The dynamic path of recreational values following a forest fire: a comparative analysis of states in the Intermountain West

Jeffrey Englin, John Loomis, and Armando González-Cabán

Abstract: This analysis examines the dynamic path of recreational values following a forest fire in three different states in the intermountain western United States. The travel cost demand analysis found that annual recreation values after a fire follow a highly nonlinear intertemporal path. The path is S-shaped, providing a range of benefits and losses in the years following a fire. While the results discourage the use of a single value throughout the Intermountain West, they do provide a range of likely values that public land managers can apply to fire-affected areas in their jurisdictions.

Résumé : Les auteurs ont analysé l'évolution des valeurs récréatives suite à un feu de forêt dans trois États différents situés dans la zone montagneuse de l'ouest des États-Unis. L'analyse de la demande via le coût des voyages révèle que les valeurs récréatives annuelles suivent une courbe inter-temporelle fortement non linéaire après un feu. La courbe est en forme de S et fournit toute une gamme de bénéfices et de pertes au cours des années qui suivent un feu. Bien que les résultats suggèrent de ne pas utiliser une valeur unique partout dans la zone montagneuse de l'ouest, ils fournissent une gamme de valeurs probables que les gestionnaires de terres publiques peuvent appliquer aux zones affectées par le feu dans leurs juridictions.

[Traduit par la Rédaction]

Introduction

The growing societal awareness of the relationship between forest fires and the maintenance of a healthy environment is making a full accounting of the economic effects of forest fires a priority among public land managers. As a result the economic values of nonmarketed resources are finding their way into public agencies' fire-management planning and decisions with increasing frequency (González-Cabán 1993). Estimating the impacts of fire on resources and the resulting economic consequences remains a difficult problem for fire managers, because they have little information on the effects of fire on recreation use. It is well known, nevertheless, that recreation is one of the dominant multiple uses in the Intermountain West. For example, 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.

The National Fire Management Analysis System (NFMAS) requires the incorporation of fish, wildlife, recreation, and wilderness as well as environmental values. 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 whether the fire was a crown fire.

The analysis uses a combined stated- and revealed-preference approach first suggested by Englin and Cameron (1996). This approach is well suited to the fire question, because it allows the cost effective sampling of users' response to fire-affected forests of different ages while maintaining a strong link to their actual observed behavior. This provides an advantage over contingent valuation studies, such as those implemented by Loomis and González-Cabán (1994, 1997), if one is interested in a more behavior-based transfer function. The published contingent valuation studies focus on particular policy questions, most notably spotted owl issues. The published revealed-preference studies suffer from limited fire-affected forests (Boxall et al. 1996; Englin et al. 1996), and so, one can only speculate on true shapes of values as forests regenerate following fire.

Recreation-demand model

Modeling the demand for hiking trails should address the fact that a characteristic of hiking demand is that trips taken to a site are typically small integers. A class of models that

Received June 20, 2000. Accepted June 13, 2001. Published on the NRC Research Press Web site at http://cjfr.nrc.ca on October 6, 2001.

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 DOI: 10.1139/cjfr-31-10-1837

have been applied to these problems are known as count-data travel-cost models. Empirical pooled-site, count-data travel-cost models of hiking demand begin by considering the following linear exponential model of hiking demand:

$$[1] \qquad \lambda_i^* = e^{(P_{i,j}, \mathbf{Z}_j, \boldsymbol{\beta})} + \varepsilon_i, \qquad i = 1, 2, \ldots, N$$

where λ_i^* is the *i*th person's quantity demanded of the *j*th site, $P_{i,j}$ is the travel cost to the *j*th recreation site by the *i*th person, the vector $\mathbf{Z}$ are characteristics of the *j*th recreation site, and $\boldsymbol{\beta}$ is a vector of parameters to be estimated.

