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SOCIAL VALUES FOR ATTRIBUTES AT RISK FROM WILDFIRE IN NORTHWEST MONTANA

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Social Values for Attributes at Risk from Wildfire in Northwest Montana

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Annual fire management and suppression expenditures by the USDA Forest Service have dramatically increased in recent years, and exceeded $1 billion in the fire seasons of 2000, 2002, 2003, 2006, 2007, 2008, and 2009. These escalating management costs can largely be attributed to the Forest Services' efforts to protect private property in the wildland-urban interface (WUI) at the expense of other market and non-market attributes. Due to increasing development within the WUI, climate change, and excessive fuel loading from decades of successful fire suppression, it is likely that fire suppression costs will continue to rise if current wildfire management priorities are not modified.

Previous economic models utilized by the Forest Service to support wildfire management decisions only accommodated market values like private structures and timber, however, new models are being developed by the Forest Service to account for various market and non-market values at risk from wildfire in order to more efficiently allocate fire management funds. The objective of this study was to derive marginal social values for several non-market attributes at risk from wildfire in Flathead County, Montana, for inclusion in wildfire management decision-support models. This was achieved by conducting a choice modeling study in Flathead County. It was found that a typical resident of Flathead County has a value for structure protection of only $0.28 per home, compared to $1.90 for a one percentage point reduction in the chance that wildfire affects their recreation opportunities, $3.23 for a one day reduction in the number of moderate smoky days, $13.36 for a one day reduction in the number of unhealthy smoky days, $13.39 for a 1,000 acre reduction of timberland burned by wildfire, and $4.52 for a 1 percentage point reduction in the number of large (greater than 5,000 acres) fires that burn on the landscape. Responses to the questionnaire also revealed that 74.3% of respondents believe that it is the responsibility of the individual homeowner, not fire management agencies, if a home burns because of a wildfire.

These findings reveal that there is a small social value for private property protection in Flathead County compared to other non-market attributes, and suggest that current fire management, which places emphasis on private property protection, is not socially efficient for Flathead County.

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1. INTRODUCTION

Unprecedented expenditures on wildland firefighting in recent years have been a source of much political and social debate. Annual suppression expenditures by the USDA Forest Service have dramatically increased in recent years, and exceeded $1 billion in the fire seasons of 2000, 2002, 2003, 2006, 2007, 2008, and 2009 (NIFC 2006, Calkin 2009). This is, in part, due to a trend towards larger and more severe wildfires arising from excessive fuel loading from decades of successful fire suppression and climate change (Calkin et al. 2005a, Westerling et al. 2006). However, escalating fire management costs can also largely be attributed to the Forest Services' efforts to protect private property in the wildland-urban interface (WUI) (OIG 2006, Gebert et al. 2007, Liang et al. 2008). As more people choose to live in the WUI for its associated natural amenities like forests, lakes, cleaner air and water, aesthetics, and recreational access, the number of homes at risk from a catastrophic wildfire is continually increasing (Brenkert-Smith et al. 2006). The number of WUI residences in the United States increased by about 52% from 1970 to 2000 (Theobald and Romme 2007), and in the fire-prone areas of the western Rocky Mountains, 2.2 million WUI homes are expected to exist by 2030—a 40% increase over current levels (OIG 2006). Since many local governments do not regulate growth in these areas or require homeowners to implement wildfire risk mitigation improvements to their land and structures (Shafran 2008), it seems probable that fire suppression costs will continue to escalate in future years as long as the Forest Service continues to bear the financial burden of protecting these homes from wildfire.

The Federal Government is concerned that fire suppression resources are not being used efficiently, and the Forest Service is under substantial pressure to reduce fire suppression expenditure. The 2001 Federal Wildland Fire Management Policy (FWFMP) includes several

statements regarding the need for fire management to be 'economically viable' and 'cost effective'. This policy recognizes ecosystem health benefits of fire, and states that 'economically viable' wildfire management must be based on the values to be protected, including natural and cultural resources, costs of protection and natural resource management objectives (USDI et al. 2001, p. 22). To support federal land management agency implementation of contemporary federal wildfire management policy, price-based decision-support tools must better accommodate non-market benefits and costs of wildfire, including the effects of fire on ecosystem health, conservation of flora and fauna, air quality, wildlife habitat, recreation opportunities, and cultural heritage (USDI et al. 2001; USDI et al. 2005). However, this is extremely difficult because very few studies have been conducted to determine the value that society places on non-market resources at risk from wildfire (Venn and Calkin 2009).

Most of the studies that have assessed changes in social welfare arising from wildfire have utilized the contingent valuation (CV) non-market valuation method, which may not be ideal given that this method reports total rather than marginal willingness to pay (WTP) for an attribute, and because of the many other criticisms associated with the method (Diamond and Hausman 1994). Other studies have combined the travel cost and CV methods to estimate how recreation values change over time in response to wildfire, but these studies do not escape the criticisms associated with CV and only provide value estimates in the context of recreation. The hedonic pricing method (HPM) has been used to derive shadow prices from private home sales for the environmental damage and risk associated with wildfire. However, HPM studies can only capture the effect of recent and nearby wildfire burned areas on the willingness of home-buyers to pay for homes in the WUI. The HPM cannot value disturbances during wildfire events (such

as high levels of smoke) and cannot estimate the change in social welfare from the impacts of wildfire on public goods such as aesthetics and recreation in national forests.

This study utilizes the choice modeling (CM) non-market valuation technique to analyze public preferences for wildfire management in northwestern Montana. CM is recognized by many economists as being less prone to the biases associated with CV (Bennett and Blamey 2001). Additionally, CM allows for the decomposition of the welfare effects of a change in environmental quality into marginal values associated with changes in the environmental attributes being valued. This allows for the estimation of the marginal social rate of tradeoff between market and non-market attributes at risk from wildfire.

