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Are wildfire management resources in the United States efficiently allocated to protect resources at risk? A case study from Montana

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ABSTRACT

Federal wildfire management agencies in the United States are under substantial pressure to reduce and economically justify their expenditures. To support economically efficient management of wildfires, managers need better estimates of the resource benefits and avoided damage costs associated with alternative wildfire management strategies. This paper reports findings from a choice modeling study of the wildfire management preferences of residents in Flathead County, Montana, where resources at risk include residential homes (estimated as level of home evacuations), recreational opportunities, air quality, timberland, and forest and watershed health. Residents are willing to pay higher state and county taxes to reduce wildfire impacts on all evaluated resources at risk, and reserved their highest marginal willingness to pay (MWTP) for reducing exposure to unhealthy smoke. Although federal wildfire managers have prioritized protection of private property, including homes, survey respondents expressed their lowest MWTP for reducing home evacuations. When coupled with the negative externality generated by the moral hazard of wildfire suppression near the wildland–urban interface, a strong economic argument can be made against prioritizing protection of private homes in Flathead County.

1. Introduction

In many parts of the world, wildfires are a societal problem that pose a threat to lives, homes and ecosystems, and cause major economic impacts (Hirsch and Fuglem, 2006; Hodzic et al., 2007; McAneney et al., 2009; Mutch et al., 2011). In response to escalating wildfire management costs and recognition of the beneficial role of fire in sustaining ecological processes, wildfire and fuel management policies in the United States have shifted from being based primarily on wildfire suppression to ones that integrate suppression, hazardous fuels reduction, restoration and rehabilitation of fire-adapted ecosystems, and community assistance (USDOI and USDA, 2000; USDOI et al., 2001; Western Governors' Association, 2001; USDA et al., 2002; USDOI et al., 2005; FEC, 2009). Current wildfire management policy also calls for protection of market and non-market resources commensurate with the value of the assets at risk (USDOI et al., 2001). Nevertheless, effective implementation of these policies has been limited (Dale, 2006; Steelman and Burke, 2007). For example, despite the agency's

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policies, the USDA Forest Service has given *de facto* priority to the protection of private structures (USDA OIG, 2006). There is acknowledgment of the need for improved accountability of wildfire management expenditures to facilitate economically efficient deployment of wildfire management resources, and the Forest Service is under substantial pressure to reduce aggregate fire suppression expenditures (USDA OIG, 2006).

The purpose of this research is to inform wildfire policymakers and managers about the wildfire management preferences of society by estimating the marginal value that residents in a region place on protection of homes and natural resources at risk from wildfire in that region, regardless of their personal exposure to this risk. Given scarce taxpayer-funded wildfire management resources, protection of one resource is often achieved at the cost of less protection of other resources. Consequently, this study utilized the choice modeling (CM) non-market valuation method to estimate the willingness of residents in Flathead County, Montana, to tradeoff protection of homes, timberland, air quality, recreation opportunities, and forest and watershed health. One may argue that it does not make sense to ask representative citizens about their WTP to protect 'statistical' private homes from wildfire, since respondents are likely to be mostly concerned about protection of their own home. However, anecdotal and empirical evidence indicates that protection of private property, including homes, is typically the number-one wildfire management objective, and a large proportion of federal wildfire management expenditures have been made for the protection of private property (USDA OIG, 2006; Liang et al., 2008). Given this reality and the moral hazard arising from it, the question is sensible and necessary, because the federal government's aim to reduce and economically justify wildfire management expenditures will require reconciliation of wildfire manager resource allocation priorities with those of society at large.

To support economically efficient management of wildfires, fire managers need decision support tools that allow them to identify areas where expected negative resource value change due to fire justifies substantial investments in suppression resources and areas where beneficial fire effects or excessive suppression costs would justify less aggressive strategies. Wildfire risk assessment models based on the quantitative wildfire risk framework described by Finney (2005) are emerging (e.g. Ager et al., 2007, 2010; Thompson et al., 2010, 2011) and have great potential to be adapted to guide economically efficient real-time wildfire suppression activities, as well as facilitating placement of wildland fuel reduction treatments, pre-season wildfire management planning and *ex-post* evaluation of suppression activities. These models estimate the probability and intensity of wildfire using landscape-scale wildfire simulation models and spatial identification of resources that may experience value change due to wildfire. However, estimates of marginal social values of resources affected by wildfire are required to integrate economic analysis tools within these wildfire risk assessment models, and such estimates are scarce (Venn and Calkin, 2011).

Of all the risks posed by wildfires, wildfire managers are most informed about the risk posed to private homes due to interactions with the local community through programs such as Community Wildfire Protection Plans and national media attention given to home losses from wildfire. There is an obvious welfare impact to homeowners, as well as political and public relations impacts for governments and their agencies, related to whether structures survive wildfires. Several studies have estimated the large negative effects of wildfires on the welfare of homeowners adjacent to, but not within a wildfire perimeter (Loomis, 2004; Mueller et al., 2009; Stetler et al., 2010). Other studies have estimated wildland–urban interface (WUI) homeowners' willingness to pay (WTP) in the range of hundreds of dollars per annum for fuel treatments that reduce wildfire risk to homes, as well as protect natural amenities in the WUI (Kim and Wells, 2005; Loomis et al., 2005; Kaval and Loomis, 2007; Kaval et al., 2007; Walker et al., 2007; Kaval, 2009). Taken at face value, the potential for wildfires to damage the large and growing value of housing stock in WUI areas may indicate that allocating taxpayer-funded fire-fighting resources to aggressively suppress wildfires threatening homes is economically justified.

A question that needs to be resolved is *whose values should be protected*: WUI homeowners' or society's at large? Homes are private goods, so the social benefits and costs of home ownership can be closely approximated by the private benefits and costs of WUI home ownership. Consequently, the social cost of wildfire damage to WUI homes can be approximated by multiplying the market prices of properties by the probability of loss to wildfire. One interpretation of federal wildfire policy is that it is justified to spend taxpayer dollars up to the expected social cost of wildfire damage to homes. However, private actors in WUI home markets (i.e. consumers, mortgage lenders and insurance companies) do not bear the full cost of WUI homeownership. WUI development, coupled with a high level of taxpayer-funded wildfire management, can be illustrated as a classic negative externality; marginal private costs of WUI homeownership are lower than marginal social costs, generating a deadweight loss to society. Compounding this negative externality, many states in the USA have state-mandated Fair Access to Insurance Requirements (FAIR) Plans, which can promote WUI development by providing insurance to homeowners where the private market has deemed the risks to be too great. Taxpayer-funded suppression and fuel treatments near WUI homes, and state-mandated insurance for WUI homes increases moral hazard and encourages more WUI development, which will require more transfers of wealth from society at large to protect the lifestyles of a comparatively small number of homeowners[1] (Loomis, 2004; Stetler et al., 2010).

