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California 94701

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Changes in Recreation Values After Fire in the Northern Rocky Mountains

Patrick J. Flowers Henry J. Vaux, Jr. Philip D. Gardner Thomas J. Mills

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Changes in recreation values after wildfire in the northern Rocky Mountains were determined by estimating the difference in the present net value of recreation activity with and without fire. To estimate the value of recreation activity at burned and unburned sites, a contingent market valuation approach was used. Hypothetical market transactions were created by soliciting bids from recreationists, which they based on photographs of recreation sites depicting scenes before and after two kinds of fire—one of low intensity and the other of high intensity. They were asked what they would pay for the situation they most preferred. The results suggest that net value changes in recreation resources are generally low, and possibly insignificant in economic efficiency analyses of fire management programs.

Retrieval Terms: fire effects, net value change, contingent valuation method, unit-day value, willingness-to-pay

Economic efficiency analyses of fire management programs require estimates of resource value changes resulting from wildfire.[1] Resource values affected by fire include both market goods, such as timber and range, and nonmarket goods, such as recreation and wildlife. The net value effects of fire on such goods can be determined by estimating the net present value of resources with and without fire.

Investigators have not agreed on a single method for valuing or estimating the benefits of recreation.[2] The most widely used methods for valuing recreation benefits are "unit-day value" and "willingness-to-pay."[2,3] The choice of technique depends on theoretical and empirical considerations. The willingness-to-pay method, though perhaps more accurate than the unit-day value method, has been used less often for measuring the effect of fire on recreation values.[4]

This note reports a study of applying contingent market valuation to estimate net value change in recreation resources after fire in the northern Rocky Mountains. In a hypothetical market transaction, recreationists were shown photographs of recreation sites before and after two kinds of fire—one of low intensity and the other of high intensity. They were asked about their willingness-to-pay for recreation at burned and unburned sites. The results indicate that changes in the present net value of recreation resources are low and often less than those in other resources, such as timber and range.

UNIT-DAY VALUE

The unit-day value method estimates recreation values by multiplying recreation-use levels by a per unit value, such as dollars per recreation visitor-day (RVD). The primary appeal of the unit-day value approach for evaluating the effects of fire on recreation is its simplicity. Data for the calculations are few and can be easily collected. The unit-day value approach has been used in several studies that examined the effects of fire on recreation. The applications varied in the duration of the postfire period analyzed and in the treatment of substitution of unburned for burned sites.

In a case study of fire damage in Washington's Entiat drainage, the change in average recreation use was estimated as the difference between average use for 3 years before the fire and annual use 3 years after the fire.[5] Annual changes in visitor days were multiplied by a per-visitor-day value, and yearly value totals were discounted

to the present and summed to produce an estimate of total net value change. A linear recovery for the 3-postfire years to prefire use levels was assumed and the recovery attributed to the restoration of the visual or esthetic qualities of the burned area.

An alternative unit-day value approach was proposed where a range of values was used rather than a single per unit value.[6] High values were assigned to higher recreation value classes and low values to lower classes. Value classes were based on an index that reflects site uniqueness and use. Another study assumed that fires curtail recreational activity for 6 months after fire.[7] To estimate damage to recreation, annual recreation use levels in RVD's were multiplied by one-half and by a per unit value. Studies of fire protection on Federal and non-Federal lands estimated changes in RVDs for 7 years after fire.[8,9] Per unit values were assigned to RVD changes for 7 years, and the annual totals were discounted and summed.

The studies demonstrate that no clear concensus has been reached on the duration for which fire effects on recreation should be measured or valued. The duration of effects ranges from 6 months to 7 years among studies that use the unit-day value approach. The choice of duration is subjective and somewhat arbitrary because research on the question is scant.

Among the unit-day value studies reviewed, only the Forest Service study explicitly recognized the possibility of substituting unburned for burned sites.[9] The study suggested that if viable recreational alternatives to burned sites exist, it is valid to assume no loss. This same assumption was made in a review of techniques for evaluating fire effects in Alaska.[10] The study concluded recreation alternatives in Alaska are so numerous, that the net change in recreation output is negligible.

WILLINGNESS-TO-PAY

The travel cost approach and the survey method are the two alternative techniques for obtaining willingness-to-pay estimates.[11] The travel cost method uses recreationists' travel distances, participation rates, and entrance fees to infer willingness-to-pay estimates. The willingness-to-pay estimates derived from the survey method are taken from direct questioning of recreationists concerning the amount they are willing to spend to participate in a recreational activity.

