of WPBR. This required ascertaining the general population's baseline knowledge of high-elevation forests, five-needle pine trees, and WPBR. The final survey instrument was developed through an iterative process over a two-year period. To ensure adequate treatment of the complex interdisciplinary issues of the project, nearly constant communication about the questionnaire was maintained with researchers specializing in natural sciences including plant ecophysiology, forest genetics, plant epidemiology, and restoration ecology. Four focus groups with the public offered insight into the relevance of information provided and questions asked, helping redirect the survey from a focus on recreational values of high-elevation forests to a broader focus on total value, which is largely comprised of nonuse values. In addition, a pilot survey tested the questionnaire and survey design with 29 randomly chosen respondents before finalizing the design.

The survey was administered online to a representative sample of households in the U.S. Census Bureau's Mountain and Pacific divisions (excluding Alaska and Hawaii). Knowledge Networks (KN), a private online research firm[1], recruited a panel through a combination of random-digit dialing and address-based sampling, which accounts for the large number of contemporary households without landline telephones. This panel consists of potential respondents for KN surveys. Panelists typically respond to approximately one survey per week in exchange for modest incentives, such as entrance into raffles and special sweepstakes. For this survey, KN selected 895 active panelists through random stratified sampling, oversampling in the Mountain division to assure adequate coverage. Over 11 days in June 2010, 542 of the selected sample completed the survey, for a completion rate of 61%.

The questionnaire, developed according to recommendations on nonmarket valuation survey design by Boyle (2003), Carson and others (2001), and Champ (2003), provided respondents with relevant background information on high-elevation forests, WPBR, and management options.[2] The background information included pictures of the five-needle pine species and WPBR, maps of the species' distributions, and descriptions of distinctive features of healthy high-elevation forests. A healthy high-elevation forest was defined as one in which all functional stages of the tree lifecycle occur simultaneously. To establish the plausibility of protecting the high-elevation forests despite the lack of options for abating the spread of WPBR, the questionnaire provided information on treatment options (which could be implemented either proactively or reactively) and typical short-term and long-term effects of these treatments on forests and related services.

The survey asked about experiences and knowledge related to high-elevation forests and WPBR. Numerous questions measuring attitudes toward the environment, both specific to this issue and in general, were included. General attitudinal questions included a subset of the New Ecological Paradigm scale items, which are widely implemented measures that have been used to explain nonuse values (Dunlap and others 2000; Kotchen and Reiling 2000). Other questions addressed relevant attitudes toward taxes, government agencies, and scientific research, as these might influence both the responses to the valuation questions and public acceptance of various management actions. The attitudinal questions asked for responses on a 5-point Likert scale for each statement, ranging from "Strongly Disagree" to "Strongly Agree" with the statement. One last set of general questions asked respondents to rate how important the various described features of high-elevation forests are to them, offering insight into the benefits provided to respondents by the resource. In addition, detailed information was obtained about each survey respondent from KN's panelist database.

After a description of management options for WPBR, survey respondents were asked about their willingness to pay for a program to manage all high-elevation forests in the Western United States for the threat of WPBR with a dichotomous-choice contingent valuation question. Respondents were told the management would be funded through a combination of individual donations, increased visitor fees, and tax increases[3]. Specifically, respondents were asked:

> *Suppose managers treat [quantity]% 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 $[bid] to fund this program?*

Each respondent was given a randomly selected quantity level of 30%, 50%, or 70% and a randomly selected bid amount of $10, $25, $50, $100, $250, $500, or $1000. The set of possible bid values was constructed to cover and transcend the range of plausible values suggested by focus group results. Respondents indicated a "Yes" or "No" response to the contingent valuation question. Asking respondents about varying bid amounts allows estimation of the probability

[1] For more information on the Knowledge Networks panel and methodology, contact the authors for supporting documentation and a list of published research utilizing the KN service, or visit www.knowledgenetworks.com.

[2] Copies of the questionnaire in its entirety are available from the authors upon request.

[3] Immediately before answering the contingent valuation questions, respondents were reminded about budget constraints and of possible reasons why they might not support the program.

that the average respondent would support the program under a given bid level by fitting responses to a logit model[4].

