# Session V

## Resource Valuation Requirements in Strategic Fire Planning

*Chair: Hayley Hesseln*

# Effects of Fire on the Economic Value of Forest Recreation in the Intermountain West: Preliminary Results[1]

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**Abstract**
*Visitors to National Forests in Colorado, Idaho, and Wyoming were asked how their visitation rates would change with the presence of a high-intensity crown fire, prescribed fire, and a 20-year-old high-intensity fire at the area they were visiting. By using pairwise t-tests, visitors to forests in Colorado showed a statistically significant decrease in recreation trips per year with the presence of a recent crown fire, a smaller but still significant decrease with a recent prescribed burn, and with a 20-year-old high-intensity fire. A multivariate test of the effect of fire on the demand curve for recreation was conducted by using the travel cost method. The multivariate test indicates that years since last fire does have a statistically significant effect on visitation in Colorado, Idaho, and Wyoming, although the effect is very small.*

The growing societal awareness of maintaining a healthy environment and the rising costs of Federal and State fire fighting is forcing public agencies to incorporate the economic value of non-marketed resources into their fire management planning and decisions (González-Cabán 1993). However, estimating the impacts of fire on resources and the resulting economic consequences is a difficult problem for fire managers because of a lack of information on the effects of fire on recreation use. However, recreation is one of the dominant multiple uses in the intermountain west. Field users of the USDA Forest Service National Fire Management and Analysis System use the Resources Planning Act (RPA) values for recreation but do not have a solid empirical basis for determining how recreation use changes immediately after fire and over the recovery interval (Loomis 1997). Flowers and others (1985) found that "The studies demonstrate that no clear consensus has been reached on the duration for which fire effects on recreation should be measured or valued. The duration effects ranges from 6 months to 7 years among the studies.... The choice of duration is subjective and somewhat arbitrary because research on the question is scant" (p. 2). Flowers and others (1985) used an iterative bidding contingent valuation method question to estimate the change in value of recreation with low and high-intensity fires in the Northern Rocky Mountains. Although they found only minor effects, part of this may be due to baseline valuations elicited. Even in the no fire case their values per Recreation Visitor Day were less than $1, a value far below values in the literature at the time. These values were about half this amount immediately after fire, a sizeable percentage reduction. Use levels were estimated to fall by nearly half immediately after fire.

Englin (1997) noted in his recent review of the literature on the effects of fire on recreation, "At present there are few studies quantifying the impacts of fire on the non-timber values produced by forests" (p. 16). Two revealed preference studies focus on the effects of fire on canoeing in the Canadian boreal forests (Boxall and others 1996, Englin and others 1996). A very recent master's thesis (Hilger 1998) applied a Poisson count data model to compare before and after recreation use levels with fire in the Alpine Lakes Wilderness Area in Washington State. Hilger found a substantial drop-off in recreation use during the year of the

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fire and up to 2 years after the fire. However, by the third year use had surpassed the pre-fire use levels. The value per day of recreation did not change with the fire, however.

The National Fire Management Analysis System (NFMAS) requires incorporation of fish, wildlife, recreation, and wilderness as well as environmental values into calculation of the dollar amount of net value change. Little guidance is available as to how field personnel are to estimate the change in recreation visitor days over time with different fire intensity levels. No information exists on recreation visitors reaction to prescribed fires that might be set to reduce the likelihood of high-intensity, crown fires.

This paper begins to fill the gap by reporting empirical estimates of how recreation use and benefits change with different ages from fire and fire intensity levels. In addition, the similarity and differences between visitors' response to fire in Colorado, Idaho, and Wyoming is investigated to determine if the visitors reaction to fire from these three areas are similar enough that they might be generalized to other intermountain forests.