The relatively greater accessibility of the cost information required in the travel cost method, as opposed to survey results, is a distinct advantage. An additional advantage is that the travel cost method is based on what people actually spend—not on what they say they will spend.[11] The disadvantage of the method for fire application, however, is that it does not adequately address either the qualitative or dynamic effects of fire on recreation.[2,11]

A survey method, termed "contingent valuation," facilitates the measurement of value changes caused by fire's impact on specific environmental qualities, and makes it possible to estimate such changes over time.[2] These capabilities are critical in estimating fire's effect on recreation, and neither are shown by the travel cost approach or the unit-day value approach. The primary disadvantage of the survey method is that willingness-to-pay estimates are of a hypothetical nature.[2]

METHODS

The contingent valuation approach was selected to estimate change, resulting from fire, in the net value of recreation on selected sites in the northern Rocky Mountains.

Net value change (NVC) was calculated by subtracting the present net value of recreation outputs for a site affected by fire (PNV_f) from the present value of recreation outputs for the same site, not affected by fire (PNV_g). A positive net value change, therefore, is synonymous with a loss and a negative change with a benefit. The formulation assumes no changes in management costs as a result of fire:

$$NVC = PNV_g - PNV_f \qquad (1)$$

in which

NVC = net value change in the recreation resource resulting from fire

PNV_g = total present value of recreation yield for the nonaffected site

PNV_f = total present value of recreation yield for the site affected by fire.

Estimating PNV_g and PNV_f requires willingness-to-pay and use level information:

$$NVC = \sum_{t=0}^{d} (WTP_{g,t})(N_g)(1+i)^{-t} - \sum_{t=0}^{d} (WTP_{f,t})(N_f)(1+i)^{-t} \qquad (2)$$

in which

$WTP_{g,t}$ = willingness-to-pay per recreation visitor day (RVD) for the site not affected by fire at time t

$WTP_{f,t}$ = willingness-to-pay per RVD for the site affected by fire at time t

N_g = average recreation use level in RVDs per acre per year for the site not affected by fire

N_f = average recreation use level in RVDs per acre per year for the site affected by fire

i = discount rate

d = assumed duration of fire's impact on recreation

To obtain willingness-to-pay data, we questioned about 1200 recreationists in the northern Rocky Mountains. Recreationists were shown two paired sets of photographic sequences constructed for the survey. One paired sequence represented unburned and burned states at various points in time after a *low* severity fire, and the other represented time sequences for unburned and burned states after a *high* severity fire.

The low-severity sequence for the burned site was represented by photographs taken 1 day, 6 months, 5 years, and 10 years after fire. The photographs depict a mature ponderosa pine stand in which fire has opened the stand by burning primarily in the un-

derstory. The unburned site in the low-severity sequence was represented by four photographs depicting stand conditions for the same times represented in the photograph series for the burned site. The photographs depict a mature ponderosa pine stand similar to the stand in the photograph sequence for the burned site, except that the shrub layer becomes much denser over time in the unburned sequence than in the burned sequence.

The high-severity sequence for the burned site was represented by four photographs taken 1 day, 3 years, 6 years, and 12 years after fire. The photographs depict a mature, overstocked Douglas-fir stand in which fire has removed most of the heavy shrub understory, and severe basal and crown scorch are evident in the timber. A single photograph, rather than a sequence, represented the unburned states for the entire postfire period in the high severity sequence. The photograph depicts the overstocked Douglas-fir stand before the fire. A single photograph was justified because of the assumption that the unburned site was in a mature successional state and, therefore, would not change significantly in appearance during the 12-year postfire period.

Sample willingness-to-pay bids were estimated for only the time periods represented by the photograph pairs. Bid values between sample bid years were derived by linear interpolation between the sample bid points. The choice of 10- and 12-year periods over which to measure the effect of fire was based primarily on the limited availability of photographic series showing fire effects over time.

The paired photographs, depicting unburned and burned sites, were shown to the recreationists in an iterative bidding format. Recreationists were first asked their site preference. They were then led through an exercise to establish the fee they were willing to pay to enter their preferred site. Responses to the first question were used to establish values for the preference variable. The preferences were needed to determine postfire use levels on sites affected by fire. The bid estimates were used to produce values for the willingness-to-pay components of equation 2.

The respondents were also asked where they would go for recreation if the site they occupied was closed because of severe fire damage. The responses were used as proxy for the rate at which recreationists substituted a nearby unburned recreation site for the burned site. The National Forest boundary was used arbitrarily to delineate substitution. If the recreationist chose to leave the National Forest, no substitution of an unburned for burned site was assumed to occur. If, instead, the recreationist chose to remain somewhere on the National Forest other than the fire site, then substitution was assumed to have occurred. The average rate of within-forest substitution was needed to determine postfire use levels on sites affected by fire.

