CHAPTER 12

CONTINGENT VALUATION OF FUEL HAZARD REDUCTION TREATMENTS

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1. INTRODUCTION

Increasing numbers of wildfires each summer has brought forward legislative and administrative proposals for expanding prescribed burning and mechanical fuel reduction programs. A policy of accelerating the amount of land to be mechanically thinned or prescribed burned is not without opposition. Prescribed burning can generate significant quantities of smoke that affects visibility and aggravates health problems for people with respiratory conditions. Prior initiatives to increase prescribed burning in states such as Florida and Washington have often been limited by citizen opposition due to smoke and health effects. The prescribed burning program is also expensive and costs as much as $250 per acre or more in some parts of the country. Thus, a policy relevant issue is whether the benefits of fuel reduction policies exceed the costs.

This chapter presents a stated preference technique for estimating the public benefits of reducing wildfires to residents of California, Florida, and Montana from two alternative fuel reduction programs: prescribed burning and mechanical fuels reduction. The two wildfire fuels reduction programs under study are quite relevant to people living in California, Florida and Montana because of these states' frequent wildfires[1]. The methodological approach demonstrated here has broad applicability to other fire prone areas of public land as well.

Wildfire on public land reduces the quality of forest recreation for some types of visitors and reduces the level of public goods arising from the forests such as water quality, and habitat for some wildlife species. Most of these resources adversely affected by wildland fire are not traded in markets, and thus, society does not have market prices as a guide to the economic values lost. Further, many of the goods and services lost from forests are public goods. The defining characteristics of public goods are that once the good is provided, no one can be excluded from consuming them, and that one person's consumption does not

[1] During the last several years these three states have experienced some of their worst fire season: California in 2003, Florida and Montana in 2000.

T. P. Holmes et al. (eds.), The Economics of Forest Disturbances: Wildfires, Storms, and Invasive Species, 229–243.

reduce the amount available to others. Protection from wildland fire and the associated risks is the public good under study in this paper. Households living at the wildland urban interface receive benefits from fuel reduction projects that reduce the intensity and extent of forest fires nearby where they live. These benefits reduce unhealthy levels of wildfire smoke, risk to their property, and loss of the aesthetics of surrounding forest landscapes. Others that enjoy forest recreation also benefit from protecting forests from catastrophic wildfire (Loomis et al. 2001).

There are several ways to estimate some of the effects of fire, such as expenditures made by households to avert some of the effects of wildfire on their private property. But this situation is different when public forests are involved, and the effects of wildfire affect non market public goods such as air quality, water quality, and habitat of non-game and endangered species. The public good values affected include those with direct human use values (e.g., air quality, water quality for drinking purposes), as well as passive use or existence values for protection of endangered species habitat. Stated preference methods such as the contingent valuation method (CVM) and conjoint/choice experiments are the primary methods capable of valuing both use and passive use values. Both of these techniques involve construction of a simulated market or simulated referenda to allow people to state how much they would pay for a particular level of one or more public goods.

In this chapter, the contingent valuation method is used to elicit how much households would pay for fuel reduction programs that reduce the number of acres of wildfire and number of houses lost. CVM has been applied to valuing a reduction in wildfire in approximately 3,000 acres of old growth forests that were habitat to threatened spotted owls (Loomis and González-Cabán 1998) and reducing risk of wildfire to property in rural Michigan (Winter and Fried 2001). The Winter and Fried study asked household how much of an increase in property taxes they would pay for a 50 percent reduction in probability of a wildfire. Their results averaged $57 per year per household. Recently, Talberth et al. (2006) conducted a CVM study that elicited willingness-to-pay (WTP) of homeowners for private fire risk reduction actions ($240), neighborhood fire risk reduction ($95) and public land wildfire risk reduction ($64). These annual WTP amounts are highest to protect one's own house, then neighborhood and then the public forests.

