OWLECON: A Spreadsheet Program for Calculating the Economic Value to State Residents from Protecting Spotted Owl Habitat from Fire[1]

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Abstract

The spreadsheet program, OWLECON, was developed to allow managers to quickly calculate the economic value of reducing fire risk to California and northern spotted owl habitat in California and Oregon. The program draws from surveys performed of California and Oregon residents. The user simply types in the current average annual acres burned and the expected acres that would burn with different fire management projects or scenarios. The program will calculate the economic value to people living around the particular National Forest. The annual value per acre protected in the fire management unit is calculated. This can be inputted into the National Fire Management Analysis System (NFMAS) so that the northern spotted owl can be considered with other multiple use resources in the net value change computation.

Federal agencies have began to recognize that in addition to protection of traditional multiple uses, other environmental values need to be incorporated into fire decision-making (González-Cabán 1993, González-Cabán and Chase 1992). These values often reflect public desire to know that rare and distinctive ecosystems exist (e.g., existence value; Krutilla 1967) and will be protected for future generations (bequest value), as well as being available for visits at future times (option value). In addition to recreation, these three values are sometimes referred to as total economic value (Randall and Stoll 1983). Vaux and others (1984) conducted the first study on the influence of fire on the economic value of forest recreation and found that "Willingness-to-pay is an appropriate measure for valuing the effects of fire on forest recreation" (p. 1). This is consistent with Federal benefit-cost directives that require use of willingness-to-pay (WTP) as a measure of benefits (U.S. Water Resources Council 1983).

This paper discusses the development of a spreadsheet program, OWLECON, that used data from two contingent valuation studies (CVM) of the willingness-to-pay (WTP) of residents in Oregon and California to protect old-growth habitat of the northern spotted owl from catastrophic fire.

Non-Market Valuation Methodology

The contingent valuation method (CVM) uses a questionnaire or survey to create a hypothetical market or referendum and then allows the respondent to use it to state or reveal his or her WTP for recreation, option, existence, and bequest values (Mitchell and Carson 1989). The first part of a CVM survey presents the current and proposed change in quantity or quality of the resource. Second, the respondent is told how they would pay for the proposed change. Then the provision rule is made clear: if you agree to pay you get the proposed quantity/ quality, if you do not agree to pay you remain at the current quantity/ quality level. The recommended WTP question format asks respondents to state whether they would pay a specific dollar amount that varies from respondent to respondent (Arrow and others 1993). The use of responses from a survey to measure WTP is not without objections, such as the validity of responses.

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Specifically, the question arises if the respondents would actually pay the dollar amounts they state or agree to pay in the survey. There have been dozens of studies testing the validity of stated WTP by comparison of values derived from other methods. A summary of these studies by Carson and others (1995) determined that CVM derived estimates of WTP for recreation were somewhat less than actual behavior-based methods for valuing recreation. Although concerns remain about the degree of accuracy of CVM estimates of WTP for existence and bequest values for natural resources that are unfamiliar to the public, the method has been shown in empirical test-retest studies to be reliable at eliciting such values (Loomis 1989, 1990). CVM is a recommended method for use by Federal agencies for performing benefit-cost analysis (U.S. Water Resources Council 1983) and for valuing natural resource damages (U.S. Department of Interior 1994), and it has been upheld by the Federal courts (U.S. District Court of Appeals 1989). A "blue ribbon panel" co-chaired by two Nobel laureate economists concluded that CVM can produce estimates reliable enough to be the starting point for administrative and judicial determinations (Arrow and others 1993).

Study Design

To statistically estimate willingness to pay as a function of acres of old-growth habitat protected from catastrophic fire, survey data was compiled from two separate CVM studies. The first study was a survey of Oregon households to determine their WTP for a fire prevention and control program to protect northern spotted owl habitat in Oregon. The second study was a survey of California and New England households to determine their WTP to reduce fire intensity and acres burned of spotted owl habitat in old-growth forests in California and Oregon.

In both the California and Oregon study a survey booklet was developed to provide the basic information to respondents before eliciting their WTP. In the Oregon resident study, respondents were asked to value a fire prevention and control program for 3 million acres of old-growth forests in Oregon that have been designated as Critical Habitat Units (CHU's) for northern spotted owls. This was emphasized by a half page map of western Oregon showing the CHU's. Below the map, the current number and size of fires in Oregon old-growth forests were described. Then the elements of the Fire Prevention and Control Program that would reduce the acres burned were listed (Loomis and González-Cabán 1997).