Two assumptions are implicit in the use of the proxy substitution rate. We assumed that (a) substitution is independent of the location of the recreation site in the northern Rocky Mountains; and that (b) the National Forest, or an area of similar size, is the planning unit for which this study's net value change estimates are appropriate.

Recreation records and acreages for 43 Ranger Districts on the westside of the Continental Divide in the Forest Service's Northern Region (R-1) (Montana, North Dakota, and northern Idaho) were used to estimate the annual recreation use levels in RVDs per acre per year (N_g in equation 2), on sites without fire. Recreation yield, as represented by visitation levels for all recreationists except fishermen for the years 1979 through 1981, were averaged for each Ranger District. The district average was divided by the district acreage to produce estimates of average annual RVDs per acre per year for each district. Mean high-, medium-, and low-use levels were estimated by ranking all the westside districts by average RVDs per acre, dividing this ranking into three equal groups, and estimating the average for each district grouping.

The bid and use level information was utilized to estimate net value change in recreation by a three-step process:

1. Produce a full set of annual willingness-to-pay values for sites affected and not affected by fire, by simple linear interpolation between sample year estimates.
2. Estimate recreation-use levels on sites affected and not affected by fire.
3. Apply equation 2, utilizing willingness-to-pay values and use levels derived in steps 1 and 2, to estimate NVC.

SAMPLE CALCULATION

The application of the methodology is illustrated by an analysis of a recreation site in the northern Rocky Mountains with a low fire severity and high recreation visitation rate. Annual sample and interpolated willingness-to-pay bids were compiled or estimated for a 10-year period after the fire *(table 1)*. The use level on the site not affected by fire was assumed to remain constant (.856 RVD per acre per year [for a high use site]). Thus, the west-side Northern Region average (fiscal years 1979 through 1981) did not need to be adjusted:

	Mean visitation rates
	Recreation visitor day/acre/year
Use level:	
Low ($Nt \leq 0.245$)	0.183
Medium ($0.2456 < Nt < 0.590$)	.390
High ($Nt \geq 0.590$)	.856

Average use levels for sites affected by fire were adjusted downward to reflect the expected decrease in the number of users on the affected sites. These adjustments were based on preference values and substitution rates estimated from our survey of recreationists.

The use level on the site affected by fire (N_f) changed over time as preferences for the sample recreation site changed after fire. The recreationists interviewed chose recreation activity on sites either on or off the National Forest where the burned site was located. If the recreationists chose to remain on the National Forest where the fire site was located, no overall reduction in use level was attributed to

Table 1—*Respondents' willingness-to-pay bids for recreation in low-severity burned site and in paired unburned site, by time after fire when photographs of recreation site were taken.*

Time of photography after fire	Unburned site		Burned site	
	Sample bids (mean)	Interpolated bids	Sample bids (mean)	Interpolated bids
	1978 dollars/recreation visitor-day			
Days				
1	0.82	—	0.47	—
Months				
6	.75	—	.61	—
Years				
1	—	0.75	—	0.68
2	—	.76	—	.75
3	—	.76	—	.82
4	—	.77	—	.87
5	.77	—	.94	—
6	—	.70	—	.89
7	—	.63	—	.85
8	—	.57	—	.80
9	—	.51	—	.76
10	.45	—	.72	—

Table 2—*Values needed to estimate average recreation use level on the site affected by fire*[1]

Time of photography after fire (years)	P_t	N_g	N_1	N_2	S	N_3	N_f
0	0.023	0.856	0.020	0.836	0.461	0.385	0.405
1	.346	.856	.296	.560	.461	.258	.554
2	.493	.856	.422	.434	.461	.200	.622
3	.640	.856	.548	.308	.461	.142	.690
4	.787	.856	.674	.182	.461	.084	.758
5	.935	.856	.800	.056	.461	.026	.826
6	.937	.856	.802	.054	.461	.025	.827
7	.939	.856	.804	.052	.461	.024	.828
8	.941	.856	.805	.051	.461	.024	.829
9	.943	.856	.807	.049	.461	.023	.830
10	.944	.856	.808	.048	.461	.022	.830

[1] P_t = Preference level
N_g = Average recreation-use level, (recreation visitor-days/acre/year) for site not affected by fire
N_1 = Number of recreationists who prefer site affected by fire
N_2 = Number of recreationists who do not prefer fire site
S = Rate of substitution for another recreation site on the same National Forest
N_3 = Number of recreationists who do not prefer fire site but remain on National Forest
N_f = Average recreation-use levels (recreation visitor-day/acre/year) for site affected by fire

fire. Use level was reduced only if the recreationist chose to move off the National Forest.