If forest managers simply wish to value an entire program or bundle of actions, CVM is often the easiest way to do it. However, if managers are interested in the individual values of different features of a fuel reduction program (e.g., smoke, probability of escape, etc), then choice experiments provide a method to estimate marginal values for each of the attributes of a fuel reduction program. In this chapter, we demonstrate the simpler contingent valuation approach. For more details on choice experiments and attribute based methods see Holmes and Adamowicz (2003).

1.1 WTP Model

In a contingent valuation survey we elicit an individual's WTP for the public program or public good. WTP is the conceptually correct measure of benefits for a new or expanded program. There are several ways in which WTP can be elicited from respondents. It can be asked as an open-ended question (e.g., what is the most you would pay), a payment card (e.g., please circle the maximum amount you would pay), or a closed-ended or dichotomous choice question format (e.g., would you pay a given monetary amount—yes or no?). As suggested by the National Oceanic Atmospheric Administration panel on contingent valuation, a closed-ended voter referendum WTP question format was used (Arrow et al. 1993). This casts the willingness-to-pay decision as voting for or against a given monetary amount. The magnitude of the monetary amount (call the bid amount) is varied across the sample.

Hanemann (1984), suggests how a respondent may answer a voter referendum or dichotomous choice CVM question. We assume that an individual's utility is a function of the public good bundle that represents the nonmarket benefits of reduced wildfires such as water quality, and endangered species habitat protection. This is represented by PG. The utility is also a function of the consumption of all private goods. Given the budget exhaustion by consumers, we can represent this composite commodity by their initial income (*I*) prior to paying for the public good. Therefore the utility function can be represented as:

$$U = f(\mathrm{PG}, I) \qquad (12.1)$$

The utility derived from the combination of public and private goods is known to the individual but it is not directly observable by the researcher, because some part of the preferences are not solely determined by observable socio-economic variables. Thus, while a portion of the utility function can be treated as deterministic, the unobservable portion is treated as stochastic. Therefore, the resulting indirect utility function and a stochastic element, is:

$$U = f(PG, I) = v(PG, I) + e \qquad (12.2)$$

where e represents an independent identically-distributed error term with a zero mean.

Under the dichotomous-choice approach, survey respondents are asked whether or not they would pay to maintain the public good if the costs to them were $X. The respondent will answer Yes if her/his utility from the public good (with the associated loss of $X in income) is greater than or equal to her/his utility level with full income, but without the public good. Thus, a "YES" respondent intends to receive the public good (PG=1), and a reduction in income by $X; while the "NO" respondent does not receive the increment in the public good, but retains their full income (PG=0). Therefore, the probability of a YES response is represented as follows:

$$P(\mathrm{YES}|\$X) = P[f(\mathrm{PG}=1, I\text{-}\$X) > f(\mathrm{PG}=0, I)] \qquad (12.3)$$

Because the individual's utility function is not observable to the researcher, we introduce the stochastic element from the utility function in equation (12.2), which results in the following transformation of the probability function into equation (12.4):

$$P(\text{YES}|\$X) = P[v(\text{PG}=1, I\text{-}\$X) + e_1 > v(\text{PG}=0, I) + e_2] \qquad (12.4)$$

where e_1 and e_2 are error terms with means of zero (Hanemann 1984). If the utility difference with the public good is greater than the difference in the error terms then the respondent is presumed to answer Yes to paying $X. If the difference in error terms is distributed logistically (Hanemann 1984, Loomis 1987) then the responses to the dichotomous-choice question are analyzed using a binary logit model to estimate the parameters, and to allow for calculation of WTP. The basic form of the logit equation is:

$$\ln\left(p_i/1-p_i\right)=\beta_0+\beta_1(Bid)+\beta_2(X_2)+\beta_3(X_3)+\ldots+\beta_n(X_n) \qquad (12.5)$$

where p_i is the probability of a yes response; β's are coefficients to be estimated; Bid is the dollar amount the household is asked to pay; and X's are other demographic and taste variables. A probit model results if the utility difference is distributed normally. The distributions of the probit and logit models are fairly similar over much of their range.