Results

Sample Demographics

Table 1 shows descriptive statistics of select demographic variables for the 542 respondents completing the survey. As reflected in the raw sample column, the mountain division was oversampled to assure regional coverage. To adjust for non-response, non-coverage, and the stratification by region, Knowledge Networks provided probability weights that match the data to benchmark distributions derived from the most recent Current Population Survey.[5] These benchmark distributions match the distributions of gender, age, race/ethnicity, categorical educational attainment, Census Region, residence within a metropolitan area, and internet access. Most of the raw sample demographics statistically differ from population statistics, although the most dramatic difference is in the Census divisions. As expected, the weighted sample demographics, with the exception of internet access rates, are statistically indistinguishable from those for the population, which consists of 27,115,377 individual households (U.S. Census Bureau 2009). Thus, the weighted sample is demographically representative of the population of the Western United States (excluding Hawaii and Alaska). All subsequent results are reported for this weighted sample.

Experiences and Knowledge

Respondents were asked about their past and expected future visitation to high-elevation forests in the Western United States, as well as some more specific locations within this area. Table 2 summarizes the responses to these questions. In general, respondents from the Mountain States differ significantly from Pacific State respondents in terms of prior recreational experience, with individuals from the Mountain States more likely to have visited one or more of

Table 1. Demographics of raw sample, weighted sample, and study population.

Variable	Raw Sample	Weighted Sample	Population[a]
Census Division			
Mountain (MT, ID, WY, CO, NM, AZ, UT, NV)	71%	32%	34%
Pacific (WA, OR, CA)	29%	68%	66%
Gender			
Male	47%	49%	50%
Female	53%	51%	50%
Age			
18-29	16%	23%	24%
30-44	22%	28%	28%
45-59	30%	26%	27%
60+	31%	22%	22%
Educational Attainment			
Less than High School	10%	15%	16%
High School	23%	25%	27%
Some College	35%	31%	31%
Bachelor and beyond	32%	29%	26%
Race / Ethnicity			
White, Non-Hispanic	75%	59%	55%
Black, Non-Hispanic	2%	2%	5%
Other, Non-Hispanic	6%	10%	10%
Hispanic	14%	25%	29%
2+ Races, Non-Hispanic	2%	4%	2%
Other Criteria			
In a Metropolitan Statistical Area	86%	91%	91%
Household Internet Access	76%	68%	76%
Number of Respondents / Housing Units	542	542	27,115,377

[a] Statistics derived from U.S. Census Bureau, Current Population Survey, 2007, U.S. Census Bureau, Population Estimates Program, 2009, and 2006-2008 American Community Survey 3-Year Estimates.

[4] We calculate mean WTP with Hanemann (1989)'s equation, mean WTP= $-\alpha/\beta$, 95% confidence intervals calculated via the delta method.

[5] Household Internet Access differs in that that benchmark was derived from KN's panel recruitment data, which dates back to 1999, rather than the Current Population Survey.

Table 2. Percentage of respondents reporting relevant experiences, plans, and knowledge.

	Mountain	Pacific	Regional Difference[a]	Combined
Have you ever visited…				
high-elevation forests in Western U.S.	59	47	*	51
Central Colorado's mountains	53	27	***	36
Rocky Mountain National Park	43	23	***	30
Glacier National Park	26	21	-	23
Yellowstone National Park	48	32	***	37
at least one of the above places	*81*	*64*	***	*69*
Do you expect to ever visit…				
Central Colorado's mountains	64	51	**	55
Rocky Mountain National Park	70	62	-	64
Glacier National Park	61	60	-	60
Yellowstone National Park	71	66	-	67
at least one of these places	*84*	*70*	**	*74*
Have you ever…				
heard of any of the 5-needle pines	39	35	-	36
heard of a high-elevation forest	55	47	-	50
heard of white pine blister rust	9	13	-	12
seen white pine blister rust	18	18	-	18

[a] Outcome of Wald test of significance of percentage point difference between regions:
*** significantly different at $p < 0.01$; ** - significantly different at $p < 0.05$;
* significantly different at $p < 0.10$.

the locations, presumably because all locations asked about are within the Mountain States region. Notably, more than two-thirds have visited at least one of the listed sites, and roughly half have visited a high-elevation forest specifically. More respondents expect to visit the listed locations in the future than have visited in the past. Nearly three-quarters of the respondents expect to visit at least one of the listed sites in the future, suggesting that the opportunity to experience the forests and the areas surrounding them is important to a large proportion of the population of the Western U.S. For comparison, a nationwide, 1983 survey of the general population found that 15% had been to Yellowstone National Park, 15% to Rocky Mountain National Park, and 6% to Glacier National Park (U.S. Department of Interior 1983), and a later report cites double-digit growth rates in visitation in the late 1980's and 1990's (Cole 1996). In addition, a recent non-scientific survey of U.S. travelers found that 73% plan to visit a national park in 2009 (TripAdvisor 2008).