The negative binomial model is an attractive model to use when modeling recreation demand, since it handles both the non-negative integer issue and the possibility of over-dispersion in the data generating process. Its likelihood function is given by

$$[2] \qquad \Pr(Y_i = q) = \frac{\Gamma\left(q + \frac{1}{\alpha}\right)}{\Gamma(q+1)\Gamma\left(\frac{1}{\alpha}\right)} (\alpha\lambda_i)^j (1 + \alpha\lambda_i)^{-(q+1/\alpha)}$$

where q is the number of trips taken by individual i and α is the overdispersion parameter. The likelihood function given in eq. 2 collapses to the Poisson distribution if α goes to zero. The log likelihood for eq. 2 is given by

$$[3] \qquad \text{Log likelihood} = \sum_{i=1}^{N} [\ln\Gamma(q_i + 1/\alpha) - \ln\Gamma(q_i) - \ln\Gamma(1/\alpha) + q_i \ln\alpha + q_i \mathbf{Z}_i \boldsymbol{\beta} - (q_i + 1/\alpha)\ln(1 + \alpha\, e^{\mathbf{Z}_i \boldsymbol{\beta}})]$$

where $e^{\mathbf{Z}_i \boldsymbol{\beta}}$ replaces λ.

Englin and Cameron (1996) first suggested that contingent behavior questions could be used to supplement observed behavior in a count-data travel-cost model context. Their analysis focused on changes in prices. A straightforward extension is to change site qualities. Both of these contingent behavior questions are asked in this study. The focus on the changes in qualities is to change the fire characteristics associated with the trail actually visited. This allows the latent demand, λ, to be made a function of the years since a fire occurred on the trail.

An empirical issue that needs to be clarified is the relationship between the econometric model and the sample frame of the data. The sample is endogenously stratified and truncated from the perspective of the general population. This is true because the respondents were intercepted on site. The more often someone visits the site, the more likely they are to be interviewed. People who don't visit have no chance of being interviewed at all. While considerable progress has been made in the statistical correction of endogenous stratification and truncation of revealed preference data (see Shaw 1988; Englin and Shonkwiler 1995*b*), no work has examined the role of these sampling issues when stated preference data is obtained with the revealed data. As a result, we are unable to deal with this issue in this analysis.

The primary effect of this issue is that statements about the general population are problematic. This is less of an issue in this context than it might be in others. First, the focus of this analysis is on users and transferability among users in the three different states, not the general population. Second, the quality changes under consideration are likely to drive people out of the market rather than draw new users from the general population into the market. As a result the general population plays a peripheral role, if any, in the analysis.

Survey and fire data

The data were gathered through three sources. One source was an on-site survey of users. The second was the USDA Forest Services Kansas City Fire Analysis System (KFAS) fire information database. Finally, travel distances between the respondent's home zip code and the site were calculated using major trunk highways. Each of the sources played an important role in the analysis.

All users were sampled during July and August 1998. Colorado users were sampled for about 35 days; Idaho and Wyoming users for about 53 days. Individuals were stopped as they returned to their cars at the parking area, and all those 16 years of age and older were given a survey to complete either on site or at home and returned in a preaddressed stamped envelope. The forests selected for the study formed the basis for the analysis and form a "subject-specific" sample frame (Zeger et al. 1980).

Colorado, Wyoming, and Idaho were the three states where the surveys were administered (Fig. 1). Survey administration varied according to the needs of the sites. The Arapho-Roosevelt, Gunnison-Uncompaghre, and Pike-San Isabel National Forests were chosen in Colorado. In Wyoming the Bridger Teton National Forest was sampled. Finally, in Idaho the Sawtooth National Forest was sampled. The primary recreation activities sampled were non-motorized recreation with hiking being the dominant activity and mountain biking being a distant second. The overriding factor was to administer surveys at a range of sites to capture the broadest possible set of revealed behavior based upon actual forest fires. Since the actual forest fire effects observed in the revealed preference data fully encompass the contingent behavior data it serves as a control in the analysis of the photograph-specific effects. The revealed behavior observations are augmented with the contingent behavior portion of the survey to enrich the set of fire regimes facing respondents. The contingent behavior data are not meant to provide variation that is nonexistent in the revealed data.