From the estimated coefficients in the logit or probit model, net WTP per household per year can be calculated using the formula from Hanneman (1989). Equation (12.6a) is used to calculate mean WTP from the logit models when WTP is greater than or equal to zero.

$$MeanWTP = \ln\left(1+\exp^{\alpha}\right)/\beta \qquad (12.6a)$$

In equation (12.6a) α is the product of the coefficient and mean values for all independent variables excluding the bid coefficient, plus the constant; and β is the absolute value of the bid coefficient. Equation (12.6b) presents the median WTP, which in the logit model is equivalent to allowing WTP to be positive or negative (i.e., if a fraction of households receive negative utility from the prescribed burning program due, for example, to smoke emissions):

$$MedianWTP = \alpha/\beta \qquad (12.6b)$$

Because forest fire prevention programs are public goods that increase the safety of all households living in the area influenced by the fuels reduction program, the value per household can be multiplied by all the households in the region that would benefit to arrive at a total annual value. The total annual benefits can be summed over the years that the prescribed burn or mechanical fuels reduction program are effective to yield a present value, which can be compared to the costs of the prescribed burning or mechanical fuels reduction program to determine the economic efficiency of the program.

1.2 Survey Design

The crux of any contingent valuation survey is an accurate and clear description of the resource to be valued; the consequences of paying and not paying; as well as specifying the means by which the respondent would pay for the program. In this example, a survey booklet was developed in conjunction with forestry professionals in California, Florida, and Montana to convey information on the extent of the problem, and two possible programs to reduce the problem (i.e., prescribed burning and mechanical fuels reduction).

Specifically, the survey booklet described the acreage that is burned by wildfires in an average year in each state, as well as the typical number of houses lost to wildfire each year in each state. The effect of wildfire on forests, houses and air quality was illustrated with a color drawing showing the flame height and rate of fire spread. This picture is shown in figure 12.1 and was designed to allow comparison to prescribed burning (fig. 12.2).

A program increasing the use of prescribed fire or controlled burning in California, Florida, or Montana was described and illustrated next (fig. 12.2). Specifically, respondents were told that the prescribed burning fuels reduction program would reduce potential wildfire fuels through periodic controlled burning. It was acknowledged that prescribed burning does create smoke, although far less than a wildfire. Then, the survey booklet provided additional information and drawings contrasting wildfire and prescribed fire. As can be seen in figure 12.2, prescribed fire is shown to have much lower flame height and slower fire spread.

The cost of financing this prescribed burning program was described as a cost-share program between their state government and the county the individual lived in.

WILDFIRE

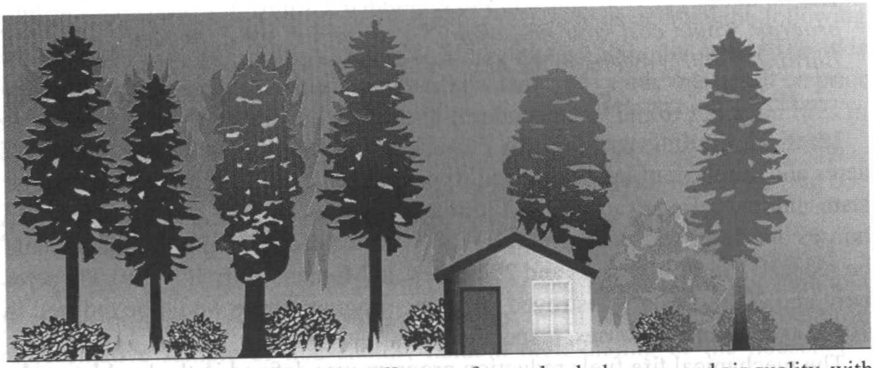

Figure 12.1. Illustration of a wildfire effects on forests lands, houses, and air quality, with a fire spread rate of one-half to two miles per hour and a flame height of 30 to 60 feet.