Certain values are needed to estimate use level on the site affected by fire *(table 2)*. The preference level (P_t) is multiplied by the use level for the nonfire site (N_g) to estimate the number of recreationists who prefer the fire site (N_1). Those who do not prefer the fire site (N_2) are estimated by subtracting those who prefer the fire site (N_1) from the use level on the nonfire site (N_g). Recreationists who do not prefer the fire site but who would remain somewhere on the National Forest (N_3) are estimated by multiplying N_2 by the on-forest substitution rate (S). Those who prefer the fire site (N_1) and those substituting somehwere on the forest (N_3) are added to produce the final use level for the site affected by fire (N_f).

The products of use level and bid were estimated for 10 years after fire for the unburned and burned sites *(table 3)*. These products, discounted to the 0 year and summed, equaled $5.40 for the unburned site and $5.12 for the burned site. Net value change was estimated by subtracting the burned site sum from the unburned site sum and the result was a value change of $0.28 per acre.

RESULTS AND DISCUSSION

Relatively small net value losses occurred in all fire situations *(table 4)*. Losses were larger for more severe fires because recreationists showed a stronger reluctance to recreate on high severity fire sites than on low severity sites. Losses were also larger at higher recreation use levels. This trend is not surprising as larger recreation value losses would be expected where recreation use potential is higher.

These net value change estimates are comparable to the $3.70 per acre estimate of recreation NVC for the Entiat study area.[5] Our recreation net value losses are also generally comparable to the recreation NVCs estimated by Schweitzer and others.[8]

Although the methods applied in this analysis are an improvement over

the methods applied in previous fire effects work, they are not without their problems and limitations. The willingness-to-pay estimates were based on examining paired photographs rather than actual sites. The use of paired photographs introduces the possibility of bias if more than fire effects differ among the photographs. It is difficult to ensure that recreationists interviewed are perceiving only differences resulting from fire in a pair of photographs, and varying their bids according to only those differences. This source of bias hinges on the choice of photographs used in the bidding process, and therefore, the avoidance of this bias was an explicit consideration in selecting photographs.

Hypothetical bias has been cited as another major potential problem with using photographs to obtain willingness-to-pay bids for hypothetical transactions in hypothetical markets. It is difficult to test for or eliminate hypothetical bias. These potential biases should be recognized in the interpretation of the results *(table 4)*.

In this analysis, we assumed that (1) average without-fire visitation levels are static over time; (2) recreationists interviewed provided bid values for the "average" recreational experience, and (3) various types of recreational activities were equally distributed across every acre. The second assumption avoided the need to treat individuals participating in different recreational activities as separate populations. Separate mean bids for each type of recreation activity, such as camping, hiking, and boating, therefore, were not needed. All three assumptions simplified the net value change analysis.

Table 3—*Discounted product of recreation-use level and recreationists' willingness-to-pay bids for burned and unburned sites*

Years	Unburned site			Burned site		
	Use level (RVDs/acre/yr)	Bid ($/RVD)[1]	Discounted product (i=4 pct)[2]	Use level (RVDs/acre/yr)	Bid ($/RVD)	Discounted product (i=4 pct)
0	0.856	0.82	0.70	0.405	0.47	0.19
1	.856	.75	.62	.554	.68	.36
2	.856	.76	.60	.622	.75	.43
3	.856	.76	.58	.690	.82	.50
4	.856	.77	.56	.758	.87	.56
5	.856	.77	.54	.826	.94	.64
6	.856	.70	.47	.827	.89	.58
7	.856	.63	.41	.828	.85	.54
8	.856	.57	.35	.829	.80	.48
9	.856	.51	.31	.830	.76	.44
10	.856	.45	.26	.830	.72	.40
Total			5.40			5.12

[1]RVD = recreation visitor-day

[2]Discounted product = (use level) (bid) $\left(\frac{1}{(1+i)^{year}}\right)$

i = discount rate

Efforts to value nonmarket resources often result in value approximations.[12] These estimates of net value change can only be considered rough measures of the effect of fire on recreation. Our use of survey information to derive a proxy substitution rate, for example, limited our analysis to measuring the effects of substitution away from the fire site only. Recreationists may substitute a burned site for an unburned site, but substitution favoring the fire site could not be addressed in this study with the data available. It was impossible in this study, therefore, to produce any net recreation benefits from fire.