The contingent behavior portion of the survey consisted of a series of four contingent behavior questions. Three of these questions had a corresponding picture that demonstrated the physical characteristics of the forest under consideration. The three fire scenarios were as follows:

(1) One-half of the trail experienced a recent high-intensity crown fire. This was depicted with a color photograph of standing blackened trees that had no needles. This fire was 2 years old.
(2) One-half of the trail experienced a light (prescribed) burn. The photograph used had the lower trunk and lower branches of the trees burned, there were reddish-colored needles on the lower branches, but the tops of the trees were green and there were numerous other green trees present.

Fig. 1. National Forests sampled in Colorado, Idaho, and Wyoming.

(3) One-half of the trail reflected an old (20 years) high-intensity fire. The photograph used had standing dead trees with white tree trunks; downed trees; and younger newer, green trees.

Each visitor was first asked the number of trips they had taken the previous year (1997) by month (May–September) to the site where they were intercepted. Next, they were asked the number of trips they had taken during the month and year of the interview and how many more trips they were planning for the rest of the season (May–September). For the contingent visitation for alternative fire situations 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 photograph. The questionnaire concluded with standard demographic questions including income, age, education, and gender. In Colorado, a total of 527 surveys were handed out, of which 354 were returned after the reminder postcard and second mailing to nonrespondents. This is a response rate for Colorado of 67%. In Idaho and Wyoming only 327 surveys were returned from a total of 1200 handed out. This is a 27% response rate. This lower response rate is mainly because of the inability to send reminder postcards and second mailings to nonrespondents. Thus, from a total of 1727 surveys handed out, a total of 674 surveys were returned for an overall response rate of 39.3%.

Fire attributes included the fire age, acres burned, and fire intensity level. For the actual behavior these data were obtained from the USDA Forest Service KFAST system and verified with the District Offices. By sample design, there was a range of small to large fires, low-intensity prescribed fires to high-intensity crown fires. The scenarios in the contingent behavior questions were also assigned the equivalent values for these variables. This was straightforward, since the pictures in each scenario were taken from existing fires with known attributes.

An important methodological issue was the procedure employed to capture the effect of forest fires. Flowers et al. (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 range 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).

To avoid the arbitrary approaches observed in the existing empirical work the forest fire effects were modeled as continuously changing over time and with dummy variables for fires of specific ages. The joint effect of the two variables (for any given age of fire) allows the data to prescribe the

Table 1. Descriptive statistics of the sample.

Variables	Mean
Trips	2.92
Demographic variables	
Income (US$)	64 319
Age (years)	37.80
Male (%)	50.89
Trail-attribute variables	
Elevation gain (m)	388.63
Lodgepole pine (*Pinus contorta* Dougl. ex Loud.) (%)	44.38
Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) (%)	31.36
Dirt road (m)	627.61
Fire age (years)	32.6
Dummy variables (percentage of area)	
0 years since fire	14.79
2 years since fire	1.78
11 or 12 years since fire	13.91
17 or 19 years since fire	6.21
25 years since fire	1.48
Crown fire	39.64

shape of the valuation curve rather than the research design imposing any particular presupposition.

The final contingent behavior question mimicked the original proposal by Englin and Cameron (1996). This question elicited the number of trips that would have been made to the site after a potential fee increase. It has the advantage of generating a second point on the demand curve, given existing quality levels, for each respondent. While not required to estimate the effect of various fire effect scenarios on recreational values, it has the advantage of helping to pin down the demand curve and bolsters confidence in the empirical estimates.