[1] The same can probably be said about many tax-funded programs, including the National Flood Insurance Program (NFIP). However, NFIP support to communities is conditional on communities agreeing to adopt flood mitigation measures that guide development in their floodplains and also requires all federally regulated financial institutions to mandate flood insurance coverage for the life of the loan as a condition for granting a loan to those wishing to finance properties located in Special Flood Hazard Areas of a community (Morgan, 2007). In contrast, there is no legislation in place that allows the federal government to regulate the construction or landscaping of WUI homes in ways that reduce wildfire risks (USDA OIG, 2006).

Table 1
Land ownership in Flathead County.
Source: NRIS (c2007).

Landowner	Area (ha)	Percent of Flathead County
US Forest Service	712,996	52.4
National Park Service	250,860	18.4
US Fish and Wildlife	4,643	0.3
Bureau of Indian Affairs	13,826	1.0
Montana State land	67,755	5.0
Plum Creek Timber Company[a]	105,263	7.7
Stoltze Lumber Company[a]	14,569	1.1
Other private landowners[a]	171,396	12.6
Water	20,093	1.5
Total	1,361,401	100.0

[a] Indicates private landowners.

Another interpretation of federal wildfire policy (one that is consistent with the Pigouvian approach of internalizing the costs of WUI home ownership) is that it is justified to spend taxpayer dollars to protect WUI homes only up to the expected benefit of WUI home protection to society at large. This interpretation of the policy appears appropriate given that the costs of wildfire management in the United States are predominantly paid for by society at large through state and federal taxes. Since the benefits of WUI homeownership largely accrue to homeowners, the expected benefit to society at large of reducing wildfire damage to WUI homes will likely be small, but not zero. American taxpayers have historically been compassionate to citizens who are victims of natural disasters, and a collective desire to conserve natural landscapes and provide opportunities for economic growth may mean WUI development is inevitable and justifies a positive level of taxpayer-funded protection.

The paper proceeds with a description of the study area. A theoretical model of wildfire management preferences is then presented, followed by a description of the application of CM to assess wildfire management preferences in Flathead County. Estimates of the WTP to protect homes and natural resources from wildfire are then reported. These estimates are discussed with reference to the literature and conclusions are drawn.

2. Study area

The case study area for this research is Flathead County, located in northwest Montana, USA. As reported in Table 1 and illustrated in Fig. 1, the majority of the county's 1.36 M ha is public land. Over half of the county is national forest managed by the Forest Service and a further 18% of the county is within Glacier National Park, a place of spectacular mountain scenery that attracts approximately 2 M visitors each year (Swanson et al., 2003; NPS, 2009). Substantial forest areas in the county are owned by Plum Creek Timber Company and Stoltze Land and Lumber Company. The public is allowed to utilize the majority of this privately-owned forestland for recreational activities, including hiking, camping, hunting, and (for a fee) wood gathering.

Visitors and residents are attracted by the amenities of Flathead County, including scenic beauty, outdoor recreation opportunities, wildlife, a clean environment, and small towns with a rural atmosphere (Power and Barrett, 2001; Swanson et al., 2003; Flathead County Planning and Zoning, 2009). The population of the county grew by 17% to 86,840 between 2000 and 2007, and much of this growth has taken place in the WUI (Gude et al., 2008; Jarvis, 2008). Although employment within the natural resource extraction sector has declined since the 1980s, it is still important in Flathead County, and commercial use of timber resources is an industry that county residents wish to preserve (Flathead County Planning and Zoning, 2009). According to the Bureau of Business and Economic Research at The University of Montana, forest management, logging and wood products manufacturing accounts for 5%–10% of total employment in Flathead County, and represents more than half of manufacturing in the county (Morgan, 2009).

About 130,000 ha or 10% of Flathead County burned in wildfires between 2003 and 2007. Residents of the county have become accustomed to forest and road closures, and smoky summer days. Fortunately, no private structures have been lost to wildfire since 1988. The importance of fire-prone forests to the livelihoods and lifestyles of Flathead County residents make this area interesting for evaluating alternative wildfire management strategies.

3. Theoretical model of preferences for wildfire management

This paper uses the choice modeling method to estimate demand for protection of attributes (resources) at risk from wildfire, thus revealing social preferences for wildfire management priorities. This technique has been widely applied to natural resource management problems (Garber-Yonts et al., 2004; Han et al., 2008; Bateman et al., 2009; Boxall et al., 2009). Choice modeling is based on two economic theories: Lancaster's characteristics theory of value (Lancaster, 1966) and random utility theory (McFadden, 1974). The choice modeling method is described in detail in Louviere et al. (2000) and Bennett and Blamey (2001) and brief notes follow.

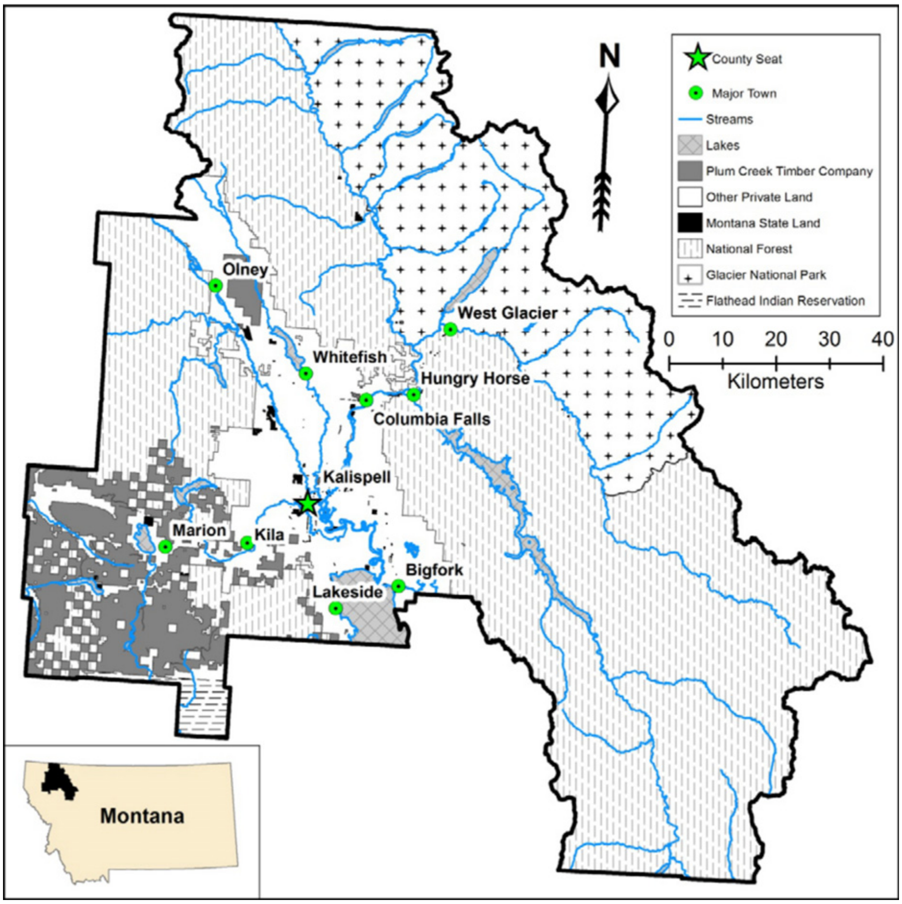

Fig. 1. Land tenure in Flathead County.