## Research Design

### *Demand Estimating Method*

This research combines data on actual number of trips taken by visitors to locations on National Forests unaffected and affected by fire with contingent visitation for alternative fire situations. The alternative fire scenarios are depicted by using color photos from National Forests. The quantity of trips is regressed on travel cost to the site, characteristics of the visitors, and attributes of the recreation site, including years since last fire and fire intensity level. This basic form yields a travel cost method demand function of the general form:

(1) Trips = function (Travel Cost, Demographics, Fire Characteristics)

Since Trips per person per year to the site is an integer, a count data regression model is appropriate (Creel and Loomis 1990, Englin and Shonkwiler 1995). This model yields a functional form equivalent to a semi-log, with the log of the dependent variable. With this functional form, the average net benefit to the visitor per day (i.e., consumer surplus or net willingness to pay) is the reciprocal of the slope coefficient on the travel cost variable (Creel and Loomis 1990). If the mean of trips is not equal to the variance of trips, the overdispersion parameter (alpha) will be significant and a negative binomial form of the count date is appropriate.

By examining the significance level on fire related variables, we can test whether the quantity of visits changes with years since the fire and estimate any corresponding change in economic value. We can also test whether the reaction to fire is similar among visitors to National Forests in Colorado, Idaho, and Wyoming by including slope and intercept shift variables for these states. The travel cost method is one of the methods recommended for use by Federal agencies (U.S. Water Resources Council 1983).

## Overall Sample Design

The physical forests selected for the study will form the basis for the analysis. The locations form a "subject-specific" (SS) sample frame which is distinct from a population-averaged (PA) sample frame (Zeger and others 1988). There are two compelling reasons for adopting an SS sample frame approach. First, a PA approach would require the definition of all possible members of fire damaged forests, a daunting task. Second, without knowledge of the universe of fire affected forests the only sampling scheme that could be operationalized would be a simple random draw. This may or may not include the policy relevant areas for any given level of sampling effort. An example of this difficulty is the Eastern

Lake Survey (Englin and others 1997). The survey randomly sampled 763 lakes from the population of all lakes greater than 4 hectares in the eastern United States. A subsequent random sample of 1,144 anglers in 1989 found that only 61 of the 763 lakes were actually visited by a sampled angler. From the perspective of valuing recreational angling the cost associated with 702 of those lakes was wasted. Unfortunately, it would be impossible to specify a stratified sampling scheme without the information gathered from the 702 lakes. Population based sampling is simply very costly.

Clearly, the problem would be even worse in a forestry setting. At least lakes can be defined in a very straightforward way when digitizing maps. Forest conditions resulting from fires could be much more challenging. The alternative is to apply the SS approach and accept the more restrictive nature of the sample. The key restrictions are the dependence upon the distributional assumptions made in the econometric analysis and proper specification of the model. We used an SS-based analysis because of the cost associated with PA-based samples in this context.

### *Sampling Strategy in Colorado*

Only two sample strata were consistently available with data judged by the U.S. Forest Service as reliable: acres burned and year of fire. Data on vegetation was incomplete for some forests and measured by three different indicators, such as vegetation type, cover class, and fuel model. In addition, the vegetation data was not reliable (Jon Skeels, personal communication). Repeated calls were made to each National Forest office to obtain fire statistics (acres, year burned, vegetation type, and recreation use). This resulted in some data for some Forests. This information was supplemented with Kansas City Fire Analysis System (KFAS) data. Inconsistencies were noted, especially on the Gunnison National Forest and were reconciled during site visits. We also attempted to ascertain the magnitude of recreation use of each burned area (e.g., areas with high, moderate or low use). This was judged by the fire specialists or by proximity to roads/ trails. Although not being able to stratify by other characteristics such as Fire Intensity Level (FIL), this is included as candidate site characteristic in the recreation demand model.

Thus, the main strata were fires of size D (100-299 acres), E (300-999 acres), F (1,000-4,999 acres) and G (5,000+ acres). The years were grouped into fire ages with zero equal to the year of the survey (1998) and counting back from there (e.g., 1-2, 3-6, 7-10, 11-20, and 21-29). This puts the earliest dates at 1970. Equivalent unburned sites were sampled on each of the National Forests to provide a control and represent the seventh age category.