A second important point is that there is considerable evidence that some people who had traveled long distances misunderstood the primary purpose recreation survey question. A small number of visitors indicated they had come several thousand miles specifically for a day hike on the trail where they were intercepted. Inclusion of these observations could cause multidestination trip bias in the estimated travel cost coefficient and, hence, overstate consumer surplus (Smith and Kopp 1980). Therefore our regression sample is limited to individuals who traveled less than 1100 miles round trip. These omitted visitors may have been on longer trips from home and misinterpreted the question as asking about their travel that day, or they belong to some other behavioral model that our pooled count demand function is not well equipped to capture. Table 1 provides the means of the key variables used in the econometric analysis. As can be seen by combining revealed- and stated-preference data, a large range of fire ages were sampled.

Econometric analysis

Table 2 reports the econometric results. This section focuses on three aspects of the analysis. First, the models examine the transferability of the results between the three study areas. Second, the models we examine trace out the intertemporal path of benefits that follows a fire event. Finally, the robustness of the results to reduced specifications is examined. Each of these analyses will be discussed in order. Note that, since the overdispersion parameter, α, is always significant, the negative binomial count data model is more appropriate than a Poisson count data model. Thus, the discussion will focus entirely on the negative binomial model.

The full model in the right-hand column of Table 2 includes own-price coefficients and intercepts for each of the three study areas, Wyoming, Colorado, and Idaho, where Wyoming is the base case and Colorado and Idaho are captured with shift variables. The model captures the independent demands in each area by adding together the base-case coefficients and the other state-specific shift variables. This allows the demand curve to flex to accommodate each of the possible situations. Multiplying the Idaho dummy variable times the travel cost variable allows the slope of the Idaho demand curve to be different from the Wyoming demand curve. Adding the Idaho dummy variable allows the intercept of the Idaho demand curve to be at a different place than the Wyoming demand curve. The same hold true for the Colorado demand slope interaction curve and the Colorado slope.

For Wyoming the base demand intercept is 0.32 and the own-price slope is –0.0045. Idaho's demand curve is found by aggregating the base-case parameter and the Idaho shift variable. The Idaho demand curve slope is –0.0077 (90% confidence interval –0.0045 to 0.0032). Similarly, Colorado's demand curve is –0.0091 (90% confidence interval –0.0045 to 0.0046). Note that the Idaho demand curve is shifted down from the Wyoming curve, and Colorado's curve is shifted down still more. The effects of the demographic and fire variables were constrained to be equal across states throughout the analysis.

The transferability of the benefit estimates

As can be seen in the full model in Table 2, the individual Idaho and Colorado intercept shifters are statistically different from zero at the 10% level or beyond. The hypothesis of equivalent number of trips is rejected, and the conclusion is that visitors to Idaho and Colorado National Forests take fewer trips to the sampled sites in those states than do visitors to Wyoming National Forests, ceteris paribus. The Idaho and Colorado price-slope interaction terms are also statistically different from zero. One can conclude that Wyoming, Idaho, and Colorado's demand curves have different slopes. Note, however, that a test that Idaho and Colorado have differently sloped demand curves is insignificantly different from zero. The t statistic testing this hypothesis is insignificant at conventional levels. The analysis provides support for the hypothesis that the demand for Wyoming trails is different than Idaho or Colorado but provides little support for the hypothesis that Colorado and Idaho are different.

Since the t statistics are different from zero the analysis suggests that the Idaho and Colorado per trip consumer surpluses are statistically different from Wyoming's. Consumer surplus is simply $\int \lambda^{*}(\cdot)$, integrated from the beginning price P_0 to the choke price P_1. With the semi-log functional form implied by the negative binomial count data model, this simplifies to $\lambda/\beta_{\text{travel cost}}$. The per-trip consumer surplus is sim-

Table 2. Econometric results for three travel cost demand models.