1.1 Research Objective and Justification

This study aims to determine public preferences for tradeoffs between attributes at risk from wildfire and to derive marginal value estimates for those attributes. For example, is the general population willing to pay increased levels of state and property taxes to increase the level of Forest Service protection of private property, or would the public be willing to accept the loss of a few homes to free up financial and human resources to better protect other amenities, like commercial timber, environmental health, and recreational opportunities? The Forest Service has continued to prioritize private property protection over natural resource protection with little to no consideration of their respective social values, and a majority of Forest Service managers and staff believe that social or political pressures have required them to give protection priority to private property (OIG 2006). This research will provide fire managers with valuable insight about the value that the general public places on non-marketed resources at risk from wildfire

and the wildfire management tradeoffs that society is willing to make to maximize social welfare.

There are ongoing efforts to develop improved decision support systems for federal wildland fire management, including a spatial framework for displaying resource values at risk suggested by Calkin et al. (2005b) that has been adopted within the new Wildland Fire Decision Support System (WFDSS). This study will generate marginal social value estimates for particular market and non-market attributes at risk from wildfire that could be used in wildfire management decision-support models, such as WFDSS. This would facilitate efficient allocation of resources in pre-season planning, socio-economic evaluation of on-going wildfire events, and ex-post evaluation of wildfire management strategies.

1.2 Layout of the Thesis

Chapter two describes the study area for this research, Flathead County, Montana. It will be shown that Flathead County is an ideal study area for this research because of its numerous market and non-market environmental amenities associated with forest land, the history and prevalence of wildfire on the landscape, the county's changing wildfire regime, and the rapid population growth that has been taking place throughout the county, including within the WUI. The third chapter presents a summary of the effect of fire on forest resources and anthropologic factors. Chapter three also briefly discuses the history of wildfire policy in the United States and provides a review of previous studies that have examined social values of non-market amenities that have been threatened, damaged, or destroyed by wildfire. Chapter four introduces the economic methods used in non-market valuation, discusses the choice-modeling methodology in detail, and includes a review of choice modeling studies that have been conducted within the

natural resource management context. The fifth chapter elaborates on how the choice modeling methodology was utilized for this research, including survey design and development, data collection and analysis, and model specifications. Chapter six presents the results of the analysis, and chapter seven discusses some potential policy implications from this research, suggests potential avenues for future research, and concludes the thesis.

2. THE STUDY AREA: FLATHEAD COUNTY

The purpose of this chapter is to introduce the study area in which this research has been performed. Section 2.1 lists some basic socio-demographic information about Flathead County. Section 2.2 discusses the county's history and economy. Section 2.3 describes the land tenure patterns and natural amenities within the county, and section 2.4 presents a brief synopsis of historic and modern fire regimes specific to the area and vegetation.

2.1 Flathead County Demographic Information

The study area for this research is Flathead County, located in northwest Montana. Countywide, the population increased from 59,218 in 1990, to 74,471 in 2000, representing a 25.8% increase within that 10 year period (US Census Bureau 2009). Flathead County continued to grow to an estimated population of 86,844 in 2007, representing a growth of 16.6% since 2000, which makes Flathead County one of the fastest growing counties in the state (US Census Bureau 2009).

There are three incorporated cities in the county: Kalispell, Whitefish and Columbia Falls. Kalispell, the largest city in Flathead County, had a population of approximately 14,223 in the year 2000, followed by Whitefish and Columbia falls, with populations of 5,032 and 3,645, respectively in 2000. In 2007, Kalispell grew to 20,298 (representing a growth of 42.7% from 2000), while Whitefish and Columbia falls grew by 60.6% and 40.4%, respectively, from the year 2000 (Table 1), making these three cities the fastest growing cities in the state of Montana (Montana Department of Labor and Industry 2009). Flathead County has had the greatest number of new subdivisions approved in the state on an annual basis since 1999 (Jamison 2000, Spence 2005), and the majority of these subdivisions have been within the WUI (Jarvis 2002).

Table 2.1: Population Change in Flathead County

City/County	% Change 2000-2007	July 1, 2007*	July 1, 2005*	July 1, 2003*	July 1, 2001*	Census 2000
Flathead County	16.60%	86,844	82,601	79,194	76,002	74,471
Columbia Falls	40.40%	5,116	4,630	4,162	3,968	3,645
Kalispell	42.70%	20,298	18,463	16,875	15,594	14,223
Whitefish	60.60%	8,083	7,113	6,467	5,940	5,032

*Estimates provided by Montana Department of Labor and Industry (2009).

The median age of Flathead County residents is 39.6 years, whereas the median age of the U.S. is 36.4 (US Census Bureau 2009). This is not surprising, given that a majority of the growth in Flathead County can be attributed to immigration and that the majority of new residents are retirees and middle aged professionals (Flathead County Government 2009). Perhaps the most drastic difference between Flathead County and the United States as a whole is racial composition: 94.7% of Flathead County residents are reported to be white, compared to 74.1% for the United States (US Census Bureau 2009). Flathead County also has a higher level of high school graduates than the national average, with 90.4% of Flathead County residents have at least a high school diploma compared to 84.0% for the United States as a whole (US Census Bureau 2009). However, only 25.1% of Flathead County residents have a bachelors degree or higher, compared to the national average of 27.0% (US Census Bureau 2009).

Table 2.2 summarizes the economic characteristics of Flathead County, Montana, and the United States for 2000 and 2007. In the year 2000, median household income in Flathead County was $34,466 and per capita income was $18,112. This can be compared to a median household income of $33,024 and a per capita income of $17,151 for Montana, and a median household income of $41,994 and a per capita income of $21,587 for the nation (US Census Bureau 2009). The US Census Bureau 2007 estimate of median household income in Flathead County is $45,021, while the per-capita income is $23,296. This compares to the U.S. median household income of $50,007 and the U.S. per capita income of $26,178. Approximately 10% of

Flathead county residents live below the poverty level[1], compared to the national average of 13.3% (US Census Bureau 2009). Labor force participation rates for Flathead County are comparable to that of the U.S., with 64.8% and 64.7% of the population over 16 years of age being employed, respectively (US Census Bureau 2009). Table 2.3 summarizes select results from the US Census Bureau for Flathead County.