There were 28 possible cells (four sizes times seven time periods). Our goal was to have at least one fire site in each cell of the matrix. Unfortunately, there were several empty cells with no fire data. Thus, three National Forests in Colorado were selected that provided coverage of most of the cells and were logistically functional (e.g., one Forest was on the way to another Forest or was proximate to Fort Collins). The Arapaho-Roosevelt, Gunnison-Uncompaghre and Pike-San Isabel National Forests were chosen in Colorado. This provides two-front range National Forests and one interior National Forest.

In Colorado we can generalize to class D and larger fires and areas with a full range of low, moderate, and high recreation use. We believe we can generalize from the forest sites sampled within a cell to the other forests within that same cell. Specifically, the common cells between the Arapaho-Roosevelt, Pike, and Gunnison National Forest areas sampled and other Rocky Mountain Region forests that were not sampled. For example, many of the Arapaho-Roosevelt fires were similar in size and date to fires on the Wind River and the Bighorn National Forests, although we are able to test this indirectly for the Wind River National Forest.

Each District Office on each of the three National Forests were visited to obtain more refined data on specific location of fires relative to recreation use. This was followed by on-site visits to ascertain visibility of the fire from the recreation trail. In some cases, we could not locate any evidence of fire or the trailhead was not signed or very difficult to find, making it unlikely there would be many recreation users (this dropped a couple of sites from the Arapaho-Roosevelt, and two on the Pike National Forest-each site had only one user/ vehicle and one of these required a four-wheel drive vehicle to get there). On the Pike National Forest, two of the recreation areas/trailheads that were burned in the Buffalo Creek fire were closed to public use, so were obviously eliminated. On the Gunnison National Forest, two sites were dropped because of very low levels of recreation use (Soap Creek: three cars over the entire Memorial Day weekend, verified with trail register and campground host) or primarily dispersed use, with no central trailhead or recreation sites (Barrett Creek had just two to three informal pull out areas with no trailheads). One site on the Gunnison could not be reached unless one had a high clearance four-wheel drive vehicle. However, we found two sites on the Arapaho-Roosevelt National Forest that were off of a dirt road and have very low use levels (Lone Pine and Kilpecker). Thus, the full spectrum of recreation use levels is represented.

Counting sampling days and travel days in between, there were about 35 sampling days during the main summer recreation season. Each site was sampled one weekday and one weekend day each month of July and August. A total of 10 sites over the three National Forests were sampled. This schedule generally allowed one sampling rotation of two days (1 weekday and 1 weekend day) at nearly all of the Colorado sites. Specific sites sampled and days sampled include:

| **Arapaho-Roosevelt National Forest** | **Number of days** |
|---|---|
| Mt. Margaret | 4 |
| Greyrock Trail | 4 |
| Kilpecker Area and Lone Pine | 4 |
| Youngs Gulch | 2 |
| Blue Lake | 2 |
| **Pike National Forest** | |
| Colorado Trail | 5 |
| Devil's Lookout | 4 |
| **Gunnison National Forest** | |
| Summerville Trailhead | 4 |
| North Bank Campground/Doc Park Trailhead | 3 |
| Caves/ Double Top | 3 |

### *Sampling in the Idaho and Wyoming Sites*

The Bridger-Teton and Wind River National Forests were the focus of the sampling in Wyoming. Trailheads located in the Teton and Gros Ventre Wilderness areas were sampled. Specifically, 13 trailheads were sampled that gave hikers access to 25 distinct trails/ destinations. The majority of these trails were in Wilderness areas. In Idaho, there were 11 trailheads providing access to 25 distinct trails/ destinations. The majority of these were in the Sawtooth National Recreation Area. All surveying occurred in the months of July and August 1998. Specific sites sampled and the number of days sampled include:

| **Wind River National Forest** | **Number of days** |
|---|---|
| Big Sandy | 4 |
| Green River | 3 |
| Elkhart Park | 5 |
| Boulder Lake | 3 |

| | |
|---|---|
| **Bridger Teton National Forest** | |
| Granite Creek | 4 |
| Cache Creek | 2 |
| Death Canyon | 1 |
| Goodwin Lake | 2 |
| Gros Venture | 2 |
| | |
| **Idaho National Forests** | |
| Redfish Lake Trailhead | 5 |
| Alturas Lake Trailhead | 3 |
| Baker Creek | 3 |
| Prairie Creek | 2 |
| Iron Creek Trailhead | 7 |
| Pioneer Cabin (Sun Valley) | 1 |
| Lake Stanley Trailhead | 4 |
| Pettit Lake | 2 |