In the Oregon survey the respondents were told: "*Adoption of this improved fire prevention and control program would on average reduce the number of acres of Critical Habitat Units that burn by half, a reduction of 3,500 acres a year (from 11 square miles to 5.5 square miles) on publicly owned old-growth forests in Oregon.*" The narrative of the California Program was similar to this and reduces the acres of high intensity fires and total acres of old-growth forests burned by all intensities of fire by 20 percent or 2,850 acres each year in California. California residents were asked their WTP to reduce the amount of old-growth forests in northern spotted owl CHU's in Oregon that burn each year by 20 percent or 1,400 acres. The third program was a combined California and Oregon Program, reducing acres burned by 4,250 acres.

Willingness-to-Pay Questions

Households were told that there were insufficient funds to pay for the improved fire prevention and control programs. In the California survey (Loomis and González-Cabán 1996, 1997) respondents were then asked, "*Thinking about Program B, which reduces the proportion of high intensity fires and also includes a 20 percent reduction in the acreage of old-growth forest that burns each year, if Program B*

were the only program available and your household was asked to pay $X each year to help pay for Program B, would you pay this amount?"

YES NO (don't know)

The same basic wording and series of WTP questions were also used to ask the WTP question for the Oregon Program and for a single program that combined the California Program and Oregon fire control program. In the Oregon resident survey, they were asked just about the Oregon program (Loomis and others 1994, 1996; Loomis and González-Cabán 1994, 1996, 1997).

The means by which all households would pay was a closed-ended or dichotomous choice question. The dichotomous choice format mimics an actual vote by asking if the person would vote (e.g., pay) for the program if it cost the household a particular dollar amount each year. The respondent has only to decide if the value to him or her is worth at least this price or not.

Sample Design

For the Oregon study, questionnaires were sent to a random sample of 1,000 Oregon households. The sample was provided by Survey Sampling Inc.[4] For the California /New England Study, random digit dialing was used to initially contact 737 households in California and 709 households in the New England. A total of 499 California households and 449 New England households were scheduled for in-depth interviews, reflecting an initial participation rate of 68 percent and 63.3 percent, respectively. The 948 scheduled households were mailed the survey booklet that contained the background information on old-growth forests, maps, and information about current and proposed fire management programs. A total of 358 interviews out of 499 were completed that were scheduled in California for a completion rate of 72 percent. In New England, 314 interviews out of 449 were completed, yielding a 70 percent completion rate.

Survey Response Rates

For the Oregon study, 425 surveys were completed and returned, which after deleting undeliverable surveys and deceased individuals yielded a response rate of 49.4 percent. The response rate is typical for a general population survey using a first mailing-postcard-second mailing without any financial incentives. For the California/New England study, the overall response rate for California was 49 percent and 44 percent for New England. The respondents were slightly older (by 3-4 years) than the state population levels and slightly more educated (by about one year). In estimating WTP we adjusted for these differences by setting the age and education at the respective state levels based on census data. The samples had a slightly higher proportion of males (52-53 percent male) as compared to the population proportion for California (50 percent) and New England (48.3 percent). There was less than a 10 percent difference between the household income of the sample and that of the respective populations.

Statistical Results

To allow managers to calculate WTP for reductions in expected acres burned, a logit WTP function was estimated, including a variable for acres. Because economic theory suggests diminishing marginal value to greater and greater reductions in acreage burned, the natural log of acres were estimated. The results of the logistic regression were determined, with the log of the probability of paying the bid amount as the dependent variable *(table 1)*. Both the bid amount and the natural log of acres were statistically significant at the 0.01 level. This suggests respondents carefully considered the details of the survey questions. In particular, the negative and statistically significant coefficient on the bid variable

[4]Mention of trade names or products is for information only and does not imply endorsement by the U.S. Department of Agriculture.