Variable	State restricted	Fire restricted	Full model
State demand slopes and intercepts			
Constant	0.8083 (0.6669)*	2.0720 (0.2045)*	0.3251 (0.5281)
Idaho		–0.4680 (0.1902)*	–0.3347 (0.1896)*
Colorado		–1.4550 (0.1290)*	–1.5478 (0.1515)*
Travel cost	–0.0049 (0.000 44)*	–0.0056 (0.0006)*	–0.0045 (0.0006)*
Colorado × travel cost		–0.0044 (0.0015)*	–0.0046 (0.0015)*
Idaho × travel cost		–0.0032 (0.0013)*	–0.0032 (0.0014)*
Demographic variables			
Income (1000s)	–0.0014 (0.0007)	0.000 68 (0.000 07)	0.000 65 (0.00 076)
Age	0.021 48 (0.002 39)*	0.019 26 (0.0022)*	0.018 78 (0.0022)*
Male	0.2321 (0.063 11)*	0.3366 (0.0670)*	0.2826 (0.0680)*
Trail-attribute variables			
Elevation gain	–0.000 65 (0.000 19)*	–0.000 75 (0.000 13)*	–0.000 65 (0.000 19)*
Lodgepole pine	–0.1454 (0.1209)*	–0.5594 (0.1265)*	–0.6780 (0.1419)*
Douglas-fir	–0.027 90 (0.2233)*	0.071 54 (0.1814)	–0.2227 (0.2228)*
Dirt road	–0.132 61 (0.317 06)*	–2.402 55 (0.249 01)*	–1.3517 (0.0331)*
Fire effects variables			
Fire age	0.0033 (0.0130)*	–0.0003 (0.0021)	–0.0383 (0.0107)*
Fire 0	–0.9954 (0.5977)*		1.4597 (0.5080)*
Fire 2	–0.049 45 (0.8064)*		2.5356 (0.6749)*
Fire 11 or 12	0.2407 (0.4242)*		1.6784 (0.3626)*
Fire 17 or 19	–0.5357 (0.4008)*		1.1559 (0.3453)*
Fire 25	0.0767 (0.5348)*		1.2459 (0.5122)*
Crown fire	0.2484 (0.057 47)*		0.0765 (0.0542)
α	1.5627 (0.065 61)*	1.4492 (0.0630)*	1.4062 (0.0631)*
Log likelihood	–4167.9	–4124.0	–4101.5

Note: Standard errors are given in parentheses.
*Significant at the 10% level or greater.

ply $1/\beta_{\text{travel cost}}$. The per trip consumer surplus estimates for Wyoming, Idaho, and Colorado are, $222, $129, and $109, respectively. While the confidence interval around the Wyoming consumer surplus can be approximated using only the variance on the travel cost variable, the calculation of the confidence interval for Colorado and Idaho is more involved because of the use of multiple variables. Using Colorado as an example, the Colorado consumer surplus per trip is calculated as $1/(\beta_{\text{travel cost}} + \beta_{\text{travel cost} \times \text{Colorado}})$.

The calculation of the confidence interval requires the variance of the consumer surplus estimate. This depends not only on the variance of the two travel cost variables but on the covariance between the two travel cost variables. The variance around the Colorado consumer surplus is simply the variance of the Colorado travel cost estimate plus the variance of the Wyoming estimate plus twice the covariance of the two travel cost parameters. The Idaho variance of the demand parameter is calculated the same way. Given these variances, Englin and Shonkwiler (1995*a*) provide the second-order Taylor series approximation of the variance of the estimated consumer-surplus estimates. Their results show that the equation for a second-order approximation of the variance of consumer surplus is simply

$$[4] \qquad \text{Var}\left(\frac{1}{\beta_{\text{travel cost}}}\right) = \frac{V}{\beta^4_{\text{travel cost}}} + 2\left(\frac{V^2}{\beta^6_{\text{travel cost}}}\right)$$