Table 2.2: Economic Characteristic Comparison for Flathead County, Montana, and U.S.

	Flathead County (2000)	Montana (2000)	United States (2000)	Flathead County (2007)	Montana (2007)	United States (2007)
Labor Force Participation	64.3%	65.4%	63.9%	64.8%	65.4%	64.7%
Median household income	$34,466	$33,024	$41,994	$45,021	$42,425	$50,007
Per-capita Income	$18,112	$17,151	$21,587	$23,296	$22,152	$26,178
Individuals below Poverty Level	13.0%	14.6%	12.4%	9.9%	14.0%	13.3%

Source: US Census Bureau (2009)

[1] The US Poverty rate is a variable threshold rate that depends on household income and family size. The US Census Bureau provides a thorough definition, available: http://www.census.gov/prod/2003pubs/c2kbr-19.pdf

Table 2.3 Demographic Results for Flathead County

Demographic		**Population**
population		84,693
Gender	Male	49.8%
	Female	50.2%
Age	Under 5 years	6.3%
	5 to 9 years	6.0%
	10 to 14 years	6.7%
	15 to 19 years	7.0%
	20 to 24 years	5.8%
	25 to 29 years	12.5%
	30 to 39 years	13.2%
	40 to 49 years	17.0%
	50 to 59 years	7.5%
	60 to 64 years	5.1%
	65 to 69 years	7.0%
	70 to 79 years	4.1%
	80 years +	2.0%
	Median Age	76.5%
Marital Status		
(Males 15 and older)	Single/Never married	28.5%
	Now married	51%
	Divorced	1.3%
	Separated	2.5%
	Widowed	16.7%
(Females 15 and older)	Single/Never married	23%
	Now married	51.2%
	Divorced	1.7%
	Separated	10.1%
	Widowed	13.9%
Children	Have children under 18	30.3%
Race	White/Caucasian	94.7%
	Black/African American	0.6%
	Native America	2.0%
	Asian	0.6%
	Hispanic/Latino	0.8%
	Other	0.2%

Education	No high school diploma	12.6%
	High school diploma / GED	58.0%
	Associate's degree	7.0%
	Bachelor's degree	16.1%
	Graduate Degree	6.4%
Income	Less than $10,000	6.1%
	$10,000 to $14,999	4.8%
	$15,000 to $24,999	13.9%
	$25,000 to $34,999	12.3%
	$35,000 to $49,999	17.9%
	$50,000 to $74,999	22.4%
	$75,000 to $99,999	11.1%
	$100,000 to $149,999	7.3%
	$150,000 to $199,999	2.2%
	$200,000 +	2.0%
	Mean income (dollars)	$66,777
	Median income (dollars)	$52,420

Source: US Census Bureau (2009)

2.2 History and Economy

The Flathead county area was first settled by three major Native American tribes: the Kootenai, the Pend d'Oreille and the Salish. The land and water in this area was reportedly so fertile that these tribes constantly had to defend their territories from the Blackfeet Indians from the eastern side of the Rocky Mountains (Montana State Government 2008).

Lewis and Clark made their way through Flathead County between 1804-1806 and paved the way for many European fur trappers and traders, who migrated down from Canada between 1800 and 1820 (Montana State Government 2008). In the 1860s, the discovery of gold attracted large groups of miners and cattle ranchers to the valley, who took advantage of large swaths of public land for grazing (Montana State Government 2008). By the 1870s and 1880s, European homesteaders looking to make a new start on 'unclaimed' land began flocking to Flathead Valley and began claiming large parcels of land, even land designated as part of the Indian Reservation (All Glacier 2009). The arrival of the North Pacific Railroad in 1883 significantly contributed to Flathead Valley's growth, and brought passengers and goods from Missoula to the southern shores of Flathead Lake (All Glacier 2009). The discovery of gold, copper, quartz, oil, and coal attracted hoards of miners and prospectors into the area that would eventually become Glacier National Park. In 1910, President Taft signed a bill to create Glacier National Park, which today includes over one million acres, of which approximately half is in Flathead County (Montana State Government 2008). Table 2.4 summarizes employment trends in Flathead County between 2000 and 2007 from the US Census Bureau.

Table 2.4 Employment in Flathead County, Montana

Industry	Employment in 2000	Employment in 2007
Service Industries	41.0%	41.0%
Retail Trade	14.7%	14.1%
Construction	9.4%	15.2%
Manufacturing	11.8%	7.8%
Natural Resource	4.2%	2.9%
Other	18.9%	19.0%
Total	100%	100%

Source: US Census Bureau (2009)

The structure of Flathead County's economy is changing rapidly. During the 19th and 20th century, the economy of the area was tied almost exclusively to extractive industries such as logging, mining, and agriculture, yet these industries have been declining in significance since the recession of the 1980s (Swanson et al. 2003). High rates of immigration, combined with the booming tourism industry, have greatly increased demand for service and retail trade industries. These industries boomed in the early 2000s and accounted for the largest percentages of total employment during that period, with 41.0% of the workforce being employed in service industries and 14.7% in retail trade in the year 2000 (Jarvis 2002). "Service industries" is a broad category that includes many high paying and low paying professions, with the fastest growing services including health services, business services, and food services (Power and Barrett 2001, Swanson 2002). Other service jobs of importance in Flathead County include professional, scientific, waste management, educational, arts, entertainment, recreation, and accommodation services (US Census Bureau 2009). Manufacturing and construction jobs account for the third and fourth largest percentage of total employment in 2000, respectively, with employment in manufacturing at 11.8 % and employment in construction at 9.4% and (US Census Bureau 2009).