Residents of Flathead County were presented with sets of wildfire management alternatives for Flathead County, where each alternative was defined in terms of the level of protection afforded to five resources at risk from wildfire, and cost of the alternative. Each set, called a choice set, contained three management alternatives and the respondent was asked to select their preferred alternative. The method posits that the utility function for respondent n, with a measured vector of socio-economic characteristics, S, and facing j management alternatives that are described by outcomes for a vector of resources at risk, X, can be decomposed into observable and unobservable components

$$U_{jn} = V\left(S_n, X_j\right) + \epsilon\left(S_n, X_j\right) \tag{1}$$

where V represents the observable elements of utility and ε the stochastic unobservable elements of utility for the jth alternative. Assuming that the respondent attempts to maximize utility from wildfire management, the random utility model posits that the probability that respondent n chooses alternative i in set J is

$$\Pr_n(i \mid J_n) = \Pr\left(U_{in} > U_{jn}\right), \quad \forall j \in J_n,\ i \neq j. \tag{2}$$

Combining Eqs. (1) and (2), and rearranging terms gives

$$\Pr_n(i \mid J_n) = \Pr\left(V(S_n, X_{in}) + V\left(S_n, X_{jn}\right) > \epsilon(S_n, X_{in}) + \epsilon(S_n, X_{jn})\right) \quad \forall j \in J_n,\ i \neq j. \tag{3}$$

To estimate Eq. (3), the stochastic components are typically assumed to be independently and identically distributed (i.i.d.) with a Gumbel or Weibull distribution. The multinomial logit (MNL) regression model is then used to estimate the probability of respondent n choosing alternative i as

$$\Pr_n(i \mid J_n) = \frac{\exp\left(\mu V(S_n, X_{in})\right)}{\sum_j \exp\left(\mu V\left(S_n, X_{jn}\right)\right)}, \quad \forall j \in J_n,\ i \neq j \tag{4}$$

where μ is a scale parameter inversely proportional to the variance of the error term and not separately identifiable. This parameter is usually assumed to equal one, implying constant error variance (Ben-Akiva and Lerman, 1985). Ratios of

Table 2
Resources at risk from wildfire and the levels employed in the choice modeling survey instrument.

Resource	Definition	Status quo level	Alternative levels
HOME EVACUATIONS	The number of households asked by the County Sherriff to evacuate their homes per year for the next 10 years because of the threat of wildfire	130	70, 100, 170, 260, 400
RECREATION OPPORTUNITIES	The chance per year for the next 10 years your public-use forestland recreation plans will be substantially affected by wildfire during the summer (%)	15	5, 25, 40
SMOKY DAYS	The average number of *moderate*[a] smoke days and *unhealthy*[b] smoke days per fire season for the next 10 years	25/6 (*moderate*/*unhealthy*)	25/1, 50/1, 50/6
TIMBERLAND[c]	The average area of harvestable private, state and federal timberland burned each year for the next 10 years (ha)	5040	3000, 4000, 6000
FOREST AND WATERSHED HEALTH	The proportion of acres burned annually by wildfires greater than 2000 ha in size (%)	90	70, 80, 95
COST	How much the respondent's household will pay annually in state and county taxes to fund wildfire management for the next 10 years ($)	125	70, 180, 250, 325, 450

[a] Moderate smoke was defined as smoke that can be seen and may be smelled, and poses a health risk to sensitive individuals, including those with lung, heart or respiratory diseases, the elderly, and children. Respondents were advised that sensitive individuals should limit outdoor exposure, and that visibility is between five and 13 miles.
[b] Unhealthy smoke was defined as smoke that can affect the respiratory health of the general population, while health effects for sensitive individuals are significantly increased over the effects of moderate smoke. Respondents were advised that the general public should limit outdoor exertion, and sensitive individuals should avoid any outdoor activity. Visibility is between two and five miles.
[c] The TIMBERLAND attribute levels were presented to respondents in acres.

estimated coefficients for the resources at risk from wildfire represent the marginal rate of substitution respondents are willing to make between the attributes. The specific MNL models estimated in this study are presented in the following section.

4. Application of choice modeling to assess social preferences for wildfire management in Flathead County

This section describes the resources at risk included in the choice sets, the design and administration of the survey, and the MNL models fitted to the survey data.

4.1. Resources at risk

In order to determine the resources at risk from wildfire that are most important to the broad constituency of residents of Flathead County, focus group meetings with specialists were held in April and June of 2008. Stakeholders were identified through discussions with the USDA Forest Service and Flathead County Planning and Zoning. In attendance at these meetings were representatives from the Forest Service's Region 1 Office, the Flathead National Forest and the Rocky Mountain Research Station, Glacier National Park, Montana Department of Natural Resources and Conservation, Montana Department of Fish, Wildlife and Parks, Flathead County Planning and Zoning, Flathead County Sherriff's Office, the Flathead Economic Policy Center, the Flathead Land Trust, the Swan Ecosystem Center, the Montana Logging Association, and Northwest Regional Resource Conservation and Development. Representatives from the real estate industry and the Montana Chamber of Commerce agreed to participate, but failed to attend the meetings. No homeowner associations existed in Flathead County at the time the meetings were held; however, almost all the attendees were Flathead County residents. Following much discussion, the group agreed upon the resources at risk and defined their associated levels quantitatively, as reported in Table 2. Since new wildfire management strategies are likely to require several years to have an impact on wildfire behavior and resources at risk, levels for all resources were defined as average annual expected outcomes for the next 10 years. An appropriate ecological timeframe for Montana may be greater than 10 years, but 10 years was chosen to ensure the timeframe was relevant and meaningful to respondents.

The attributes and their levels reported in Table 2 are described in detail by O'Donnell (2009), but a brief description of several of them is warranted here to aid interpretation of the results. The focus group participants were adamant that the attribute quantifying homes at risk should be defined in terms of homes requiring evacuation, because no homes have been destroyed by wildfire in the county since 1988. However, to reinforce the notion that home losses could occur, respondents were informed that evacuated homes are considered to be in danger of being damaged or destroyed by wildfire.