Future efforts to include substitution in an analysis of recreation net value change should measure substitution to and away from the fire site. Substantially improved data on recreation site substitution, however, are unlikely to change the economic efficiency conclusions of a fire management analysis. These estimates indicate that the general magnitude of net value change in recreation resulting from fire is low and possibly low enough to be insignificant in economic efficiency analyses of fire management programs. The net value change of timber and range are often considerably higher and, therefore, of greater relative importance in fire efficiency analyses.[13,14] Estimates of recreation net value change should be included for a complete analysis, however, and the estimates and methodology provided here offer a satisfactory approach.

Table 4—*Estimates of recreation net value change for 10-year postfire evaluation period in the northern Rocky Mountains*

Use levels and discount rate (pct)	Fire severity	
	Low	High
	1978 dollars/acre	
Low:		
4	0.13	1.02
10	.13	.79
Medium:		
4	.13	2.17
10	.24	1.71
High:		
4	.28	4.74
10	.15	3.89

NOTES

[1]Althaus, Irene A.; Mills, Thomas J. *Resource values in analyzing fire management programs for economic efficiency.* Gen. Tech. Rep. PSW-57. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982. 9 p.

[2]Vaux, Henry J., Jr.; Gardner, Philip D.; Mills, Thomas J. *Methods for assessing the impact of fire on recreation.* Gen. Tech. Rep. PSW-79. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1984. 13 p.

[3]Johnson, F. Reed. *Recreation benefit estimation in theory and practice: A comment on imperfect methods.* J. For. 78(1): 24-25; 1980 January.

[4]U.S. Water Resources Council. *Procedures for evaluation of national economic development (NED) benefits and costs in water resource planning (level C) and proposed revisions to the*

standards for planning water and related land resources. Federal Register 44: 30226-30224; 1979.

[5]Bakker, Pieter. *Economic impacts of forest fires: the Entiat case.* Seattle, WA: University of Washington; 1975. 113 p. Dissertation.

[6]Crosby, John S. *A guide to the appraisal of: wildfire damages, benefits, and resource values protected.* Res. Paper NC-142. St. Paul, MN: North Central Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1977. 43 p.

[7]Marty, Robert J.; Barney, Richard J. *Fire costs, losses, and benefits: an economic valuation procedure.* Gen. Tech. Rep. INT-108. Ogden, UT: Intermountain Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1981. 11 p.

[8]Schweitzer, Dennis L.; Andersen, Ernest V.; Mills, Thomas J. *Economic efficiency of fire management programs at six National Forests.* Res. Paper PSW-157. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1982. 29 p.

[9]U.S. Department of Agriculture, Forest Service. *Fire protection on non-Federal wildlands: a report on the efficiency, national interest, and Forest Service role in fire protection on non-Federal wildlands.* Washington, DC: Cooperative Fire Protection Staff, Forest Service, U.S. Department of Agriculture; 1982. 62 p.

[10]Knapp, Gunnar. *Approaches for analyzing the effects of wildfires on resource values in Alaska.* Anchorage, AK: Institute of Social and Economic Research, University of Alaska; 1982. 42 p.

[11]Dwyer, John F.; Bowes, Michael D. *Benefit-cost analysis for appraisal of recreation alternatives.* J. For. 77(3): 145-147; 1979 March.

[12]Dyer, A. A.; Hof, J. G. *Comment on "Benefit cost analysis for appraisal of recreation alternatives."* J. For. 77(3): 147-148; 1979 March.

[13]Flowers, Patrick J.; Shinkle, Patricia B.; Cain, Daria A.; Mills, Thomas J. *Timber net value changes from wildfire in the northern Rocky Mountains: estimates for situation-specific fire cases.* Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; [In press].

[14]Peterson, David L.; Flowers, Patrick J. *Estimating postfire changes in production and value of northern Rocky Mountain-Intermountain rangelands.* Res. Paper PSW—173. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1984. 19 p.

The Authors:

PATRICK J. FLOWERS, formerly a research forester with the Station's Fire Management Planning and Economics Research Unit, at Riverside, California, is now economist with the Montana Division of Forestry, Missoula. **THOMAS J. MILLS,** formerly head of the research unit, is now leader, Renewable Resources Economics Group, Forest Service, U.S. Department of Agriculture, Washington D.C. **HENRY J. VAUX, JR.,** is professor of soil science, and **PHILIP D. GARDNER** is an assistant professor of soil science—both at the University of California, Riverside.