By 2007, the economy of Flathead County had become more heavily tied to construction jobs, presumably to keep up with demand for residential developments in the area. In 2007,

construction jobs accounted for 15.2% of employment in Flathead County, while manufacturing jobs accounted for only 7.8% of employment. The proportion of employment in retail trade decreased from 14.7% to 14.1% (US Census Bureau 2009), though given the strong population growth, the number of retail jobs probably increased, even though the proportion declined. Employment in service industries remained at 41% of total employment within Flathead County (US Census Bureau 2009).

Despite the movement towards a service oriented economy in recent years, employment within the natural resource extraction sector is still an important component of the economy of Flathead County. In 2000, the farming, agricultural services, forestry, fishing, and mining industries accounted for 4.2% of employment in Flathead County (US Census Bureau 2009); however, these figures do not include the self-employed (which is a large part of logging) or state and federal employees (Morgan 2009). When the self-employed and state and federal employees are taken into account, Flathead County employed 250 workers in logging and forestry (generating $10 million in wages) and 1,517 workers in wood products manufacturing generating $64.1 million in wages) in 2004 (Morgan 2009). This represented about 57% of Flathead County employment in manufacturing, 62% of manufacturing worker earnings, and an average annual pay that was 107% of the manufacturing average for Flathead County in 2004. According to Morgan (2009), wood products, forestry and logging account for 5% to 10% of total employment and worker earnings in the county, and represent more than half of the manufacturing in the county.

2.3 Land Tenure and Natural Amenities

The communities within Flathead County are a quintessential representation of communities associated with many market and non-market forest amenities. Visitors and new residents are attracted to Flathead County by the numerous natural amenities the county provides, including scenic beauty, access to outdoor recreation, a clean environment, a small-town atmosphere, and wildlife (Power and Barrett 2001, Swanson et al. 2003). Flathead County is also home to the western part of Glacier National Park, which is described as the number-one attraction for visitors to northwest Montana and is considered to be one of the most critical drivers of the local economy, drawing approximately 2 million visitors each year (Swanson et al. 2003, NPS 2009). Figure 2.1 and Table 2.5 illustrate and report land tenure patterns in Flathead County.

Table 2.5 Land Tenure in Flathead County, Montana

Land owner	Hectares	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%
State	67,755	5.0%
Bureau of Indian Affairs	13,826	1.0%
Plum Creek*	105,263	7.7%
Stoltze Lumber Co.*	14,569	1.1%
Other Private land owners*	171,396	12.6%
Water	20,093	1.5%
Flathead County total Area	1361401	100

* Indicates private landholders

Flathead County is the third largest county in Montana encompassing approximately 3,361,230 acres (1,360,241 ha) or 5,252 square miles (Flathead County Planning and Zoning 2009). Flathead County contains portions of four National Forests and two Wilderness Areas: Flathead National Forest, which includes portions of the Great Bear and Bob Marshall Wilderness Areas, has approximately 1,875,545 acres (759,006 ha) within Flathead County and

comprises nearly 55% of the total county acreage (Montana Natural Resource Information System 2009). Other National Forests that have lands within Flathead County are Kootenai National Forest, Lewis and Clark National Forest, and Lolo National Forest, which total approximately 115,390 acres (46,697 ha). Combined, the National Forests and Wilderness Areas comprise approximately 59% of the total acreage of Flathead County (Montana Natural Resource Information System 2009).

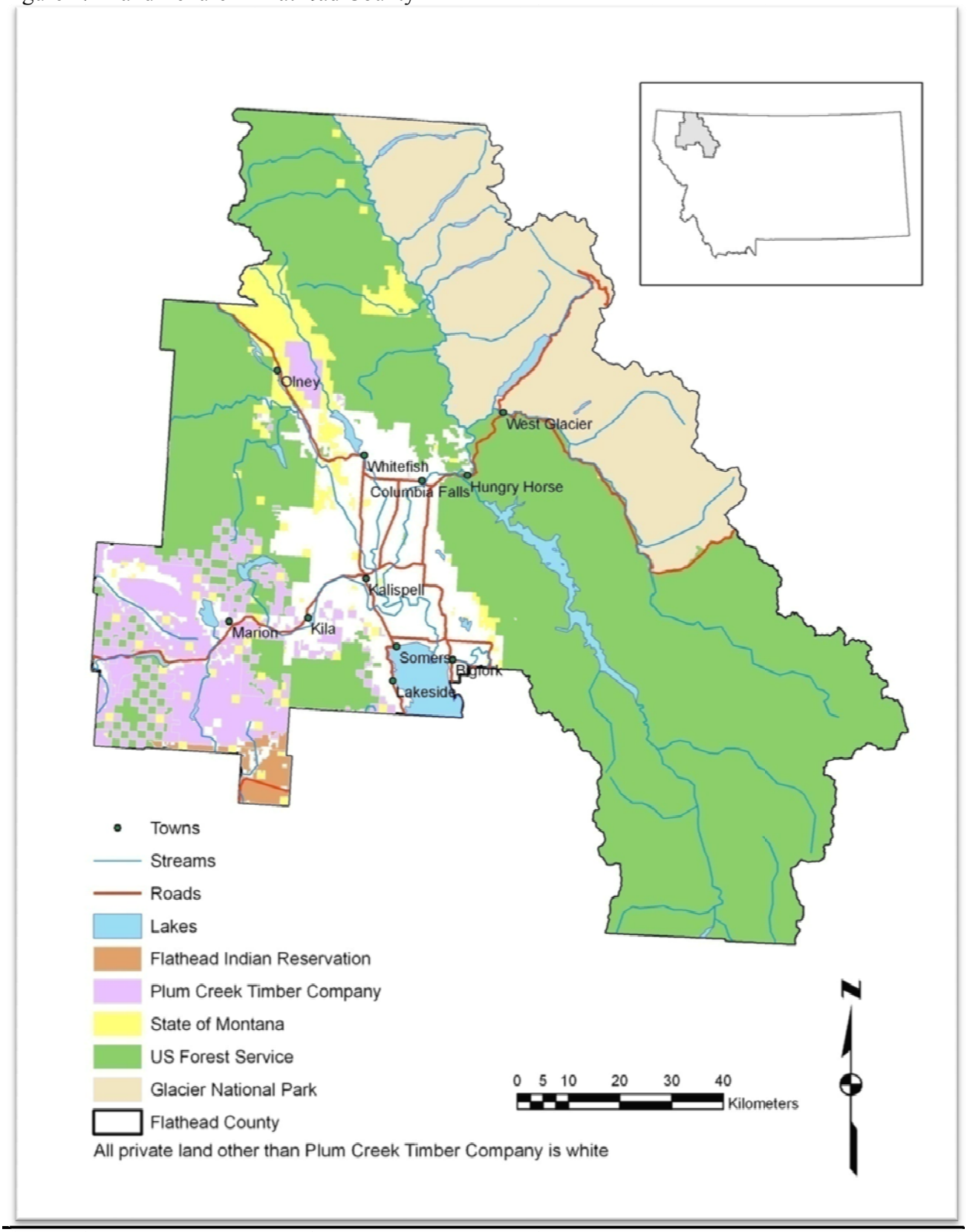
Approximately 635,214 acres (257,062 ha) of Glacier National Park's 1,008,306 acres (408,047 ha) is located in Flathead County, which comprises approximately 19% of the total land mass of the county (National Park Service 2009). Other federally managed lands in Flathead County include the Lost Trail National Wildlife Refuge (7,885 acres (3191 ha)), Swan River National Wildlife Refuge (1,568 acres (635 ha)), and the Flathead, Batavia, McGregor Meadows, Smith Lake and Blasdel Waterfowl Production Areas (totaling 5,189 acres (2,100 ha)) (US FWS 2009). Approximately 29,864 acres (12,086 ha) of The Flathead Indian Reservation is located within Flathead County (Flathead County Planning and Zoning 2009).