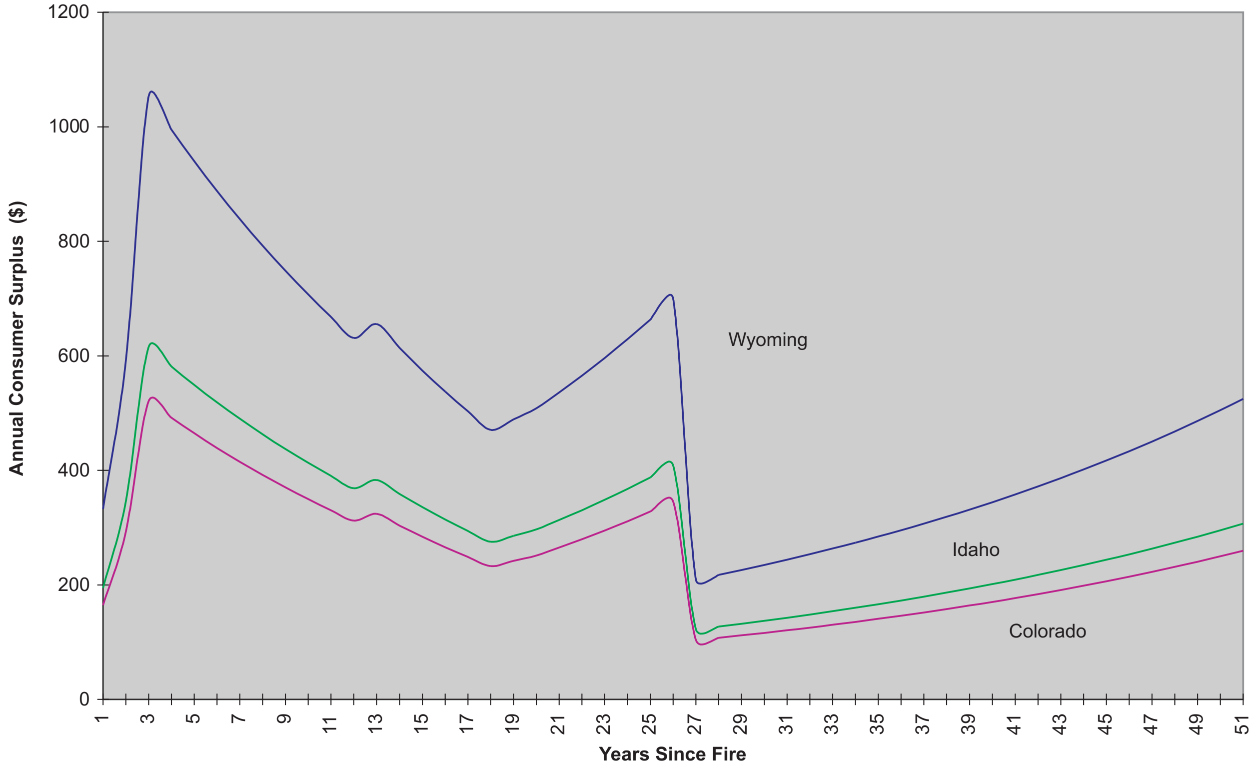
where V is the variance of $\beta_{\text{travel cost}}$.

Using this procedure the 90% confidence interval around the Wyoming consumer surplus estimate is found to be $192–251, while the estimated Colorado confidence interval is $91–128 and the Idaho confidence interval is $94–165. This confirms the difference between the Wyoming and Colorado samples as well as confirming the ambiguity associated with the Idaho sample. The Idaho sample's confidence intervals overlap on one end with Colorado's and on the other with Wyoming.

These benefit measures make intuitive sense. The sampling area in Wyoming is in and around the Grand Teton and outside Yellowstone National Parks, an area famous for its beauty. The Idaho sampling area is in a well-known area outside of Ketchum, Idaho, but it is not as well regarded as Wyoming's nor does it draw from as wide an area as Wyoming. Finally, the majority of the Colorado sampling frame focuses on trails along the Front Range (e.g., Colorado Springs, Denver, and Fort Collins) and primarily draws its visitors from Denver and Front Range cities (Colorado Springs to Fort Collins).