Table 1-*Logit equation for respondents' willingness-to-pay (WTP) reduce fires in old-growth forests in California and Oregon.*

Variable	Coefficient	T-Stat	P-Value
Constant	-4.7087	-4.93	0.000
Lacres[1]	0.4182	3.93	0.000
Ogexist[2]	0.178	2.84	0.005
Envgimp[3]	0.3654	4.08	0.000
Educ[4]	0.0367	2.13	0.033
Ages[5]	-0.0107	-3.58	0.000
Donate[6]	0.2933	2.88	0.004
Bid[7]	-0.011	-14.45	0.000

[1]Log of acres.
[2]The importance of knowing that old-growth forests exist.
[3]The importance of the quality of the environment.
[4]Education level in years.
[5]Persons age in years.
[6]Dummy variable for whether respondents had contributed to an environmental organization in the past 12 months.
[7]Dollar amount respondents were asked to pay.

suggests that the higher the dollar amount respondents were asked to pay, the less likely they would pay. This demonstrates they considered seriously the dollar amount they were asked to pay. The fact that acres is significant implies that the amount of habitat protected influenced their probability of paying a given dollar amount.

Details of Computer Program

A Microsoft-DOS computer and a Lotus 123 spreadsheet program (Lotus version 2.0 or higher) is the preferred hardware and software. If running a Windows version of Lotus 123 you will need Microsoft Windows. Lotus 123 for DOS or 123 for Windows can also be run in Windows 95. The program should also operate under Quatro Pro or Microsoft Excel by importing the Lotus spreadsheet. However, all instructions are for Lotus.

Running the Program

To run this program, five variables will need to be changed that are displayed on the screen. The five variables are: **current acres that bum; with management action acres that bum; forest-wide acres protected by management action; number of people living around the national forest** (these are the primary beneficiaries from reducing fire risk in spotted owl habitat); and the **number of years the management action provides reduced fire risk** to the acres protected in the National Forest. This information is collected from a specific management area.

Current Acres That Burn

This number represents the average annual acres that burn in a management area with the current level of fire prevention and control programs in place. Enter this number in cell **D19**.

With Management Action Acres That Burn

The average annual number of acres that would burn after implementation of the proposed fire prevention and control program should be estimated. The number of acres that burn annually after a fire prevention and control program have been implemented should be less than the acres that burn with no management practices. If the estimate shows a number for **management acres that burn** that is greater than current acres that burn, the economic results section will display an error (ERR). Enter the annual acres that burn after the implementation of the fire program in cell **D20.** (The program will calculate a value for acres that no longer burn [D19-D20]. This number represents the current acres that burn subtracted from **management action acres that burn).**

Forest-wide Acres Protected by Management Action

Fire managers often express the effectiveness of a fire prevention and control program as the broad area that will receive a reduction in the probability of wildfire. For example, performing a brush removal program on 1,000 acres throughout a 10,000 acre area provides reduced likelihood of catastrophic fire to the entire 10,000 acres, even though only 500 acres less will burn in any given year as a result of the brush removal. Nonetheless, the reduction in fire risk occurs on the entire 10,000 acres. Thus, 10,000 acres are protected in this example. This number of acres often corresponds to what one would analyze in the National Fire Management Analysis System (NFMAS) for acres protected. Thus, the resulting value per acre protected calculated by OWLECON could be input into NFMAS for the net value change analysis.

Number of People Living Around the National Forest

The number of persons living around the National Forest is input as a conservative measure of the number of beneficiaries of the fire management action. This will be multiplied by the estimated value per person to arrive at the total benefits arising from the fire management action. Usually this number would be the number of people living in the multi-county impact area used for IMPLAN input-output analyses or social impact analyses. The counties and their populations can often be determined by looking in the Forest Plan.

Years Action Is Effective

To calculate a present worth or present value for the management action, the number of years for which the action is effectively reducing fire risk needs to be entered. If the management action such as a prescribed burn or brush removal would reduce the number of acres burned by the same amount for 10 years, enter 10. In other words, enter the number of years for which the management action protects the number of acres entered. If the management action provides a declining amount of protection, in each year after the management action the simple discounting feature used in this program will overstate the effect and should not be used. In this case, set the **years** variable to the duration of time in which the management action provides a constant annual benefit. The program can be run for each of these "time steps" and then sum the stream of benefits discounted outside of the program using the spreadsheet.