Smoke can occur at various severity levels and focus group participants agreed the smoky days attribute adopted in this study should account for *moderate* and *unhealthy* smoke. Respondents were provided with the smoke definitions reported in the notes accompanying Table 2, where *moderate* smoke was defined by adapting the Montana Department of Environmental Quality (MDEQ, 2008) definitions for 'moderate' and 'unhealthy for sensitive groups' smoke levels, and *unhealthy* smoke was defined by adapting the 'unhealthy' and 'very unhealthy' definitions. To ensure that respondents understood how local forest management can affect air quality, the survey instrument reported that the likelihood of local high-severity wildfires that are resistant to control and generate unhealthy levels of smoke can be reduced by mechanical thinning and prescribed burning practices that generate moderate levels of smoke. The survey also clearly stated that local forest management cannot entirely eliminate smoke, as smoky conditions in Flathead County can result from fires hundreds of kilometers away.

The focus group agreed that the best way to quantitatively capture the effect of wildfire on forest and watershed health was fire size. Natural scientists in the focus group argued that, historically in Flathead County, stand-replacing and mixed-severity wildfires rarely exceeded 2000 ha and had mostly positive effects on biodiversity conservation, and forest and watershed health, including maintaining winter range for game species, and long-term maintenance of fish habitat. In contrast, large (greater than 2000 ha) wildfires can lead to severe degradation of water quality and fish habitat, and large stands of even-aged forest regrowth, which is not beneficial for most native species. The survey material presented this information to respondents along with two color photographs showing the effects of a small, patchy, mixed-severity wildfire versus a large, severe wildfire.

The research team and focus group participants were aware of a strong anti-tax sentiment in the county. However, wildfire management is costly, taking the form of landscape-level mechanical thinning and prescribed fire, forest road maintenance in large public forests, and suppression of wildfires using fixed-wing aircraft, helicopters, fire engines and ground crews. Presently, the only believable payment vehicle in the United States to support large-scale wildfire management is the status quo—taxes that fund government wildfire management agencies. Federal agencies have borne most wildfire suppression costs in Flathead County; however, the survey focused on changes in state and county taxes to fund wildfire management because changes in federal income taxes were less likely to be perceived by respondents as a realistic payment mechanism to fund alternative wildfire management strategies in Flathead County. Respondents are more familiar with geographically focused state and county-level programs. The status quo cost per household was estimated from actual state and county allocations of taxes to wildfire management over the period 2006–2008 (O'Donnell, 2009). Respondents were informed that county, state and federal taxes are fully committed. Hence, increases in wildfire management costs associated with alternative strategies in Flathead County would have to be funded by increases in their state and county taxes.

4.2. Survey design and administration

Given the six resources at risk and their levels, there are 9216 ($4^4 \times 6^2$) possible combinations of the attributes, which would be infeasible to present to survey respondents. An orthogonal main-effects experimental design was developed in SAS (Statistical Analysis Software) with the macros developed by Kuhfeld (2004). By this procedure, an efficient design with 96 combinations of the attributes (i.e. wildfire management alternatives) was divided into eight blocks of six pairs of alternatives, ensuring each block included every level of each attribute. The status quo alternative was added to each pair so the respondent would always have a 'no change' option. An example choice set is provided in Fig. 2. Each respondent was randomly assigned one of the blocks.

A 19-page, color survey document was produced containing five sections. Section 1 included a cover page outlining the survey's purpose, followed by questions about the respondent's residence and opinions on wildfire management. Section 2 provided background information about historic and contemporary wildfire regimes in Flathead County, and described market and non-market costs and benefits of wildfire. Section 3 defined the resources at risk and cost attributes used in the choice sets, and presented an example choice set accompanied by a description of the tradeoffs implied by choosing one alternative over another. In Section 4, respondents were presented with one block of six choice sets. Section 5 asked questions regarding the respondent's socio-economic characteristics, including age, sex, length of residence in Flathead County, occupation, income and level of education.

The survey was pre-tested at a shopping mall and, following some modifications, 1200 copies were mailed to a random sample of Flathead County residents in October 2008 that was stratified to ensure approximately half the surveys arrived at urban addresses (low personal exposure to wildfire) and the other half at rural addresses (higher personal exposure to wildfire). Following Dillman (2007), a pre-notification letter was followed a week later by the survey with a $2 bill incentive. A postcard was sent two weeks later that thanked respondents who had returned the survey and reminded those who had not. Two weeks after the reminder card, respondents who had not yet returned the survey were mailed a replacement survey with a more strongly worded cover letter to encourage completion.

4.3. Analysis

Two MNL model specifications were fitted to the survey data: a basic model without covariates and the model with socio-economic covariates that achieved best fit to the data. The latter model facilitated investigation of how respondents'

Choice Set 6	Average annual outcomes of wildfire management strategies over the next 10 years		
Attribute	Status Quo	Strategy K	Strategy L
Number of homes requiring evacuation because of the threat of wildfire 	130 homes	170 homes	260 homes
Chance per year that your forest recreation opportunities will be substantially affected by wildfire 	15%	40%	15%
Number of smoky days per year 	25 moderate / 6 unhealthy days	25 moderate / 6 unhealthy days	50 moderate / 1 unhealthy days
Acres of timber assets burned per year by wildfire 	12,600 acres	12,600 acres	7,500 acres
Forest and watershed health: percent of acres burned in large fires 	90%	95%	80%
Cost to me each year 	$125	$70	$325
I would choose (select one only)	☐	☐	☐

Fig. 2. Example of a choice set.

socio-economic variables affected wildfire management preferences for Flathead County. These models are represented by Eqs. (5) and (6), respectively.

$$\Pr_n(i \mid J_n) = \frac{\exp\left(\beta' X_{in} + \alpha C_{in} + \tau Q_{in}\right)}{\sum_j \exp\left(\beta' X_{jn} + \alpha C_{jn} + \tau Q_{jn}\right)} \tag{5}$$

$$\Pr_n(i \mid J_n) = \frac{\exp\left(\beta' X_{in} + \alpha C_{in} + \tau Q_{in} + \gamma' S_n X_{in} + \theta' S_n C_{in}\right)}{\sum_j \exp\left(\beta' X_{jn} + \alpha C_{jn} + \tau Q_{jn} + \gamma' S_n X_{jn} + \theta' S_n C_{jn}\right)} \tag{6}$$

Table 3
Definitions for socio-economic covariates, and the proportion of respondents in the sample and in the population that fall into each of these demographic groups.