The respondents from the Mountain States and those from the Pacific States did not exhibit any significant differences in response to questions about familiarity with five-needled pines, high-elevation forests, and white pine blister rust. Half of the respondents had heard of a high-elevation forest, while only about one-third had heard of the specific trees described as inhabiting the forests. Familiarity with the disease WPBR was low. More respondents reported seeing WPBR than hearing about it, suggesting that they have seen the symptoms without knowing their causes. One might worry also that respondents are conflating the effects of WPBR with other threats to the trees in high-elevation forests, such as mountain pine beetles. However, this question followed text in the questionnaire that explicitly differentiated WPBR from these threats. Regardless, experiences with WPBR are significantly less prevalent than with the high-elevation forests that the disease threatens.

Attitudes

Respondents were also asked about their level of agreement with statements about the environment and governance. The responses to these statements are shown in table 3. The statements are ordered by how strongly respondents agreed with the statements on average. A few general patterns stand out among these results, including a story of the importance of the existence of the forests themselves. Statements 1, 3, and 4, receiving relatively strong support, speak to the long-term protection of the forests. The low level of support for the statements at positions 12 and 13 corroborates this, because, taken together, the inverse of these statements says that people should intervene in the forests but not for the purpose of fulfilling human needs. Similarly, recreation and other direct uses of the forests receive only moderate support in positions 8, 9, and 11. The support for statement 2 reflects an understanding of the dominance of natural processes, whereas most other general perspectives pertaining to the relationship between humans and the environment receive relatively moderate support. In a final note on the attitudes, despite aggregate neutrality for statement 16, which describes opposition to new taxes in general, the statement that tax money is often spent ineffectively (14) received high support, while low support for statement 17 demonstrates a general lack of trust in government agencies or, at least, that they could improve their public relations.

Respondents were also asked about the importance of some of the features of high-elevation forests. Table 4 summarizes the responses to these statements. Again, direct

Table 3. Respondent attitudes.

	Mean[a]	Agree[b]
Environmental Attitudes		
1. It is important that high-elevation forests exist for future generations.	4.2	76%
2. Despite our special abilities humans are still subject to the laws of nature.	4.1	72%
3. Protecting five-needled pines from the threat of extinction is important.	4.0	68%
4. Humans have the responsibility to protect ecosystems from pests or diseases that humans introduced.	4.0	66%
5. All environmental issues are important.	3.8	56%
6. When humans interfere with nature it often produces disastrous consequences.	3.5	48%
7. The earth has plenty of natural resources if we just learn how to develop them.	3.5	50%
8. It is important that high-elevation forests provide recreation activities, such as hiking or camping.	3.4	47%
9. It is important that forests I am personally attached to are treated for WPBR.	3.4	41%
10. It is important that I pay my fair share for the environment.	3.4	44%
11. Tourism related to high-elevation forests is important.	3.1	29%
12. People should not intervene in high-elevation forests.	2.7	22%
13. Humans have the right to modify the natural environment to suit their needs.	2.6	21%
Governance Attitudes		
14. Tax money is often wasted or applied to unimportant purposes.	3.9	59%
15. Scientific research provides an important service to society.	3.8	65%
16. I oppose all new taxes.	3.0	23%
17. U.S. government agencies typically act in the best interests of U.S. citizens.	2.7	25%

[a] Responses range from Strongly Disagree = 1 through Neutral = 3 to Strongly Agree = 5.
[b] Percentage of respondents responding > 3, expressing agreement at some level.

use ranked lowest in importance, with the least supported features being recreation opportunities and unique appearance, the latter of which relates directly to the experience of visiting the forests. In contrast, the top three rated features, water provision, protection of soil, and habitat for wildlife, all link to the importance of the role of high-elevation forests in providing broader ecosystem services. Each of these favored features emphasizes the function of the forests rather than the value of the individual trees as trees.

Economic Preferences

In addition to exploring the public's attitudes toward high-elevation forests and the threat of WPBR, we measured economic preferences, and thus the value of the benefits provided by the forests, with a contingent valuation question. Table 5 summarizes responses to this question by bid value, and table 6 reports five models based on these responses. Because the dependent variable in each model is dichotomous (i.e., yes/no), logistic regressions are estimated. Table 5 shows that each successively higher bid value corresponds to a smaller proportion of respondents choosing "yes." Similarly, the coefficient on Bid is negative and significant at $p < 0.01$ in each of the models reported in table 6. This demonstrates the effect predicted by economic theory that, all else equal, as the cost of a treatment plan increased, respondents were less likely to respond "yes."