Additionally, much of the land area of Flathead County is owned by private timber companies, such as Plum Creek Timber (260,111 acres (105,263 ha)) and Stoltze Lumber Company (36,000 acres (14,569 ha)) (Johnson 2007). While this land is privately owned, the public is allowed to utilize a majority of this land for many recreational activities like hunting, camping, and hiking (Plum Creek Timber 2009). Plum Creek has also joined organizations such as The Nature Conservancy, The Trust for Public Land, and other conservation organizations to manage their land for conservation purposes (Plum Creek Timber 2009).

With so much of the land area of Flathead County being comprised of National Forests, National Parks, Wilderness, and Wildlife reserves, it is no surprise that access to recreation, the sense of 'rural livelihood', and scenic views are thought to be significant contributors to the attractive character of the county (Flathead County Planning and Zoning 2009). In a survey of

Flathead County residents conducted by Flathead County Planning and Zoning (2009), air and water quality were mentioned most frequently as qualities that make Flathead County unique and desirable, as well as a sense of living a 'rural' lifestyle. Many residents expressed a desire to protect the lakes, rivers, ponds, groundwater, open land, and air quality for future generations. Co-habitation of people and wildlife is also a quality that makes Flathead County unique and desirable, according to residents of the county, who said the frequent interaction with and access to wildlife is an important and defining characteristic of Flathead County. Commercial use of timber resources was also a characteristic of Flathead County that many residents wished to see preserved.

Figure 2.1 Land Tenure in Flathead County



2.4 Forest Types, Fire Regimes, and Recent Fires

The natural vegetation of Flathead County is comprised of several forest types, described in Fisher et al. (1998). Ponderosa pine (*Pinus ponderosa*) dominates the lower, arid elevations of the county up to around 1350 m, while western larch (*Larix occidentalis*), whitebark pine (*Pinus albicaulis),* subalpine fir (*Abies lasiocarpa)* and lodgepole pine (*Pinus contorta*) dominate in higher elevations. Douglas-fir (*Pseudotsuga menziesii*) can be found scattered throughout the elevation gradient of the county up to about 2500 m.

The dominant forest types in the study area are mixed mesic forests, mixed subalpine forests and mixed xeric forests (NRIS 2007). Mixed mesic forests are typically located on north, east, and northwest facing aspects at elevations between 550 m and 2625 m where ample moisture is available, and include species such as Douglas-fir, western larch, ponderosa pine, grand fir (*Abies grandis*) and Engelmann spruce *(Picea engelmannii)* (Fisher et al. 1998). Mixed subalpine forests typically occur at higher elevations from 750 m to 3330 m and are characterized by high levels of precipitation in the form of snowfall. Species primarily include lodgepole pine, subalpine fir, Douglas-fir and Engelmann spruce, though whitebark pine can also be found in mixed subalpine forests from 1070 m to 3330 m (Fisher et al. 1998). Mixed xeric forests comprise the dryer, south facing forests at low elevations under 1460 m. The dominant species in these forests are Douglas-fir, ponderosa pine, and Rocky Mountain juniper *(Junicus scopularium)* (Fisher et al. 1998).

A fire regime is the general pattern that fire follows in a particular ecosystem in regard to fuel consumption, spread patterns, intensity, severity, frequency, and seasonality (Bond and Keeley 2005). Major changes to fire regimes alter landscape patterns, processes, and functional linkages. Because fire can have a significant impact on forest resources, changes in fire regimes can have serious long lasting consequences for a forest ecosystem adapted to a particular fire

regime (Brown et al. 2004). These changes can affect vegetation composition and diversity, water systems and aquatic habitat, and animal habitat and composition of faunal communities.

Historically, fires were a common occurrence in northwest American forests due to the presence of Native Americans who managed fire to meet their resource needs, including maintaining open stands for travel, improving hunting opportunities, and supporting agriculture (Agee 1993). Forest communities evolved to thrive in the low-intensity, high frequency fire regime facilitated by Native American settlement that maintained ecological health and diversity, and rarely destroyed old growth trees because of insufficient fuel accumulation (Agee 1993).