Socio-economic covariate	Definition	Sample (%)	Flathead County (%)
OLDER	Dummy variable for respondents at least 50 years of age (yes = 1; no = 0)	68	35[a,b]
WEALTHIER	Dummy variable for household income at least $75,000 per annum (yes = 1; no = 0)	29	23[b]
MORE EDUCATED	Dummy variable for highest level of education earned is above a high school diploma or GED (yes = 1, no = 0)	57	30[b]
SECOND HOME	Dummy variable for respondents who received the survey at a residence other than their primary residence (yes = 1; no = 0)	7	9[c]
NEW RESIDENT	Dummy variable for respondents who have lived in western Montana for zero to five years (yes = 1; no = 0)	9	16[d]
LOT > 0.4 HA	Dummy variable for respondents whose residence is on a lot that is at least 0.4 ha	42	38[e]

[a] To be consistent with the survey request that respondents be 18 years or older, this statistic is the percent of Flathead County residents aged 18 and over who are at least 50 years of age.
[b] US Census Bureau (c2009).
[c] Adapted from Gude et al. (2008).
[d] Onboard Informatics (2010).
[e] Flathead County Planning Board (2008).

where i, j and n are as defined earlier; X is the vector of resources at risk reported in Table 2; C is a scalar of the cost of particular wildfire management strategies (where alternative levels are reported in Table 2); Q is an alternative specific constant (ASC) that is unity for the status quo and zero for the other two alternatives in each choice set; S_nX_{in} is a matrix of interactions between the socio-economic characteristics of respondents reported in Table 3 and the resources at risk; and S_nC_{in} is a vector of interactions between socio-economic characteristics and the cost of the wildfire management strategy. Preliminary analysis revealed that splitting the attribute SMOKY DAYS into two attributes, MODERATE SMOKE days and UNHEALTHY SMOKE days (as defined in the notes accompanying Table 2) facilitated interpretation of respondents' preferences. Because of this procedure, X is a vector of six resources at risk.

The ASC accounts for variations in choices that are not explained by changes in the levels of the resources at risk, cost or socio-economic variables. This includes what Samuelson and Zeckhauser (1988) termed 'status quo bias', a common economic phenomenon whereby decision-makers adhere to a status quo choice more frequently than would be predicted by the canonical model. In this paper, the neutral term 'status quo effect' (SQE) is preferred, because 'status quo bias' immediately suggests some type of flaw. The SQE can account for diverse economic phenomena, including the difficulty of changing public policies. There are complementary rational and psychological explanations of the SQE (Thaler, 1980; Adamowicz et al., 1998; Meyerhoff and Liebe, 2009; Boxall et al., 2009; Carlsson, 2010), and failing to accommodate the SQE in economic models may lead to exaggeration of individuals' responses to changing economic variables (Samuelson and Zeckhauser, 1988).

Several covariates were designed and tested to capture the preferences of respondents living in areas with higher exposure of homes to wildfire risk, that is, residents in the WUI. Many definitions of the WUI have been published (e.g. Davis, 1990; Stewart et al., 2007; Theobald and Romme, 2007). In the *Flathead County Community Wildfire Fuels Reduction/Mitigation Plan* in place at the time of this study, WUI homes were defined as being within 2.4 km (1.5 miles) of forestland (GCS Research, 2005). Covariates based on this definition of the WUI were statistically insignificant predictors of wildfire management preferences. Covariates based on the USDOI and USDA (2001) population density definitions of the WUI and wildland–urban intermix were also statistically insignificant predictors of wildfire management preferences. Analysis revealed that a covariate for respondents who live on a lot at least 0.4 ha in area (LOT > 0.4 HA) best captured the statistically significant preference for reducing home evacuations that was *a priori* expected from residents in the WUI. This covariate has been adopted as a proxy for the WUI in this study. Spatial analysis highlighted that these respondents live on the suburban fringe or in rural parts of the county, and are proximate to forest.

From the models represented by Eqs. (5) and (6), average household MWTP for a one-unit improvement in protection of the kth resource at risk (X) can be estimated by Eqs. (7) and (8), respectively

$$-\frac{\beta_k}{\alpha} \tag{7}$$

$$-\left(\frac{\beta_k + \sum_{m=1}^{M} \gamma_{km} R_m}{\alpha + \sum_{m=1}^{M} \theta_m R_m}\right) \tag{8}$$

R_m is the fraction of the population of Flathead County that falls into each of the m socio-economic characteristic categories (as reported in Table 3), and all other parameters are as defined above. Following the method of Han et al. (2008), Eq. (8) produces an adjusted average household MWTP that corrects for the potential that respondents to the survey were not representative of the socio-demographics of Flathead County. Aggregate MWTP for Flathead County can then be estimated by multiplying the average household estimates derived from Eqs. (7) or (8) by the 31,062 occupied housing units in the county (US Census Bureau, c2009). The scaling problem associated with μ in Eq. (4) is resolved when one attribute coefficient is divided by another, as in Eqs. (7) and (8), since the scale parameter cancels out.

5. Results

The survey closed in January 2009 with 587 usable responses from 1020 deliverable surveys (180 were returned by the post office as undeliverable) and an effective response rate of 58%. As is common with postal surveys, respondents in this study were on average older, wealthier and better educated than the residents of Flathead County as a whole (Table 3). Preliminary survey questions revealed residents of Flathead County are largely content with wildfire management, with 60% of respondents indicating that current wildfire management is about right, 29% expressing a desire for higher levels of suppression and only 11% indicating that more wildfires should be allowed to burn.[2] When homes do burn due to wildfire, 74% of respondents indicated that the primary responsibility rests with the homeowner, not with fire management agencies, including the Forest Service, Montana Department of Natural Resources and Conservation, and the Flathead County Volunteer Fire Department. Only 46% of respondents living within 2.4 km of forestland indicated they were insured against wildfire loss. Anecdotal evidence suggests the majority could be insured through the private market, but the owners choose not to. There is no state-mandated insurer of last resort in Montana for those who cannot obtain private insurance, as Montana does not have a FAIR Plan. Wildfire evacuation experience is relatively low, with only 5% of respondents indicating they have been ordered to evacuate at least once.

The survey also revealed that Flathead County residents hold strong utilitarian values for their forests with 56% of respondents indicating there is too little emphasis on timber harvesting on state and federal lands, and 40% indicating there is presently too much emphasis on protection of the environment. Nevertheless, there is a perception of declining forest health in the county, with 60% of respondents who have lived in western Montana for at least 10 years indicating that they believe forest health has declined. As expected, respondents also expressed concern about the payment vehicle used in this study, with 43% opposing additional taxation for government programs.

5.1. Wildfire management preferences in Flathead County

It is likely that the high level of respondent-reported satisfaction with current wildfire management, coupled with the opposition to additional taxation contributed to respondents frequently selecting the status quo management option. Indeed, 141 respondents always chose the status quo management option regardless of the attribute levels of the alternatives. A standard t-test of means of socio-demographic and attitudinal characteristics (including aversion to additional taxes) of the respondents who always selected the status quo revealed no statistically significant differences relative to the rest of the sample. Their responses do suggest a preference for the status quo; however, given the experimental design, they are also evidence of inconsistent preferences with respect to the choice attributes. Following Adamowicz et al. (1998), these respondents were excluded from the analysis because they adopted a simple heuristic decision rule and did not invest the time and effort necessary to carefully consider the management alternatives.