PRESCRIBED BURNING

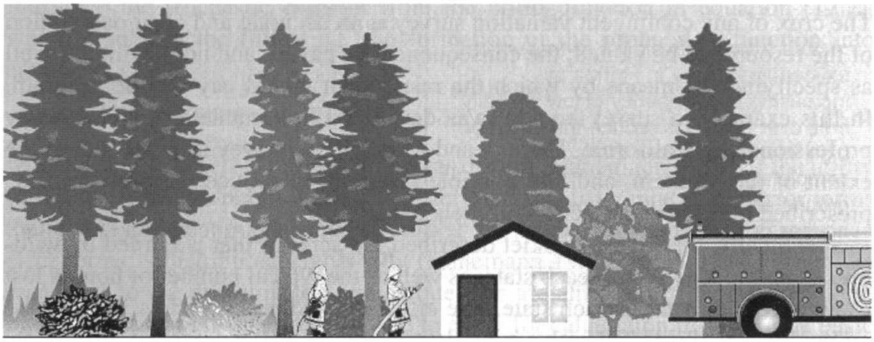

Figure 12.2. Illustration of prescribed burning effects on forest lands, houses and air quality, with a fire spread rate of 60 to 120 feet per hour and flame height of 4 to 8 feet.

The WTP elicitation wording for California was:

"California is considering using some state revenue as matching funds to help counties finance fire prevention programs. If a majority of residents vote to pay the county share of this program, the Expanded California Prescribed Burning program would be implemented in your county on federal, state, and private forest and rangelands. Funding the Program would require that all users of California's forest and rangelands pay the additional costs of this program. ...If the Program was undertaken it is expected to reduce the number of acres of wildfires from the current average of 362,000 acres each year to about 272,500 acres, for a 25 percent reduction. The number of houses destroyed by wildfires is expected to be reduced from an average of 30 a year to about 12. Your share of the Expanded California Prescribed Burning program would cost your household $__ a year. If the Expanded Prescribed Burning Program were on the next ballot would you vote:
___ In favor ___ Against? "

Identical wording was used in Florida and Montana, except the number of acres and numbers of houses burned were changed to correspond with particular state numbers. For example, in Florida, currently 200,000 acres burn and 43 houses are destroyed in an average year. With the proposed program this would be reduced to 150,000 acres and 25 houses. In Montana, currently 140,000 acres burn and 20 houses are destroyed. With the program, these would be reduced to 105,000 acres and 8 houses, respectively.

The mechanical fire fuels reduction program was defined in the booklet as the following: "*Another approach to reducing the buildup of fuels in the forest is to "mow" or mechanically chip the low- and medium-height trees and bushes* *into mulch. This is especially effective at lowering the height of the vegetation, which reduces the ability of fire to climb from the ground to the top or crown of the trees. In addition, mechanical "mowing" slows the growth of new vegetation with the layer of mulch acting as a barrier....Mowing or mulching ...is more expensive...due to increased labor and equipment needs...However, unlike prescribed burning, mulching does not produce any fire smoke."*

For the mechanical fuel reduction program, the survey booklet stated the same wildfire acreage reduction as achieved with the prescribed burning program, and stated that only one of the two programs would be implemented. The mechanical fire fuels reduction dichotomous choice WTP question in California was stated as follows:

> *"If the Mechanical Fire Fuels Reduction Program was undertaken instead of the Expanded Prescribed Burning Program, it is expected to reduce the number of acres of wildfires from the current average of approximately 362,000 acres each year to about 272,500 acres, for a 25 percent reduction. The number of houses destroyed by wildfires is expected to be reduced from 30 a year to about 12. Your share of this Mechanical Fire Fuels Reduction Program would cost your household $X a year. If the Mechanical Fire Fuels Reduction program were the ONLY program on the next ballot would you vote:*
> ___ *In favor* ___ *Against?"*

Identical wording was used in Florida and Montana, except the number of acres burned and numbers of houses were changed to correspondent with particular state numbers discussed after the wording of the prescribed burning WTP question.