After a century of successful fire suppression by federal and state land management agencies, fire regimes have departed from their historical norm (Shang et al. 2007). Fuel levels have increased to a high level, and high intensity, high severity fires are now more likely to occur (Shang et al. 2007, Wang et al. 2007). Agee and Huff (1987) reported that this is due to an accumulation of large fuel sources that, once caught on fire, burn at a high enough intensity to reach the crowns of old growth trees. Fire suppression efforts have led to fires that are more difficult to control and more expensive to fight (Conrad et al. 2001).

The historic fire regime of mixed mesic forests is best characterized as one of moderate-frequency (30-100 years) and mixed-severity burns (NRF 2009). Warmer and drier forests, usually dominated by Douglas-fir, tend to burn more frequently, with some steep and dry slopes having an average return interval of 25-50 years (Pfister et al. 1977, Arno 1980). The warm and wet conditions that prevent many ignitions also encourage dense growth and regeneration within moister forests of this type (Cooper et al. 1991). In general, the longer these productive forests go without fire, the greater probability that fire will carry up into the tree canopies when they do burn. Though stands that burn every 25-50 years may see mostly understory fire, this forest type is predisposed to experience some degree of crown fire, depending on weather conditions and terrain (Arno 1980).

The mixed subalpine forest type, characterized by cool and moist weather conditions, is predominantly characterized by low frequency, high severity wildland fire, with stands having a mean fire return interval of 117 to 139 years (NRF 2009). Dense thickets of fire-sensitive trees develop during long, fire-free periods. Periodic drought then primes these stands for severe, stand replacing wildfires (Pfister et al. 1977, Arno 1980). Because much of the vegetation and debris is likely to burn only under extreme weather conditions, fire patterns within this forest type are largely "weather dominated" (Agee 1997). Lodgepole pine dominated forests, however, are dry enough, on average, to support regular understory fires in addition to stand replacing events (Pfister et al. 1977, Arno 1980). Fires can also be encouraged by mountain pine beetle outbreaks that commonly occur in lodgepole dominated stands (Arno 1980).

The dry, low elevation xeric forests typically experience prolonged dry seasons every year (Agee 1990) and were historically predisposed to a high-frequency (approximately every 30 years), low severity fire regime. Prior to the successful fire exclusion efforts of the past century, live fuels were seldom fire hazards in these forests. In the past, regeneration was checked by fires that revisited stands before many young trees could develop thick, fire-resistant bark and pruned low branches from older, fire-tolerant trees (Brown et al. 2004). As a result, stands usually contained groups of widely-spaced trees, most of which had sparse low foliage. Fire carried largely through the forest understory, and only in rare thickets could it run from treetop to treetop (Arno 1980, Fischer and Bradley 1987, Barret and Arno 1991). After these forests burn, it would take about three years for fuels to re-accumulate to a level capable of carrying another fire (Heyerdahl 1997). However, human activities over the past 150 years have significantly changed the fire regimes of these forests. Heavy livestock grazing depleted fine fuels that carry light and frequent fire, and the fire suppression efforts practiced since 1910 have allowed many of xeric forests to grow ‘unnaturally’ thick with trees (Brown 2004). Consequently, the historically low-severity fire regime in these forests has turned into a high-severity or mixed-severity fire regime

over millions of hectares in the West (Morgan et al. 1996). These higher-severity fires are more likely to kill large trees, have detrimental effects on soils, watersheds, and wildlife habitat, and they can have serious consequences for humans who have settled in and around these forests (Brown et al. 2004).

The Fire Regime Condition Class (FRCC) is a qualitative measure of the degree of departure from historical fire regimes (Schmidt et al. 2002). The first class, FRCC 1, signifies low departure from historical conditions, and includes the higher-elevation mixed subalpine forests in Flathead County. FRCC 2 signifies moderate departure from historical conditions with fire frequencies departing from historic frequencies by one or more return intervals, and includes the mixed mesic forest types in Flathead County. Lastly, FRCC 3 indicates high departure from historic conditions with fire frequencies departing from historic frequencies by multiple return intervals, and includes the mixed xeric forest types in Flathead County (NRF 2009).