The final dataset for analysis included the preferences of 446 respondents for the 'without covariates' model and 413 respondents for the 'with covariates' model.[3] Table 4 reports the results for both MNL models. In the model without covariates, coefficients on all resources at risk are statistically significant at better than the 1% level. Higher levels of all resources at risk correspond with worse fire management outcomes, so the negative sign on the coefficients is expected. For example, the negative coefficient on cost means that the higher the cost level, the lower the probability the wildfire management option would be selected. The ASC coefficient is positive and statistically significant in the model without covariates. This SQE indicates that respondents had a preference for the status quo regardless of the level of change in resources at risk.

In the model with covariates, the coefficients on the resources at risk reflect change in probability of a wildfire management strategy being selected for a base-case group of respondents who do not fall into any of the covariate categories. That is, they reflect the preferences of people under 50 years who live in households with incomes under $75,000 per annum, have no more than a high school level of education, received the survey at their primary residence, have lived in western Montana for at least 5 years, and do not live in a house on at least 0.4 ha of land. For this group of respondents, the level of home evacuations and moderate smoke did not have a statistically significant effect on the probability of a wildfire

[2] The low response in favor of letting more wildfires burn is not surprising given that respondents were being asked about wildfire management in their own metaphorical backyards, Flathead County.

[3] Some respondents did not complete questions in the survey related to the socio-economic covariates used in the 'with covariates' model (e.g. household income) and were dropped from the analysis.

Table 4
Regression results.

Variable	Model without covariates		Model with covariates	
	Coefficient estimate	p-value	Coefficient estimate	p-value
HOME EVACUATIONS	−0.0016***	<0.001	−0.0004	0.626
RECREATION OPPORTUNITIES	−0.0101***	<0.001	−0.0180***	0.005
MODERATE SMOKE	−0.0171***	<0.001	−0.0062	0.315
UNHEALTHY SMOKE	−0.0652***	<0.001	−0.0783**	0.013
TIMBERLAND[a]	−0.0787***	<0.001	−0.1205***	<0.001
FOREST AND WATERSHED HEALTH	−0.0241***	<0.001	−0.0259***	0.004
ASC	0.2382***	0.001	0.2933***	<0.001
COST	−0.0055***	<0.001	−0.0080***	<0.001
OLDER × HOME EVAC			−0.0011*	0.100
OLDER × RECREATION			0.0028	0.631
OLDER × MOD SMOKE			−0.0012	0.838
OLDER × UN SMOKE			0.0166	0.565
OLDER × TIMBERLAND			0.0280	0.348
OLDER × F&W HEALTH			0.0177**	0.033
OLDER × COST			0.0023***	0.010
WEALTHIER × HOME EVAC			0.0002	0.743
WEALTHIER × RECREATION			−0.0135**	0.027
WEALTHIER × MOD SMOKE			−0.0069	0.255
WEALTHIER × UN SMOKE			−0.0526*	0.084
WEALTHIER × TIMBERLAND			0.0240	0.441
WEALTHIER × F&W HEALTH			−0.0029	0.742
WEALTHIER × COST			0.0029***	0.001
MORE EDUCATED × HOME EVAC			−0.0003	0.704
MORE EDUCATED × RECREATION			0.0081	0.150
MORE EDUCATED × MOD SMOKE			−0.0050	0.365
MORE EDUCATED × UN SMOKE			0.0214	0.448
MORE EDUCATED × TIMBERLAND			−0.0231	0.422
MORE EDUCATED × F&W HEALTH			−0.0193**	0.017
MORE EDUCATED × COST			0.0001	0.984
SECOND HOME × HOME EVAC			0.0016	0.206
SECOND HOME × RECREATION			0.0168*	0.097
SECOND HOME × MOD SMOKE			−0.0006	0.954
SECOND HOME × UN SMOKE			0.0781	0.184
SECOND HOME × TIMBERLAND			0.0122	0.834
SECOND HOME × F&W HEALTH			0.0389**	0.012
SECOND HOME × COST			0.0041***	0.001
NEW RESIDENT × HOME EVAC			−0.0028**	0.030
NEW RESIDENT × RECREATION			0.0020	0.843
NEW RESIDENT × MOD SMOKE			−0.0114	0.258
NEW RESIDENT × UN SMOKE			−0.1545***	0.003
NEW RESIDENT × TIMBERLAND			0.1436***	0.005
NEW RESIDENT × F&W HEALTH			−0.0025	0.870
NEW RESIDENT × COST			−0.0020	0.197
LOT > 0.4 HA × HOME EVAC			−0.0015**	0.026
LOT > 0.4 HA × RECREATION			0.0010	0.858
LOT > 0.4 HA × MOD SMOKE			−0.0118**	0.033
LOT > 0.4 HA × UN SMOKE			0.0138	0.622
LOT > 0.4 HA × TIMBERLAND			0.0027	0.925
LOT > 0.4 HA × F&W HEALTH			−0.0148*	0.064
LOT > 0.4 HA × COST			−0.0007	0.391
Number of observations	7614		6516	
Log L	−2520.4		−2094.3	
Wald statistic[b]	444.47***	<0.001	450.42***	<0.001

* Significant at 10% level.
** Significant at 5% level.
*** Significant at 1% level.
[a] TIMBERLAND entered the model in units of 400 ha (1000 acres).
[b] The hypothesis is that all parameters are jointly zero.

management option being selected; however, the coefficients had the expected sign. All other choice attribute coefficients were negative and statistically significant, indicating that higher (less desirable) levels of these attributes were associated with lower probability of wildfire management strategy selection. As in the model without covariates, the ASC coefficient is positive and statistically significant.

The covariates highlighted many informative wildfire management preference differences between socio-economic groups in Flathead County. For example, older respondents, new residents to western Montana and residents living on

Table 5
Average household MWTP to protect resources at risk from wildfire in Flathead County.

Resource	Marginal unit	Model without covariates		Model with covariates	
		Average household MWTP ($)	95% confidence interval ($)	Average household MWTP ($)	95% confidence interval ($)
HOME EVACUATIONS	1 house	0.29	0.17–0.41	0.24	0.10–0.39
RECREATION OPPORTUNITIES	1 percentage point	1.82	0.80–2.85	2.26	0.94–3.59
MODERATE SMOKE	1 day	3.09	1.87–4.31	2.34	0.92–3.77
UNHEALTHY SMOKE	1 day	11.79	6.08–17.50	13.28	6.60–19.97
TIMBERLAND	400 ha	14.24	9.47–19.00	12.77	6.56–18.98
FOREST AND WATERSHED HEALTH	1 percentage point	4.35	3.09–5.61	4.20	2.55–5.86
SQE (ASC)	na	43.07	9.67–76.47	36.52	8.81–64.23

at least 0.4 ha of land were the only groups who expressed a preference for management options that reduced home evacuations. This finding is understandable for respondents on at least 0.4 ha, because they reside on the suburban fringe and in rural parts of the county closer to wildfire-prone forests. Notably, wealthier respondents and second home owners are less likely to select management options that reduce home evacuations, although these findings are not statistically significant. Perhaps, this indicates that such residents have a greater capacity to rebuild.