A simple-minded, but true, implication of the findings is that one could not simply take a welfare estimate and apply it to the other two sites with much success. A wider perspective, however, is that the range of use at the sites chosen for this analysis is very broad. The sites range from local hiking sites to world-renowned hiking sites with some middle ground covered as well. It is likely that any public lands manager could reasonably place his or her site on a spectrum

Fig. 2. Three-state comparison of the intertemporal welfare path following a forest fire.



covered by this analysis. Roughly speaking, the value of a day hiking trip is \$90–250 depending on the quality of the site.

The dynamic path of the benefit estimates following fire

The fire-restricted model in the middle of Table 2 shows the importance of not constraining fire age to have one continuous effect. In the fire-restricted model, the coefficient on fire age is insignificant when one does not allow for discontinuous effects as reflected by the time varying dummy variables. The alternative specification that captures the effects of forest fires through a combination of a continuous variable, years since the fire, and dummy variables for five discrete times since the fire performs admirably.

The five dummy variables are immediately following the fire, 2 years after the fire, 11 or 12 years following the fire, 17–19 years after the fire, 25 years after the fire, and whether or not the fire was crown fire. The specific fire year dummy variables that are available are the result of the age of fires at the actual sites surveyed and the contingent behavior questions. Each possible dummy variable was constructed and implemented in the model. A series of tests of equality of coefficients were then conducted to reduce the model to a more tractable specification. Coefficients that were not significantly different from each other were pooled. For example, there was no statistically significant difference between the 11- and 12-year parameters so they are grouped in the final model. These provide a fixed effect at specific ages. The impact of ages not captured in the observed data was calculated by interpolating between the ages where actual parameters were estimated. For example, the fixed effect of a 5-year-old fire was found by linearly interpolating between –0.04945 (a 2-year-old fire) and 0.2407 (an 11- or 12-year-old fire). The calculation would then be ((–0.04945 + 0.2407)/9)3 + –0.04945 = 0.0143.

There is a continuous component to the change in visitation. The continuous component was driven by the age of the trees. This is captured in the fire-age variable. For a 5-year-old fire this is simply $0.0033 \times 5 = 0.0165$. The total effect of the fixed 5-year effect and the continuous effect is $0.0143 + 0.0165 = 0.0308$. The approach of combining dummy variables with a continuous variable allows great flexibility in the modeling of the demand for sites following a fire.

The welfare effects are found by evaluating the full model for each individual for each possible year in each of the three states following a hypothetical fire. The number of trips to be taken by each individual is given by $e^{X\boldsymbol{\beta}}$, and the welfare is $e^{X\boldsymbol{\beta}}/\beta_{\text{travel cost}}$ (see Englin and Shonkwiler (1995*b*) for a discussion and derivation of this result). The summary results are found by averaging the individual calculations of welfare.

All of the fire variables are highly significant except for the crown fire variable. Clearly, fire has an effect on recreation use. The crown fire variable is positive but only significant at the 15% level. Nevertheless, there is good reason to suspect that it will be important to the values that people hold for a forest, and omitting it may bias other fire effects coefficients. The temporal pattern of fire effects on recreation benefits in each state is shown in Fig. 2. This pattern may not be what some public land managers would have thought. Unlike the speculation of Boxall et al. (1996), the damage function is not a concave function growing over time. Rather, the function is S-shaped. It jumps up above the mature forest values during the first year, grows even higher by the second year, and drops back to the level of the first year by years 17–25. After this the value drops once more and then rises slowly to mature forest values. The early part of this pattern is identical to the analysis of Hilger (1998) who performed an ex post analysis of use and value in the first 5 years following the Rat Creek – Hatchery Creek fire in Leavenworth, Wash., in 1994.