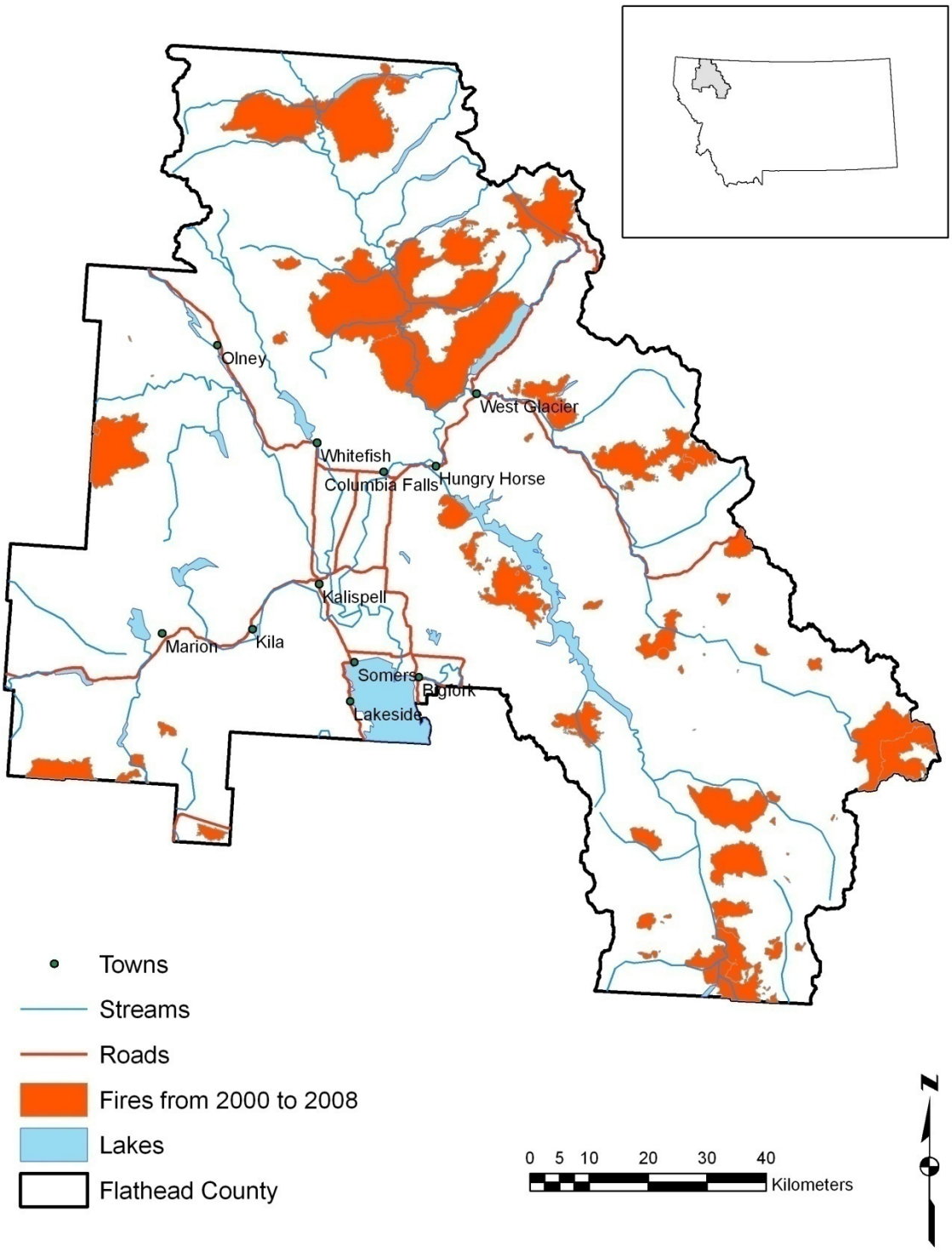
Over the 2003 to 2007 wildfire seasons, about 325,000 acres burned in Flathead County, or approximately 10% of the county. Approximately 295,500 of these acres (91%) burned in large fires greater than 5000 acres (DNRC 2009). Table 2.6 summarizes the number of acres burned in Flathead County in recent years, and figure 2.2 illustrates wildfire prevalence in Flathead County.

Table 2.6: Recent Fire History in Flathead County

Year	Acres
2000	20,998
2001	81,736
2002	17
2003	240,644
2004	0
2005	4,064
2006	2,940
2007	76,482

Source: GIS data USDA (2008)

Figure 2.2 Fire History in Flathead County



2.5 Summary

This chapter presented a brief summary of the environmental and socio-economic characteristics of Flathead County. Due to the area's plethora of non-market and market forest amenities, the areas rapid population growth, and the prevalence of wildfire on the landscape, Flathead County provides an ideal study area to examine social preferences for alternative wildfire management strategies and social willingness to pay to protect non-market forest attributes at risk from wildfire.

3. WILDFIRE ECONOMICS AND POLICY

This chapter sets the ecological, political, and economic context of wildfire in the United States in order to frame the methods applied in this research. Section 3.1 discusses the ecological effects of wildfire on forest resources. Section 3.2 presents a synopsis of wildfire policy in the United States, including the history and evolution of wildfire policy, current wildfire policy, and policy failures. Section 3.3 discusses the economic aspects of wildfire and wildfire management, including economic decision support tools and a review of economic valuation studies that have assessed the value of non-market forest amenities specific to the context of wildfire, and section 3.4 concludes with a summary.

3.1 Effects of Fire on Forest Resources

Fire effects are described as the physical, chemical, and biological impacts of fire on ecosystem resources and the environment (DeBano et al. 1998). Fire induced changes in air quality, water quality, soil properties, and nutrient cycling are commonly referred to as abiotic fire effects, while biotic fire effects include changes in vegetation and impacts on wildlife (FEN 2009). The effect of fire on natural resources is largely dependent upon the characteristics of the resources being affected and the behavior of the fire. Additionally, the role of fire in maintaining ecosystem health and stability is a controversial and highly debated topic, and the long-run (100 + year) temporal effects of fire management and suppression in the United States are not well understood (Busenberg 2004). For these reasons, it is difficult to generalize the effect of fire on many types of forest resources, especially in the long run. Nevertheless, fire is an unavoidable natural process that will always occur within forests, and therefore its effect on natural resources, the environment, and society must be discussed. The remainder of this section will discuss the known effects of fire on air quality, water quality, soil, vegetation, and wildlife.

3.1.1 Air Quality

The most obvious effect of fire on air quality is smoke. Smoke is usually an unwanted side effect of fire and is comprised of airborne solid and liquid particulates and gases, including carbon monoxide and carbon dioxide (Therriault 2001). The exact composition of smoke depends on multiple factors, including the fuel type and moisture content, the fire temperature, and weather conditions (Therriault 2001). Particulate matter is the principal pollutant of concern from wildfire smoke, given the relatively short-term exposures (hours to weeks) typically experienced by the public (Lipsett et al. 2008).

Smoke can facilitate the development or worsening of several health effects within an exposed population. Particulate exposure is the primary cause of health complications resulting from short-term exposure to wildfire smoke. Mild symptoms may include eye and lung irritation, while more serious symptoms include reduced lung function, bronchitis, exacerbation of asthma, and even premature death (Lipsett et al. 2008).

While smoke exposure for most individuals is not likely to lead to long-term health problems (MDEQ 2008), the Montana Department of Environmental Quality (MDEQ 2008) describes specific groups of individuals that are more likely to experience the negative health effects of wildfire smoke. These people, including those with respiratory or heart disease, the elderly and children, should try to limit their exposure to smoke to minimize the risk of smoke-related health problems. Visibility guidelines provided by the MDEQ can be used to determine the risk levels associated with varying levels of smoke to the general public and these sensitive groups (guidelines presented in chapter 5 and Appendix A).