Relative to the base-case group of respondents, wealthier respondents were more likely to select wildfire management options that protected forest recreation opportunities, while second home owners were less likely to select such management options, other attributes being equal. Wealthier and new residents were more likely to select management options that reduced exposure to unhealthy smoke days. Interestingly, respondents on at least 0.4 ha were the only socio-economic group for which moderate smoke levels had a statistically significant effect on the selection of wildfire management strategies. Due to the spatial location of these respondents, they are likely to have had greater experience with wildfire smoke.

New residents were the only socio-economic group to express a statistically significant unwillingness to select wildfire management options that protected more timberland from wildfire. This is perhaps reflecting an alternative understanding about the importance of the timber industry to the local economy relative to other residents, or a perception that the timber industry threatens the amenities that have attracted them to Flathead County.

There are no realistic alternative payment vehicles to taxation for large-scale wildfire management. To test whether the high proportion of respondents who indicated an unwillingness to pay additional taxes to fund wildfire management compromised the reliability of the models, a MNL model without covariates was fitted only to the choices made by these respondents. Difference in means tests revealed that the attribute coefficients, including for the ASC dummy, were not statistically significantly different from the model without covariates reported in Table 4. Next, the relationship between unwillingness to pay additional taxes and the significance of the SQE was investigated by re-estimating the model without covariates with the addition of an interaction: the ASC dummy multiplied by a dummy for respondents who had indicated opposition to any additional taxation. With this interaction term, the ASC coefficient was found to be statistically insignificant ($p = 0.24$), and difference in means tests revealed no statistically significant change in the levels of the coefficients for the resources at risk. Thus, the ASC dummy appears to be capturing a preference for the status quo that is motivated by aversion to additional taxation to fund wildfire management. These tests do suggest that the high proportion of protest responses did not compromise the MWTP estimates for resources at risk.

5.2. *Social willingness to pay to protect resources at risk from wildfire in Flathead County*

Table 5 reports average household MWTP for models without and with covariates, which were estimated with Eqs. (7) and (8), respectively. Confidence intervals (95% level) were estimated by the method described by Efron and Tibshirani (1986) using 500 bootstrap repetitions, and highlight that all average household MWTP estimates are statistically significantly different from zero. Eq. (8) adjusted the estimates from the model with covariates to be representative of the county as a whole and it is only these estimates that are considered throughout the remainder of this paper. Table 5 indicates large differences in MWTP between attributes. For example, the average household in Flathead County is only willing to pay $0.24 per annum for the next 10 years to avoid one home evacuation per year for the next 10 years. However, the average household is willing to pay $13.28 per annum for the next 10 years to avoid one unhealthy smoke day per year for the next 10 years.

The WTP calculation for the SQE is τ/α, resulting in a WTP of $36.52 annually for the next 10 years for current wildfire management outcomes. Ignoring the ASC is likely to overestimate WTP when evaluating alternative wildfire management strategies. Subtracting the WTP for the status quo from the WTP for any wildfire management strategy that deviates from the status quo will provide a conservative interpretation of preferences and may represent a lower bound WTP (Garber-Yonts et al., 2004; Boxall et al., 2009).

Aggregate MWTP of residents in Flathead County to protect resources at risk from wildfire are reported in Table 6. These estimates reveal, for example, that residents in aggregate are willing to pay $130,527 per year for 10 years for a one

Table 6
Aggregate MWTP to protect resources at risk from wildfire in Flathead County.

Resource	Aggregate MWTP ($)	10% improvement from status quo	WTP for a 10% improvement from the status quo ($)
HOME EVACUATIONS	7,523	13 homes	97,794
RECREATION OPPORTUNITIES	70,302	1.5 percentage points	105,452
MODERATE SMOKE	72,828	2.5 days	182,070
UNHEALTHY SMOKE	412,592	0.6 days	247,555
TIMBERLAND	396,665	504 ha	499,798
FOREST AND WATERSHED HEALTH	130,527	9 percentage points	1,174,742
SQE (ASC)	1,134,376		na

percentage point improvement in forest and watershed health for 10 years. However, since the units of measurement for the levels of each attribute differ, it can be misleading to infer socially efficient protection priorities from the MWTP estimates in Tables 5 and 6. One way to interpret the results so as to reduce the effect of the different units of measurement on WTP is to estimate WTP for a specific percentage improvement in levels of each attribute from the status quo, say 10%. WTP for the latter are also reported in Table 6 and reveal that WTP to reduce home evacuations by 10% is still low relative to most choice attributes. Despite unhealthy smoke having the highest MWTP out of all the choice attributes, reducing unhealthy smoke exposure by 10% per annum is worth only half as much as reducing timberland burned by wildfire by 10%, and less than one-quarter as much as improving forest and watershed health by 10%.

6. Discussion

Residents of Flathead County are willing to pay to reduce wildfire impacts on all resources at risk in Flathead County that were considered in this study. While priority ordering of the attributes is challenging because of differences in units of marginal change between the attributes, the results do suggest protection of forest and watershed health and timberland, and reducing exposure to unhealthy smoke are more important than reducing home evacuations and exposure to moderate smoke, and protecting recreation opportunities. In this section, the WTP estimates are discussed and compared with published WTP estimates for similar resources in North America.

It is important to recognize that HOME EVACUATIONS captures WTP to prevent fire from burning close enough to homes to warrant relocating residents to a safe area, and is not likely to be a sound proxy for WTP to protect a home at imminent risk of loss due to wildfire, nor WTP to avoid human injuries or death. Nevertheless, the low average household MWTP to reduce evacuations is particularly striking given the high priority wildfire managers have historically placed on private property protection. At the time of this study, median property values in Flathead County were $220,000 (Onboard Informatics, 2010). Flathead County residents expressed an aggregate MWTP of 3.4% of the median property value to avoid one evacuation. The low average household MWTP to reduce home evacuations does strongly contrast with studies in the western United States that have estimated the high WUI household WTP for fuel treatments to mitigate wildfire impacts (Kim and Wells, 2005; Kaval et al., 2007; Kaval, 2009). However, the difference is rational, since in this Flathead County study the beneficiaries of reduced evacuations are unspecified WUI homeowners, whereas in the fuel treatment studies the respondents would be certain of receiving private benefits from treatments through reduced future burn probabilities around their homes.