Models 1, 2, and 3 in table 6 explore the effect of the quantity of forest treated on the probability of a respondent choosing yes. Attitude and demographic variables that plausibly could relate to specific motivations for nonmarket values are included in models 1, 2, and 3, including living in a metropolitan area, which is often assumed to relate to environmental attitudes in general, Census region, which is shown in table 2 to correlate with visitation and plans, and presence of children, which could be expected to relate to a certain type of concern for future generations[6]. Model 1 tests for a linear quantity effect on this probability by including the percentage of all high-elevation forests in the Western U.S. treated for WPBR as an independent variable.

Table 4. Ratings of the importance of features of high-elevation forests.

Forest Feature	Mean[a]
Water Provision	4.3
Protection of Soil	4.3
Habitat for Wildlife	4.3
Very Old Trees	4.2
Scientific Value	3.9
Unique Appearance	3.7
Recreation Opportunities	3.6

[a] Responses range from Not at all Important = 1 to Very Important = 5.

[6] Although one might speculate that income would influence respondents' choices over the dependent variable, economic theory predicts that income is not part of the data generating process estimated here (Hanemann 1998).

Table 5. Percentage of respondents choosing "yes" or "no" at each bid amount.

	Bid Amount							
Choice	$10	$25	$50	$100	$250	$500	$1,000	Overall
No	12%	32%	46%	48%	65%	71%	91%	52%
Yes	88%	68%	54%	52%	35%	29%	9%	48%

Table 6. Logit equation coefficients for dichotomous-choice responses.

	Model 1	Model 2	Model 3	Model 4	Model 5
Constant[a]	-1.0647 (.8304)	-.8704 (.7150)	-.8465 (.6234)	-1.1368** (.5138)	.7280*** (.2049)
Bid	-.0047*** (.0006)	-.0047*** (.0006)	-.0047*** (.0006)	-.0047*** (.0006)	-.0041*** (.0006)
Quantity	.0046 (.0098)	-	-	-	-
Quantity 50% (Dummy)	-	-.0108 (.4073)	-	-	-
Quantity 70% (Dummy)	-	.1829 (.3915)	-	-	-
Existence for future generations matters[b]	1.2277*** (.4497)	1.2303*** (.4494)	1.2302*** (.4507)	1.1949** (.4638)	-
Recreation activities are important[b]	.6038* (.3469)	.6052* (.3462)	.6048* (.3467)	.6617* (.3513)	-
Opposition to all new taxes[b]	-1.4541*** (.3975)	-1.4663*** (.3997)	-1.4621*** (.3965)	-1.4464*** (.4018)	-
Have visited areas with high-elevation forests	1.1254*** (.3819)	1.1101*** (.3870)	1.1162*** (.3812)	1.0852*** (.3621)	-
Plan to visit areas with high-elevation forests	.5290 (.4275)	.5398 (.4305)	.5502 (.4317)	.4097 (.4247)	-
Metropolitan region (Dummy)	-.1898 (.3664)	-.2031 (.3722)	-.1948 (.3640)	-	-
Mountain Census division (Dummy)	-.3505 (.3056)	-.3553 (.3051)	-.3558 (.3059)	-	-
Presence of Any Children in Household (Dummy)	-.3447 (.3304)	-.3476 (.3322)	-.3367 (.3304)	-	-
Log likelihood	-283.759	-283.497	-283.823	-284.464	-324.366
Likelihood ratio statistic[c] (deg. of f.)	181.93 (10)	182.45 (11)	181.80 (9)	180.52 (6)	100.72 (1)

[a] The dependent variable is set to 1 if the respondent chose "yes," and 0 for "no."
[b] Attitude represented by dummy variable corresponding to response > 3, expressing some level of agreement with statement.
[c] Statistic compares fit of each model against restricted model of only a constant.
Linearized standard errors in parentheses, omitted coefficients signify variables not included in model; *** - significant at p < 0.01; * - significant at p < 0.10.

This effect is not found; the coefficient on Quantity is insignificant (a Wald test fails to reject null hypothesis that the coefficient is equal to zero, p = 0.480). Model 2 loosens the restriction of linearity, but the lack of significance on the two quantity dummy variables signifies that the response to neither the 50% quantity (a Wald test rejects a test of difference from 0 at p = 0.552) nor the 70% quantity (rejected at p = 0.481) differs from the response to 30% quantity. Further, the coefficients on the two dummy variables are statistically indistinguishable (Wald test rejects difference at p = 0.849). Likelihood ratio tests verify that neither model 1 nor model 2 statistically improves upon the fit of model 3, which pools responses across Quantity levels (with likelihood ratio test statistics 0.13 and 0.65, 1 and 2 degrees of freedom, and p = 0.719 and p = 0.722, respectively), demonstrating that choices were not responsive to differences in the quantity of acreage protected.