The funding of both of these fuels treatment programs was explained as being on a county-by-county basis, where if a majority of the county residents voted for the program, the state would match funds for the approved counties and everyone in the county would be required to pay the additional stated amount for their county. The bid amount, denoted by $X, varied across respondents and had the following values: $15, $25, $45, $65, $95, $125, $175, $260, $360, and $480. The bids were allocated equally across the sample. This range of values was based on prior surveys regarding Oregon and California respondents WTP for reducing fires in old growth forests to protect spotted owls (Loomis and González-Cabán 1998).

2. DATA COLLECTION AND SURVEY MODE

The surveys were conducted in Florida in 1999 and in 2001 in California and Montana through a phone-mail-phone process in all three states. To obtain a representative sample of households, random digit dialing of the households living in a sample of California, Florida, and Montana counties was performed. The counties were selected so there was a mix of counties that frequently experience wildfires, counties that occasionally experience wildfires, and counties that rarely experience wildfires. This variation had two useful features. First, it ensured variation in responses to questions like whether the respondent "had seen a wildfire". Second, targeting this sample aided in generalizing the results to all areas of the state.

Once initial contact was established, language was verified (except in Montana), along with elicitation of initial attitude and knowledge of wild and prescribed fire, followed by the scheduling of appointments with individuals for detailed follow-up interviews. During the interim time period, a color survey booklet was mailed to the household. These interviews were conducted with the aid of this color booklet. The booklet was sent in English to Caucasians and in Spanish to Hispanic households. The individuals were asked to read the survey booklet prior to the phone interview. Phone interviews were conducted in either English or Spanish depending on the language of the booklet received.

2.1 Survey Response Rate

Because the survey was conducted in two waves and with two ethnic groups in California and Florida, the response rates are compared from the initial random digit dial phone survey and the follow-up indepth interviews separately (table 12.1). While, the response rates to the initial phone calls were all over 40 percent, only in California there is a statistically significant difference between the groups in response to the initial phone call. The highest response rate (85 percent) is by

Table 12.1. Comparison of response rates in California, Florida, and Montana

	California		Florida		Montana
	Caucasians	Hispanics Spanish	Caucasians	Hispanics Spanish	Caucasians
First Wave – Screener Interview					
Total initial sample Contacted	794	620	840	652	602
Completed initial	328	468	714	553	406
1st Wave response rate (%)	41.3	75.5	85	85	67
Second Wave – In Depth Interview					
Net sample for 2nd wave	257	420	714	553	381
Total surveys completed	187	139	443	336	272
2nd wave response rate (%)	72.8	33.1	62	61	71

Hispanics phoned by a Spanish-speaking interviewer in Florida. The extra effort to contact people in their native language was definitely worthwhile in the initial interview.

Unfortunately, in the indepth interviews, after mailing a Spanish language booklet to Hispanic households, a relatively low response rate of 33 percent for California was obtained in this phase. The experience in Florida was different where the English and Spanish response rates to unit non-response, completed screener, and completion of the entire survey process are very similar. The participation rate for the initial screener was the same at 85 percent for both populations and near identical for the indepth interview at 62 percent for English and 61 percent for Hispanics (table 12.1, Second wave). A χ^2 statistic confirms no significant difference in response rate by Caucasians and Hispanics to the initial screener survey or the main interview in Florida.

In Montana, a total of 602 Caucasian households were contacted and 406 of them or 67.4 percent completed the initial interview. Of these 381 were available for the in-depth interview. The in-depth interview resulted in 272 completions, for a response rate of 71.4 percent on this phase (table 12.1, Second wave).

2.2 Specification of the Logit WTP Models

Because we are dealing with two programs, in three states and two ethnic groups, there could potentially be up to 12 separate logistic regression equations. For the purposes of this chapter, and to estimate a generalized WTP function for each program that could be applied to other states in a form of benefit function transfer, a relatively simple logistic regression model was estimated. To facilitate transfer to other states only simple demographics like household income and education levels were included, and survey variables were omitted since their values would not be known for other states. We did test whether a state specific intercept shifter dummy variable and a corresponding state specific bid interaction variable were statistically significant. As a general rule, we retained variables whose coefficients had t-statistics about one or higher.