## Survey Protocol

The interviewers stopped individuals as they returned to their cars at the parking area. The interviewers introduced themselves, gave their university affiliation, and gave a statement of purpose. Then the interviewer gave a survey packet to all individuals in the group 16 years of age and older with the following statement:

> We would like you to take a survey packet with you today as you are leaving. You do not need to fill it out now, although you can if you like. Rather take the survey packet with you and answer the questions on your way home or when you return home. All the instructions are included. The packet includes a postage paid return envelope. The survey asks a few questions about your visits to this area and how they may be affected by different fire management options. We think you will find the survey interesting. Your answers will be used by the U.S. Forest Service in deciding the level of fire prevention and response to fires.

In Colorado, we further stated:

> I do need you to fill out your name/ address on this card, so we can send you a reminder if we don't get the survey back in the next couple of weeks. However, your name/ address will not be associated with your responses. Your responses are completely confidential and you will not be put on any mailing lists as a result of this survey.

Surveys were also handed out by University of Nevada-Reno students at sites in Wyoming and Idaho. In addition, at sites in Wyoming, surveys were given to the Campground Host to hand out to visitors as well.

## Survey Structure

Recreation users were first asked to check off their primary or main recreation activity. Then they were asked their travel time and travel distance to the site. This was followed by questions about their travel costs and a dichotomous choice contingent valuation question for participating in their current activity (e.g., hiking, camping) at the site where they were contacted at for the existing forest condition. Individuals were asked whether visiting the site was their primary purpose, one of many equally important reasons, or a minor stop. Then individuals were asked about past years trips, current number of trips so far this year and planned trips to the site during the rest of the year. In addition, we asked how these trips would change if their trip costs increased. By sampling at different hiking trails or sites, some of which had not been burned, some recently burned, and some burned in the past, we could determine whether there is a statistical relationship between site visitation and fire effects by using current observed behavior.

The next portion of the survey presented three contingent behavior scenarios:

- One-half of the trail experienced a recent high-intensity crown fire. This was depicted with a color photo of standing blackened trees that had no needles. The photo was taken from the Buffalo Creek fire that occurred 2 years earlier.
- One-half of the trail experienced a light (prescribed) burn. The photo used had the lower trunk and lower branches of the trees burned, there were reddish colored needles on these lower branches, but the tops of the trees were green and there were numerous other green trees present.
- One-half of the trail reflected an old (20 years) high-intensity fire. The photo used had standing dead trees with white tree trunks, downed trees, and younger newer, green trees.

For each scenario, visitors were asked how their trips to the site where they were intercepted would change if half the trail were as depicted in the photo. The questionnaire concluded with standard demographic questions.

The advantage of the fire effects in the stated preference portion of the survey is that a wide range of the impacts of fire on forest conditions could be conveyed to each visitor. These photos allowed us to determine the effect that high-intensity crown fires, prescribed fires, and older fires have on recreation use.

The increase in trip costs used as bid amounts were $3,7,9,12,15,19,25,30,35, 40 and 70. These were based on limited pretesting and previous recreation studies.

The surveys were pretested at two of the National Forests. Individuals were asked to fill out the survey and provide any comments or feedback. A few questions were clarified as a result of comments during the pretests. No focus groups were performed as the subjects of this survey were on-site users who were knowledgeable about the areas they were visiting and had first hand experience in trading their travel time and travel cost for access to the recreation sites studied.