Comparison of models 3 and 4 demonstrates a lack of influence of the included demographic variables upon a respondent's predicted choice. Not only are the coefficients on each of the demographic variables in model 3 insignificant, but also the fit of the restricted model (model 4) is statistically identical to that of the extended model (with likelihood ratio test statistic 1.28, with 3 degrees of freedom, failing to reject the null that the coefficients on excluded variables are 0 at $p = 0.734$). Thus, neither the presence of children in the household, residence within a metropolitan area, nor living in the Mountain States influenced responses to the contingent valuation question.

In contrast, inclusion of responses to attitude and visitation questions improves model 4's fit over the restricted model 5 (with likelihood ratio test statistic 79.80 for 5 degrees of freedom, rejecting the null hypothesis at $p < 0.01$). Not surprisingly, respondents opposed to taxes in general had a lower probability of positive response than those more accepting of new taxes (significant by Wald test at $p < 0.01$). While those who have visited areas with high-elevation forests had a higher probability of positive response than those who have not (significant by Wald test at $p < 0.01$), the smaller coefficient, with a weaker significance, on the importance of recreational opportunities in the forests (significant by Wald test at $p < 0.1$) suggests that users' positive responses were driven by other motivations, in addition to their ability to enjoy use of the forests. The "option" motivation for nonuse valuation is not demonstrated, as plans for future visitation fail to significantly predict response (Wald test failed at $p = 0.335$), whereas the "bequest" motivation, which holds that the existence of high-elevation forests for future generations matters, is supported by the significance of the corresponding attitude (significant by Wald test at $p = 0.010$).

Given these tests, model 4 provides the most robust and parsimonious specification. Using this model and the percentages of respondents supporting attitudes presented in table 3, mean per household willingness to pay for a program to treat high-elevation forests for WPBR is estimated to be \$172.55 (statistically different from 0 at $p < 0.01$), with a 95% confidence interval ranging from \$104.06 to \$241.04. If we extrapolate this estimate to the population of the Western United States, an aggregate value of treating high-elevation forests for WPBR is estimated to be between \$2.8 billion and \$6.5 billion, with a point estimate of \$4.7 billion.

Discussion

The most obvious conclusion of this study, reflected in the large and significant aggregate values reported above, is that an informed, general population of the Western United States cares about the problem of WPBR in their high-elevation forests and is willing to trade off household income in order to manage the threat. Despite expressing a lack of trust in the beneficence of government agencies and the efficiency of spending of public tax dollars, people exhibited an average willingness to pay a substantial amount into what, in all likelihood, would be a government-implemented program for protecting high-elevation forests. The large confidence interval reflects a large variance associated with this estimate. Nonetheless, the estimated lower bound of aggregate benefits to the Western U.S. of \$2.8 billion demonstrates that the public strongly supports the allocation of substantial funding toward addressing the threat of WPBR in high-elevation forests.

The lack of sensitivity to the quantity of forest protected in the contingent valuation question, paired with the direct evidence of the effect of attitudes upon responses, highlights that existence values dominate in terms of what matters to the population. Given that the valuation question asked about a program aimed at forest health 100 years from now despite being implemented today, this result reflects that, though respondents recognize that a lot might change over the next century, they assert that the sustained existence of at least some of the high-elevation forests will remain important. Supporting this interpretation, responses to the attitudinal questions demonstrate an understanding of the importance of benefits derived from the natural services provided by these forests and a recognition of the role that natural processes play in determining changes in resources such as forests.

Not only indirect uses, such as the enjoyment of ecosystem services supported by the high-elevation forests, but also values related to nonuse contribute substantially to the public benefit provided by the continued existence of the forests. Indirect uses, such as the services of water provision and soil retention, tend to be produced by disperse, interrelated ecological systems not conducive to meaningful valuation of their individual, essential parts through valuation of the end uses. In addition, responses to attitudinal questions tend to de-emphasize the importance of direct uses, such as recreation and tourism, even though large proportions of the population have visited areas with high-elevation forests in the past. Instead, the importance of protecting some of the forests for the future is emphasized, and the proportion of the population intending to visit the areas at some undetermined point in the future matches or exceeds the proportion already visiting them, suggesting a combination of bequest and option motivations for nonuse values. In sum, our findings support the argument that adequate valuation of natural resources for public decision-making must accommodate nonmarket values, and that in some cases, such as the presently examined issue of protecting high-elevation forests from white pine blister rust, these values are quite substantial.

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