It is important to note that the program estimates of benefits is most valid for acreages that no longer burn between 150 acres and 50,000. Using it with acres less than this or more than this involves a high degree of extrapolation beyond the range of the data used in the statistical analysis, and the results may be less accurate. Also, as each acreage figure is entered, the program will recalculate the values in the results section. These numbers will not be correct until all three acreages are entered. After the last number is entered, then the values in the Economic Results Section will be correct for the acreage scenarios that have been created.

Spreadsheet Example for Habitat of Northern and California Spotted Owl in California

This section will illustrate use of the program and interpretation of the results for the Calowl2.wk1 file in OWLECON. For the example, we set the value of the five input variables as:

- Current Acres that burn = 10,000; type into cell D19.
- With Management Action Acres that burn = 9,000; cell D20.
- Forest-wide Acres Protected by Management Action = 200,000; cell D23.
- Number of People Living Around National Forest = 1,000,000; cell D25.
- Number of Years Action is Effective For = 10; cell D26.

Interpreting the Results

The annual per person benefit of $25 is the amount that an average person living around the National Forest would pay each year to reduce 1,000 acres of crown or catastrophic fire in northern or California spotted owl habitat *(table 2)*. These dollars represent the sum of recreation use value and existence value for knowing the spotted owl exists in their natural habitat as well as bequest value. Bequest value is the benefit received from knowing that protection today provides spotted owls and their habitat to future generations. The U.S. District Court of Appeals for the District of Columbia (1989) has required the Federal government to include these values when calculating natural resource damage assessments. These types of values are included in U.S. Fish and Wildlife Service Environmental Impact Statements (EIS) on the benefits of protecting endangered species (U.S. Fish and Wildlife Service 1994).

Because protection of the 1,000 acres of spotted owl habitat from burning simultaneously provides benefits to people living around the National Forest, the $25 is multiplied by the number of persons living around the National Forest. Although research indicates that benefits of preserving the northern and California spotted owl is nationwide (Loomis and González-Cabán 1996), to be conservative we have chosen only to expand the values to those 1 million people living around the National Forest. Usually this number would be the number of households living in the multi-county impact area used for IMPLAN input-output analyses. This area can be determined by looking in the Forest Plan.

The product of value per household and the 1 million people surrounding the National Forest results in a total value of $25 million. When divided by the number of acres that no longer burn, this value is $25,006 per acre that no longer burns. This would be the value to compare to the per acre costs of the fire management action used to achieve the 1,000 acre reduction in area burned. Dividing the total economic value by the number of acres protected yields a value of $125 per acre. This would be the value input into NFMAS to calculate the net value change from protecting 1 acre of California or northern spotted owl habitat from burning. Protecting officially designated northern spotted owl critical habitat and California spotted owl areas in California are not distinguished. All of the dollar figures are in 1995 dollars. If the base year dollars of the NFMAS analysis is different or if the costs are in current year dollars, the benefit figure will need to be scaled up. This is usually done by applying a price index such as the Implicit Price Deflator or Consumer Price Index.

Table 2-*Sample OWLECON results for California.*

Habitat for Northern and California Spotted Owl in California
Date of Analysis - October 11, 1998

I. INPUT VARIABLES	Acres
Current Acres that burn	10,000
With Mgmt Action Acres that burn	9,000
Acres that no longer burn	1,000
Forest-wide Acres Protected by Mgmt Action	200,000
Number of People Living Around National Fores	1,000,000
Number of Years Action is Effective For	10

II. ECONOMIC RESULTS
Annual Economic Values

Per Person Benefits	Total Value Around N.F.	$ Per Acre No Longer Burning	$Per Acre Protected
$25	$25,006,294	$25,006	$125
Present Value @ 4 pct. Per Acre No Longer Burning		Present Value Q 4 pct. Per Acre Protected	
$202,823		$1,014	

Because the WTP equation is non-linear, doubling the amount of acres protected from burning will not double the total economic value. This makes economic sense, as protecting each additional acre contributes slightly less benefit than protecting the first few acres. The present value of the benefits arising from the acres that no longer burn is calculated at the USDA Forest Service interest rate of 4 percent for the number of years specified as an input *(table 2)*. The present value per acre protected is also valued.

Conclusion

Public land managers in California and Oregon now have a powerful tool for estimating the economic benefits of reducing acres burned of old-growth forests that are habitat of the northern and California spotted owl. Judicious use of this tool should aid managers in developing budget requests for fuels reduction and prescribed fire programs to protect spotted owl habitat.

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