Some speculation about the factors that are driving this response shape seem worthwhile. An increase in visitation following forest fires seems to be common. This effect seems to be simply the result of the novelty of the ecological attributes that follow a fire, especially 1 or 2 years following the fire. At this time the flowers and animals that follow a fire are apparent. Many of these attributes can only be found in fire-affected areas and people seek them. These areas are fairly unique in important recreational areas. Over time, however, the open areas give way to brush, often thick brush. This phase continues for several years. The length of time varies by the productivity of each site but generally lasts for a number of years. This generates a downward slope that lasts until the forest canopy begins to close. At this point the forest begins to look like a "forest" from most recreational users' perspective. The value of the forest grows through time until a steady value associated with mature forests is reached.

Management implications

Recreation is one of the most dominant multiple uses in the Intermountain West. Yet managers have little information on the effects of fire on recreation use. The results of this study provide some indication of what managers can expect in terms of the effect of fires on recreation demand. For example, closing trails after a fire is not necessarily a good idea given that the study suggests that a segment of recreationists find the situation desirable, and the visitation rate would be expected to increase. In addition, recently burned areas may provide opportunities to educate visitors to national parks and national forest lands about fire ecology and the need for fire or its reintroduction in national parks and forests. A possible downfall is the potential for increased user impacts such as campsite impacts, crowding, and congestion and, possibly, more off-trail use if visitors are exploring the new species growing after fire. These might require additional monitoring and management efforts to redirect users to less crowded trails. Long-term planning could also benefit from this kind of information. For example, between years 17 and 25 after the fire a decrease in demand is projected. A possible result of this reduction is that other substitute sites may suffer increased demand and experience overuse problems. Another important implication of these results is the necessity to exercise caution when using recreation values from one area, state, or region to another. Values are not necessarily transferable between locations, and a significant under- or over-estimation of the impacts could occur.

Summary and limitations

Surveys of visitors to National Forests in Colorado, Idaho, and Wyoming were conducted to determine whether nonmotorized recreation responded to different fire ages and fire intensities. Revealed- and stated-preference data were pooled when estimating a negative binomial travel cost method demand curve. We found that fire age had a statistically significant effect on the demand of nonmotorized recreation users, holding other site attributes such as forest type constant. The temporal pattern revealed an initial positive visitation response to recent fires, with decreasing visitation for the next 17 years, followed by an 8-year rebound in use. The tests for transferability of demand and benefits estimates across the three states indicated significant differences in number of trips and price slopes between Wyoming and the other two states.

The research protocols employed in this analysis are quite flexible. They are designed to develop temporal measures of value that are driven by the data. The data include a wide range of observed fires, but fill out those points with contingent behavior data. Since the sampling design captured a wide range of fire effects and use patterns, the results broadly address the needs of public lands managers who manage fire-affected ecologies. The results do not find a single, one size fits all welfare measure. They do point to the range of likely values and provide guidance about the path these values will take over the first half century following the fire.

At least two important limitations should be kept in mind. One of these is that the research focuses on the ecological communities of the Rocky Mountains. While there is some heterogeneity across ecological attributes, it is not broad enough to suggest that these results could be broadly applied. The presence of Douglas-fir, for example, should not be used to infer the applicability of the values to the Cascade Mountains. A second limitation is that, as yet, there is no information that allows one to transport these welfare results across activities. While a wide range of activities is present on forests, this study has not differentiated among them. Nevertheless, the results provide a first glimpse into the time path that recreational values take following a fire in the intermountain western United States.

Acknowledgements

Support for this work provided by a Cooperative Agreement between the Pacific Southwest Research Station of the USDA Forest Service and Colorado State University and the University of Nevada, Reno. The help of the staff of the Arapho-Roosevelt, Gunnison-Uncompaghre, Pike-San Isabel, Bridger Teton, and the Sawtooth National Forests is greatly appreciated. The authors also benefitted from the research support provided by Eric Biltonen, James Hilger, Eric Huszar, Jered McDonald, and Shawn Stoddard.

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