## Inclusion of Non-survey Site Characteristics

To isolate the effects that fire may have on recreation visitation, it is important to control for non-fire related site attributes. The candidate measures of site attributes chosen included those that have been significant in past forest recreation studies (Englin and others 1996). Thus, several site characteristics such as elevation gain of the trail, miles of dirt road, elevation of trail above sea level, etc., were chosen on this basis. Fire attributes included the fire age, acres burned, and fire intensity level. These data were obtained from the USDA Forest Service KFAS system and verified with the District Offices. By the sample design, there was a range of small to large fires and low-intensity prescribed fires to high-intensity fires. There was also a range of ages of fires, although most were fairly recent. There were six unburned sites in Colorado.

## Preliminary Results

### *Survey Returns*

In Colorado, the interviewer took note of refusals. There were only 14 refusals out of 541 contacts made. A total of 527 surveys were handed out. Of these, 354 were returned after the reminder postcard and second mailing to non-respondents. Thus, the overall response rate was 67 percent. In Idaho and Wyoming, a total of 1,200 were handed out. Of these, 325 were returned. The response rate was 27 percent. This is lower because of the inability to send reminder postcards and second mailings to non-respondents.

### *Descriptive Statistics*

Given the sampling at trailheads on the Colorado National Forests, it is not surprising that most of the visitors in Colorado were hiking (59 percent) or mountain biking (30 percent). The average visitor was on-site for 5 hours and had three persons in their group. About two-thirds of the trips were single-destination trips. The typical Colorado visitor drove 77 miles (one-way) and had gas costs of $12 (for a gas cost per round trip mile of 7.8 cents).

Of most interest to this study is the comparison of current trips taken with trips that would be taken with the three fire scenarios. A typical visitor had taken about two trips and planned two more during the remainder of the season. These four trips would decrease to 2.3 trips with a recent, high-intensity fire over 50 percent of the trail *(table 1)*. The four trips would decrease to 3.35 trips if 50 percent of the trail had been burned by a light fire or prescribed fire. If 50 percent of the trail visited would have shown the effects of an old (20 years) high-intensity fire, they would take 2.96 trips instead of 4 trips. Pairwise t-tests of each fire scenario against the baseline trips all indicate a statistically significant reduction in trips at the 0.01 level. This pattern is consistent with the number of visitors that would change their trip visitation rate if there were a high-intensity fire (55 percent would change), low-intensity (23 percent), and old high-intensity (33 percent). Both the trip reduction and visitor reduction is similar to Flower and others (1985).

The demographics of the Colorado sample included 56 percent male respondents with an average age of 36.5 years and education of 16.3 years *(table 1)*. More than 90 percent of the sample worked outside the home and visited the recreation site on weekends, holidays, or paid vacation. The average household size was 2.54 people. The typical household earned $67,232.

The visitors to the Idaho and Wyoming National Forests were slightly older (43.4 years) than the Colorado visitors but had nearly identical education levels (college graduate). A lower proportion of the visitors returning surveys handed out in the Idaho and Wyoming National Forests were males (44 percent) as compared to Colorado National Forest visitors. However, in terms of timing of visits, nearly identical proportions visited on weekends, holidays, or vacations (75 percent) as did Colorado visitors. However, distance traveled of Idaho and Wyoming forest visitors was much greater at 613 miles.

**Table 1**-*Descriptive statistics of the Colorado sample and Idaho/Wyoming sample.*

| **Variable** | **Colorado** | **Idaho/Wyoming** |
|---|---|---|
| Travel distance | 77 miles | 613 |
| Previous season | 2.06 | 1.42 |
| Trips so far this year | 2.19 | 1.77 |
| Trips planned | 1.77 | 1.06 |
| Total trips this season | 3.96 | 2.84 |
| Trips if high-intensity fire | 2.33 | 1.74 |
| Trips if low-intensity fire | 3.35 | 2.45 |
| Trips if old high-intensity fire | 2.96 | 2.02 |
| **Demographics of visitors** | | |
| Percent males | 56 pct | 44 pct |
| Age | 36.55 | 42.4 |
| Education | 16.3 | 16.1 |
| Work | 90 pct | 80 pct |
| Visit on weekend, holiday vacation | 78 pct | 75 pct |
| Household income | $67,232 | $70,179 |