The general form of the logistic regression model for the prescribed burning and mechanical fuel reduction for Caucasians interviewed in California, Florida, and Montana (where Montana is the base case, so no shift variable is needed):

$$\begin{aligned}\ln\left(p_i/1-p_i\right)= \beta_0+\beta_1(Bid)+\beta_2(CAState)+\beta_3(CABid)+\\ \beta_4(FLState)+\beta_5(FLBid)+\beta_6(Income)+\beta_7(Ed)\end{aligned} \quad (12.7)$$

where CABid and FLBid are interaction terms of CAState or FLState and the Bid amount variables, and Ed is the household education levels in years.

The Hispanic logistic regression models (equation 12.8) are similar to equation (12.7), except that because interviews only took place in California and Florida, the state of Florida is used as the base case, so there are no intercept shifter variables or bid interaction variables for Florida.

$$\ln\left(p_i/1-p_i\right)=\beta_0+\beta_1(Bid)+\beta_2(CAState)+\beta_3(CABid)+\beta_4(Income)+\beta_5(Ed) \quad (12.8)$$

3. RESULTS

3.1 Descriptive Statistics by Fuel Reduction Program and Samples

The percent yes to the dichotomous choice CVM question for each state and each program, along with the key demographics were computed (table 12.2). As shown in table 12.2, the prescribed burning program consistently received 60 percent or higher Yes responses, ranging from a high of 84 percent among Hispanics in California to 60 percent among Caucasians in Montana. The mechanical fuel reduction program support was much lower among Caucasians, being only 34 percent to 50 percent, but 50 percent to 68 percent among Hispanics. Education levels and household income were highest in California and lowest in Montana for Caucasians. Hispanics education levels and income were higher in Florida than in California.

3.2 Results of Logit Regressions

In the logistic regression equations that follow, we started estimations with the full model specified in equation (12.7) (i.e., state intercepts and bid interaction terms, income and education) and then dropped any variable that was not significant at least at the 0.33 p value, correspondingly roughly to a t-statistic of one. This seemed a reasonable trade-off between avoiding omitted variable bias and minimizing variance due to inclusion of irrelevant variables.

The logit equation for Caucasian residents of the three states for the prescribed burning and mechanical fuel reduction programs are presented (table 12.3a). The

Table 12.2. Selected descriptive statistics of the sample by fuel reduction program

	California	Florida	Montana
Caucasians			
Income	$71,797	$53,078	$45,905
Years of Education	15	15	14
Yes Prescribed Burning (%)	75	73	60
Yes Mechanical (%)	50	45	34
Hispanics			
Income	$32,947	$37,982	
Years of Education	12	14	
Yes Prescribed Burning (%)	84	64	
Yes Mechanical (%)	68	50	

Table 12.3a. California, Florida, and Montana logistic regression for Caucasians WTP for Prescribed Burning and Mechanical Fuels reduction

	Prescribed Burning		Mechanical Fuel Reduction	
Variable	Coefficient	t-Statistic	Coefficient	t-Statistic
Constant	1.5986	2.376**	-0.3826	-1.850*
CASTATE	0.6782	2.683***	0.3694	1.227
CASTATEBID			0.0015	1.103
FLSTATE	0.3789	1.756*	0.3182	1.696*
INCOME	2.94E-06	1.033	4.11E-06	1.863
EDUC	-0.457	-0.976		
BID	-0.0042	-5.981***	-0.0032	-3.941***
Mean dependent var		0.6875		0.4238
McFadden R-squared		0.0708		0.0391
Log likelihood		-341.64		-451.15
Rest. Log likelihood		-367.68		-469.54
Likelihood Ratio statistic (5df)		52.067***		36.774***
Probability (LR stat)		5.23E-10		6.65E-07
Obs with Dep = 0	185			397
Obs with Dep = 1	407			292