An economically rational resident would be willing to pay up to their expected annual welfare loss from one evacuation in the county to avoid one evacuation. The MWTP to avoid one home evacuation in the county will vary between respondents according to factors including the respondent's: (a) perception of the probability their own household will be ordered to evacuate; (b) perception of the probability of structure loss given a home is evacuated; (c) private home value; (d) level of compassion towards other Flathead County residents who are ordered to evacuate; (e) level of insurance coverage; (f) level of emotional attachment to the home and its surroundings; and (g) valuation of the inconvenience of being evacuated. Consider a respondent with a $220,000 home built among wildland fuels. If the respondent perceives there is a 1% chance per annum that they will be ordered to evacuate and that evacuated structures are protected 98% of the time, the expected annual private cost to the resident is $44 ($220,000 $\times$ 0.01 $\times$ 0.02), which could be adjusted up or down depending on the importance of other factors such as (d)–(g) listed above. For many residents who reside in homes distant from wildland fuels, their private risk of being evacuated is zero, and their MWTP to avoid one home evacuation will be a function of the disutility of knowing other residents may be evacuated. Given that no homes have been destroyed by wildfire in Flathead County since 1988, and evidence that property owners tend to underestimate the risk of natural disasters if they have not had recent experience (Bin and Polasky, 2004; Morgan, 2007), many respondents may perceive the probability that evacuated homes will be destroyed by wildfire to be very close to zero. In that case, WTP to reduce evacuations will be close to zero and perhaps consist predominantly of WTP to avoid the inconvenience of being evacuated.

The science demonstrating the health effects of wildfire smoke exposure is incomplete and there are few estimates of the economic costs of wildfire smoke exposure (Kochi et al., 2010; Venn and Calkin, 2011). Nevertheless, protecting air quality was a major reason that the Forest Service decided to suppress all wildfires in California during the summer of 2008. No studies have estimated WTP to avoid wildfire smoke (Kochi et al., 2010). Consequently, there are no estimates in the literature that are directly comparable to the MWTP to reduce wildfire smoke exposure reported here. Some studies have estimated economic costs of wildfire smoke based on dose–response functions and WTP to avoid the health costs of urban air pollution particulate matter (PM). For example, Rittmaster et al. (2006, 2008) estimated the mean value of health impacts related to an increase in PM 2.5 levels to 35 mg/m^3 due to the Chisholm Fire, near Edmonton, Canada, on 24 May 2001 at CAN$2.8 M (US$2.7 M in 2007 dollars). With 1.1 million people exposed to the smoke plume, that is equivalent to US$2.45 per resident and US$6.14 per household.[4] The US EPA (1999) reported a WTP of $28 (adjusted to 2007 dollars) to avoid one day of acute respiratory symptoms where cause of the symptoms is urban pollution PM. Dickie and Messman (2004) estimated WTP to avoid the same symptoms at $90/day for adults and $190/day for children. The household MWTP of $13.24/day of avoided unhealthy smoke exposure estimated in this study is low relative to Dickie and Messman (2004). Most likely, this occurred because respondents were informed of increased likelihood of symptoms (especially for sensitive groups), not that they would experience symptoms with certainty.

The high WTP to protect forest and watershed health in Flathead County is consistent with other estimates of WTP for forest protection or restoration in the US (Loomis and González-Cabán, 1998; Garber-Yonts et al., 2004; Loomis et al., 2005, 2009). In aggregate, Flathead County residents were willing to pay $992/ha ($396,665/400 ha) of timberland protected from wildfire per year. This relatively high valuation can be explained by the perceived high importance of the timber industry to the local economy, and the desire Flathead County residents have expressed to retain rural livelihoods and a commercially viable timber industry (Flathead County Planning and Zoning, 2009). Timberlands also provide many non-market goods and services, including aesthetically pleasing landscapes and wildlife habitat, which respondents may have been considering when trading off timberland protection against other values at risk.

Evaluating the effects of wildfire on recreation is challenging because they depend on the size of the fire and availability of substitute recreation sites, and will also vary substantially between recreational pursuits over space and time. In an international meta-analysis of contingent valuation studies that have valued forests, Barrio and Loureiro (2010) found that WTP was particularly sensitive to the provision of recreational services. A possible explanation of the low willingness of Flathead County residents to pay to protect recreational opportunities from wildfire, relative to the other resources at risk, is that they have many recreational opportunities to choose from because of the abundance of public forestland in the county. The high availability of forest recreation sites may mean little cost is imposed when one forest-based recreational trip must be substituted for another due to wildfire. Another possible explanation is that recreationists are willing to recreate in burned areas when access is restored, perhaps to enjoy some of the positive effects of wildfire on recreational experiences (e.g. promotion of wildflowers). In support of this hypothesis, Hesseln et al. (2004) found that the welfare of Montanan hikers and bikers was not substantially affected by wildfire burning forest recreation areas. Further, Brown et al. (2008) found recreational visits in the Mount Jefferson Wilderness of Oregon did not change substantially after 16,000 ha burned in 2003, and Loomis et al. (2001) found that the welfare of recreationists in Colorado increased post-wildfire. However, other studies have found that wildfire has a substantial negative effect on the welfare of forest recreationists (Hesseln et al., 2003).

7. Conclusions

With US federal land management agencies under pressure to reduce and economically justify wildfire suppression expenditures, there is a need to investigate social preferences for wildfire management to estimate benefits of suppression. This study empirically mapped the wildfire management preferences of residents in Flathead County, Montana. The use of a multi-attribute valuation framework facilitated estimation of wildfire management tradeoffs residents are willing to make between resources at risk in Flathead County. The estimated shadow prices for resources at risk can be used to support policymakers and wildfire managers plan economically efficient wildfire management and fuel treatment programs, and their utility could be enhanced by integrating them within a spatial and temporal wildfire risk analysis framework.

Flathead County residents expressed statistically significant marginal willingness to pay (MWTP) to protect all resources at risk from wildfire that were evaluated in this study. Residents also expressed substantial aversion to change from the status quo, which is a common economic phenomenon. Overall, respondents reserved their highest MWTP for reducing exposure to unhealthy smoke, reducing timberland burned, and increasing forest and watershed health (by reducing the proportion of land burned by fires at least 2000 ha in area). Notably, respondents expressed their lowest MWTP for reducing home evacuations, where homes are considered to be in danger of being damaged or destroyed by wildfire. This is in marked contrast to local and national wildfire manager protection priorities, and calls into question the allocative efficiency of wildfire management resources.

The economic efficiency of wildfire management (and WUI development) will be enhanced by reconciling wildfire manager protection priorities with those of society at large. The low MWTP to reduce home evacuations in Flathead County has potential wildfire management and policy implications at the national level. When coupled with the negative externality generated by the moral hazard of wildfire suppression near the WUI (not estimated in this study), a strong economic argument can be made against prioritizing protection of private homes. Further research is necessary to determine whether the resource protection priorities in Flathead County apply more generally throughout the United States.

[4] City of Edmonton household size was 2.5 in 2001 (Statistics Canada, 2003).

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