The reaction of Idaho and Wyoming National Forest visitors to fire was similar to Colorado visitors in terms of the response pattern of trips. Specifically, total trips dropped the most from current condition to the high-intensity fire scenario, dropping from 2.84 trips per year currently to 1.742 trips per year if 50 percent of the trail had been burned by a 2-year-old high-intensity fire. A recent low-intensity or prescribed fire only results in a slight decrease in visitation from current levels, a reduction from 2.84 trips to 2.45 trips per year. Like Colorado, the drop in visitation with an older (20 years) high-intensity fire is in between these other two scenarios, a reduction from 2.84 trips to 2.02 trips with the older, high-intensity fire.

## Multivariate Statistical Analysis

The data set makes possible estimation of several types of travel cost method (TCM) models. Annual visitation models require combining information on trips actually taken at the time the visitor received the survey and trips planned during the remainder of the season. This is necessary to so that all visitors are considered equally, since some were sampled early in the season and others later in the season. Without this adjustment, those sampled earlier in the season would appear to take fewer trips. Given the non-negative integer nature of reported trips, a count data model is often most appropriate (Englin and Cameron 1996). At this point in time we have not corrected for endogenous stratification that may result from on-site sampling (Englin and Shonkwiler 1995). These models estimated the relationship between visitation and fire age and fire intensity as well as visitor demographics.

As is required to meet the assumptions of the TCM for travel cost to be interpreted as a price paid for visiting the site, individuals visiting multiple sites on a given trip from home (i.e., a multi-destination trip) were excluded from the analysis. Further, individuals reporting one-way travel times greater than 5 hours were also deleted as many of these individuals may also be on multi-destination trips. This is necessary because it would be misleading to attribute the entire trip cost to any one particular site. In addition, for this preliminary analysis the dataset was limited to individuals that answered all the key questions necessary to estimate the price variable (e.g., they answered travel time and travel cost questions in the survey). Individuals who traveled less than 1 mile to the site were also deleted on the presumption they either live adjacent to the site (which violates another assumption of the travel cost method; Parsons 1991) or were on a multi-destination trip and were staying at a resort or location nearby the site for other purposes such as camping. Further analysis of this data set will involve relaxing some of these conditions to include more individuals in the analysis. For this preliminary, combined, three-state analysis, the travel cost variable was defined as an individual's gasoline cost plus their travel time valued at one-fourth the wage rate. This approach is consistent with the U.S. Water Resources Council (1983) guidelines for TCM.

### *Three State Model*

Preliminary results for the combined Colorado, Idaho, and Wyoming datasets are shown in *table 2.* The travel cost variable is statistically significant and yields a value of $47 (1/ 0.021) per day of recreation on the Wyoming National Forests. The travel cost (price) slope interaction terms for Colorado and Idaho are also statistically significant. This indicates that the Colorado and Idaho visitors demand curve has a different price slope and benefits per trip. Specifically, Colorado net benefits per day is $95 (1 / (0.021-0.010446)), while the Idaho net benefits per day is $123 (1/(0.021-0.012866)). However, the demand curve intercept shifter for Colorado is not significant, implying no difference with Wyoming. In this full model, the Idaho demand curve intercept shifter is significant, although it becomes insignificant in the restricted model.