*, **, and *** Indicates significance at the 0.1, 0.05, and 0.01 levels, respectively.

bid coefficients are negative and statistically significant ($p<.01$), indicating the higher the dollar amount respondents were asked to pay, the lower the chances they said they would pay. This shows internal validity to the CVM responses, i.e., respondents took the dollar amount they were asked to pay seriously, otherwise the bid coefficient would not be statistically significant and negative. In the prescribed burning program, the California (CAState) and Florida (FLState) intercept shifters were positive and statistically significant at the 1 percent and 10 percent level respectively, mirroring the higher percentage of Yes responses of these two states relative to Montana for the prescribed burning program.

In the mechanical fuel reduction program, the FL intercept shifter and income are positive and statistically significant at the 10 percent level. The California bid interaction variable (CABid) was also positive, which when added to the own price bid variable, indicates a more price inelastic response to the dollar bid amount than Florida and Montana.

A logit equation for Hispanic residents of California and Florida for the prescribed burning and mechanical fuel reduction programs (Florida is the base case) was estimated (table 12.3b). The bid coefficients are negative and statistically significant, indicating the higher the dollar amount respondents were asked to pay, the lower the chances they said they would pay. The California intercept shifter (CAState) and California bid interaction (CAStateBid) variables are

Table 12.3b. California and Florida logistic regression for Hispanics' WTP for Prescribed Burning and Mechanical Fuels reduction

Variable	Prescribed Burning		Mechanical Fuel Reduction	
	Coefficient	t-Statistic	Coefficient	t-Statistic
Constant	2.2285	2.700***	3.2653	5.509***
CASTATE	0.9883	3.947**		
CASTATEBID			0.0022	2.401**
INCOME	-4.94E-06	-1.102		
EDUC	-0.0796	-1.367	-0.2074	-4.829***
BID	-0.0026	-3.213***	-0.0022	-2.503**
Mean dependent var		0.7469		0.5885
McFadden R-squared		0.0711		0.0523
Log likelihood		-255.35		-380.65
Rest. Log likelihood		-274.93		-401.69
Likelihood Ratio statistic (5df)		39.141***		42.079***
Probability (LR stat)		6.51E-08		3.86E-09
Obs with Dep = 0 123				244
Obs with Dep = 1 363				349

*, **, and *** Indicates significance at the 0.1, 0.05, and 0.01 levels, respectively.

positive and statistically significant indicating that Hispanics in California are more likely to pay for these programs, and are less price sensitive. However, for the Mechanical fuel reduction program, the combined effect of the California bid interaction variable and bid coefficient is to essentially net each other out. Given this result, it is not possible to calculate WTP for California Hispanics for the Mechanical Fuel reduction program.

3.3 Willingness-to-Pay Results

Using equation (12.6a) Mean WTP was estimated for Caucasians and Hispanics (table 12.4). Mean (median) WTP of Caucasians for prescribed burning was $460 ($424) in California, $392 ($344) in Florida, and $323 ($254) in Montana. For the mechanical fuels reduction program the mean WTP of Caucasians in California was $510, while it was much lower in Florida at $239 and Montana at $186. For the mechanical fuel reduction program the median WTP, which also allows for negative WTP of any respondent, is substantially less than the mean, with median WTP being about one-fifth in California ($87) and Florida ($48), and even slightly negative in Montana. These results are consistent with the lower percent yes in table 12.2, and suggest far less support for mechanical fuel reduction program than prescribed burning in these three states.

Table 12.4. WTP for Prescribed Burning and Mechanical Fuels reduction programs in California

	Prescribed Burning		Mechanical Fuel Reduction	
State	Caucasians	Hispanics	Caucasians	Hispanics
California				
Mean	$460	$838	$510	n/a
Median	424	794	87	n/a
Florida				
Mean	$392	$473	$239	$373
Median	344	344	48	124
Montana				
Mean	$323		$186	
Median	254			

Hispanics in Florida mean (median) WTP is $473 ($344) for the prescribed burning program, about half what Hispanics in California would pay $838 ($794). Hispanic's in Florida WTP for the mechanical fuel reduction program is $373 with a median WTP of $124.