**Table 2**-*Negative binomial pooled regression models for Colorado, Idaho, and Wyoming.*

| | Unrestricted model | | | Restricted model | | | |
|---|---|---|---|---|---|---|---|
| **Variable** | **Coefficient** | **Std error** | **P-Value** | **Coefficient** | **Std error** | **P-Value** | **Mean** |
| Constant | 2.7258 | 0.37480 | 0.000 | 2.307 | 0.4982 | 0.000 | |
| TravelCost | -0.021062 | 0.002333 | 0.000 | -0.0261 | 0.0022 | 0.000 | 11.41 |
| TravelCost*FireAge | -0.50938E-04 | 0.12787E-03 | 0.690 | | | | -221.3 |
| ColoradoTravelCost | 0.010446 | 0.0019513 | 0.000 | 0.01205 | 0.00239 | 0.000 | -7.909 |
| IdahoTravelCost | 0.012866 | 0.0022554 | 0.000 | 0.01606 | 0.00303 | 0.000 | -18.73 |
| Age | 0.0084770 | 0.004151 | 0.041 | | | | 36.42 |
| Education | -0.09393 | 0.02278 | 0.000 | -0.05239 | 0.033 | 0.121 | 16.32 |
| Income | 0.49237E-05 | 0.9774E-06 | 0.000 | 0.531e-05 | 0.159e-05 | 0.000 | 57470.00 |
| FireAge | -0.77023E-03 | 0.2526E-03 | 0.002 | -0.8027e-03 | 0.334e-03 | 0.015 | -63.09 |
| Colorado | -0.18393 | 0.18407 | 0.317 | | | | 0.6177 |
| Idaho | -0.60969 | 0.17228 | 0.000 | -0.3027 | 0.202 | 0.135 | 0.1872 |
| Alpha | 1.4007 | 0.8635E-01 | 0.000 | 2.53 | 0.161 | 0.000 | |
| Number of observations | 1015 | | | 1015 | | | |
| Log likelihood function | -2250.768 | | | -3926.028 | | | |
| Restricted log likelihood | -3885.351 | | | -4292.666 | | | |
| Chi-squared | 3269.167 | | | 733.275 | | | |
| Degrees of freedom | 10 | | | 7 | | | |
| Significance level | 0.000 | | | 0.000 | | | |

By using this information, the transferability of values across National Forests in Colorado, Idaho, and Wyoming can be evaluated using the significance of the state intercept dummies for Colorado and Idaho (Wyoming is base case) and state price slope interaction variables. In both the unrestricted and restricted models, the significance of the Colorado and Idaho price slope interaction terms suggests there may be different underlying demand curves for these two areas from each other and from Wyoming. As such, transferring demand functions from one state to the other would lead to a biased estimate of net benefits per day of recreation. The error would be smaller for Colorado and Idaho transfers as the reduced model shows consumer surplus of $71 and $98, respectively. On the positive side, the insignificance of the state intercept dummies suggests the state demand equations might do a reasonable job predicting trips.

The FireAge variable is statistically significant as an intercept shifter in the demand function but not in terms of affecting the slope of the demand function (i.e., FireAge* TravelCost is insignificant). Thus, trips per person does change (slightly) with FireAge, but value per day does not. FireAge has a negative sign, since FireAge is measured as years since fire, with -1 being 1 year, -10 being 10 years, and so forth. Therefore, the longer it has been since a fire, recreation use increases. Because the negative binomial model is equivalent to a semi-log of the dependent variable, the marginal effect of FireAge is calculated as the anti-log of the demand function. By using the Restricted model, such calculations indicates that trips per person has a very small response to fire age. Specifically there is a change of about a one-tenth of a trip per person as FireAge increases from a recent fire to a 10- year-old fire to no fire (FireAge equals 50). We still need to test whether there are different FireAge coefficients by state, by using a state FireAge interaction term.

## Conclusions

The responses to photos depicting recency and intensity of fires suggest that the number of trips per visitor falls in the first few years after a forest fire. The reduction is fairly small for prescribed fires and much larger (about two trips per person) for a recent high-intensity fire. Pooling these contingent behavior responses with actual trip responses to wildfires in Colorado, Idaho, and Wyoming and performing a multi-variate analysis suggests a very small effect of age of the fire on visits per person. The average response across all three states model, which pools contingent behavior and actual behavior, suggests each visitor would change their trips by less than one-tenth a trip per year.

Additional analysis is planned to evaluate if incorporating fire via a simple dummy variable for presence or absence of fire is a better way to model fire effects than age from fire. In addition, inclusion of other recreation site characteristics will be tried.

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