The ranking of mean WTP per household in the states follows the magnitude of acres protected from fire and houses saved. While all the state programs represented an equivalent proportional reduction (25 percent reduction) in acres and houses burned, the absolute magnitude or amount of fewer acres that burned and number of houses saved did vary across states. In terms of the three states program, California would protect 90,000 acres and 18 houses. Florida would protect 50,000 acres and 18 houses, and Montana's 35,000 acres and 12 houses. The ranking of mean WTP per household is in the same order as the amount of acres prevented from burning and houses saved. In particular, mean WTP of California households are noticeably higher than Florida households, which are noticeably higher than Montana residents.

With mean willingness-to-pay of more than $400 per household, and more than 13 million households in California, the willingness-to-pay for either of these fuel reduction programs is about $5 billion. In Florida, with 7.6 million households this translates to about $3 billion for the prescribed burning and $2 billion for the mechanical fuels reduction program. In Montana, with only 366,000 households state level benefits would be close to $118 million for prescribed burning and $68 million for mechanical fuel reduction. Note, the survey explicitly indicated that only one of the programs would be implemented, so that it would be incorrect to add the values of these two fuel reduction programs together. However, these state level values reflect only what state residents would pay for the program, and Loomis and González-Cabán (1997) found that non-resident households often have a willingness-to-pay to prevent wildfires in ecologically important forests in other states.

4. CONCLUSIONS

This chapter demonstrated how the contingent valuation method (CVM) could be used to estimate willingness-to-pay for prescribed burning and mechanical fuels reduction programs among Caucasian and Hispanic households in California, Florida, and Montana. The simple format of the willingness-to-pay function including income, education, and a state intercept shifter may make the function suitable for benefit function transfer for calculating benefits of the two fuels reduction programs to other states.

The survey and statistical results suggest substantial willingness-to-pay of California, Florida, and Montana households for a prescribed burning or mechanical fuels reduction program that would decrease the number of acres burned by wildfires in their respective states by, at least, 25 percent. The range of California households' willingness-to-pay for the reductions in about 90,000 acres burned in the wildland urban interface where houses are at risk is $400-$500. These $400-$500 amounts are substantially larger than the $75 per year Loomis and González-Cabán (1997) found for California household's willingness-to-pay to reduce fires in 3,000 acres of remote National Forest old-growth that was habitat for spotted owls. The relative magnitude of willingness-to-pay in the two studies are sensible, in that this current study involved a reduction of 90,000 acres, predominantly in the wildland urban interface, while the 3,000 acres was more remote public land forests without houses. Our values are also larger than Winter and Fried (2001) who used property taxes as a payment vehicle to elicit willingness-to-pay for a 50 percent reduction in risk. Their lower values of $57 per household may in part be due to a large number of zero and protest responses to use of property taxes as the payment vehicle, and the fact this was a rural area in Michigan with relatively low house prices at risk compared to California.

The strong support in our study for the two fuel reduction programs is demonstrated by the high mean WTP for both the prescribed burning and the mechanical fuels reduction programs, and suggests these kinds of treatments to be economically feasible and efficient. However, unlike California where there is only a 10 percent difference in household's WTP for prescribed burning and mechanical fuel reduction, Florida and Montana resident's have much higher WTP for prescribed burning than for mechanical fuels reduction (by about one-third in Florida, and nearly double in Montana).

Information provided by fire managers in California indicates that prescribed burning is expensive, costing more than $250 per acre in many locations. Although prescribed burning costs may be less in other part of the country, nonetheless, is an expensive proposition. However, when compared to the benefits estimated here attributable to prescribed burning programs, up to $5 billion in Californian and $2-3 billion in Florida, the results indicate that many fuels reduction projects may be economically efficient as the benefits per acre are an order of magnitude greater than the costs in these two states.

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