In addition to health effects, wildfire smoke causes many public nuisances. The EPA (1990) defines nuisance smoke as the amount of smoke in the ambient air that interferes with a right or privilege common to members of the public, including the use or enjoyment of public or private resources. This may include visibility loss, pollution and odor. Smoke particles and ash

can accumulate on buildings and other infrastructure, causing physical or aesthetic damage that can become an economic liability for a community (Maler and Wyzga 1976, Baedecker et al. 1991). Reduced visibility can cause safety concerns, especially along highway systems and at airports, and in some cases may lead to prolonged road and runway closures.

Since a major component of wildfire smoke is carbon dioxide and other greenhouse gases, wildfires are thought to be a major contributor to global warming. According to Levine and Cofer (2000), fires account for approximately one-fifth of the total global emissions of carbon dioxide. In addition to this direct contribution of greenhouse gasses, wildfire can indirectly contribute to global warming by destroying flora capable of carbon sequestration. This phenomenon could lead to a continually worsening 'snowball effect' as global temperatures continue to rise, resulting in increased drought and, consequently, increased wildfire activity (Westerling et al. 2006, Keeton et al. 2007).

Brown and Bradshaw (1994) found that, when compared to historic fire regimes, annual smoke emissions have been higher in recent years. This is because the uncharacteristically severe, stand replacing fires common in recent years lead to a greater consumption of fuel per unit area. The same emissions relationship applies for carbon (Venn and Calkin 2008). Since more frequent, less severe wildfires increase the number of natural fuel breaks and can prevent the accumulation of surface and ladder fuels that leads to stand replacing wildfires, and because frequent, low-severity wildfires encourage vigorous vegetation regrowth, more wildfire may reduce carbon emissions from North American forests in the long-run (Venn and Calkin 2008). Models that estimate carbon emissions from wildfires are in development (e.g. Clinton et al. 2006, Page-Dumroese and Jurgensen 2006; de Groot et al. 2007); however, further research is necessary to estimate the spatial and temporal distribution of carbon stored in fire-adapted forests (Venn and Calkin 2008).

3.1.2 Water Quality

The effect of fire on water resources is mixed and largely depends on the characteristics of the fire, the characteristics of the water resource, and seasonal timing. Fire is thought to directly alter water resources by increasing temperature and causing sediment and ash deposition, whereas indirect effects of fire include alterations to channel morphology, turbidity, and increased nutrient levels due to sediment deposition (FEN 2009).

Fire can lead to both short-term increases in water temperature from directly heating water resources, as well as long-term increases by removing canopy cover that protects water surfaces from sunlight. Brooks et al. (1997) found that removal of riparian vegetation around streams can increase water temperature between 4^{o}C and 15^{o}C. Water temperature is an important characteristic of healthy water resources because of the significant effects temperature has on biotic activity, particularly macroinvertebrates, which serve as the primary food source for higher trophic levels (Vannote et al. 1980). Since most aquatic animals are cold blooded, increases in temperature will increase metabolic activity and increase an organisms demand for food and oxygen resources (Gorden et al. 2004). Since oxygen is less soluble at higher temperatures, however, this combination of increased demand and limited supply can have negative impacts on aquatic ecosystems, including ecosystem collapse (Gordon et al. 2004).

Fire can also disrupt the natural nutrient cycles of water systems by destroying the aquatic vegetation that facilitates those services, causing nutrient leaching, volatilization, and transformation of the system (FEN 2009). DeBano et al. (1998) described how fire depletes metals and nutrients such as nitrogen, phosphorous, potassium, calcium, magnesium, copper, iron, manganese and zinc by killing aquatic vegetation or changing terrestrial conditions, while other metals and nutrients like calcium, magnesium, and potassium are converted into oxides and accumulate in ash. Fire retardants and other toxic chemicals used during suppression activities may also accumulate in water systems, causing further ecological damage (FEN 2009).

Water quality is inherently correlated with soil properties, which will be discussed in further detail in the following section. However, it is worthwhile to note that fire events are a major cause of accelerated rates of soil erosion (Brooks et al. 2003), which, when combined with moderate to heavy post-fire rain, can lead to further nutrient accumulation in water stores and can facilitate the flooding of streams and wetlands. High levels of post-fire rain can lead to increases in flood peakflows, which can severely affect stream conditions and habitat quality, and can present dangers to human health and safety (Neary et al. 2005).

3.1.3 Soil

Like other forest resources, the effect of fire on soil varies significantly depending on fire characteristics and the properties of the site being burned. High intensity fires are likely to affect physical properties (such as structure, texture, porosity, and water holding capacity) and biological properties (such as plant roots, microbes, and micro/macro invertebrates) by heating the soil directly (FEN 2009). Soil disturbances arising from a high intensity fire are likely to be more negative and longer lasting, while changes from low-intensity fires (including prescribed burns) are likely to be less severe, and may even be beneficial due to the nutrients added from ash and the moderate heating of organic soil matter (Pritchett and Fischer 1987, Hungerford et al. 1990).

During a fire event, organic substances are moved downward in the soil by vaporization and condensation. This can create a water-repellent soil which increases post-fire runoff and can lead to further soil erosion (FEN 2009). The degree of soil erosion also depends on factors like slope, the amount of vegetation killed, fire severity, soil composition, and post-fire rainfall (FEN 2009). While research consistently indicates that fires do increase erosion rates, the actual rates of soil loss are generally lower than erosion caused by other common forest operations (road building, harvesting, thinning, mechanical site preparation (Yoho 1980, FEN 2009).

3.1.4 Vegetation

The effect of fire on vegetation is largely dependent on fire severity; high temperature and longer exposure is more likely to cause plant mortality. For vascular plants, the growing points (meristems or buds) are extremely vulnerable to damage from fire, especially when they are actively growing and their tissue moisture content is high (Wright and Bailey 1982). Plant mortality depends on the amount of meristematic tissue killed. In some instances, susceptible tissue may not be exposed to heating by fire because it is protected by structures such as bark or bud scales or because it is buried in duff or soil (FEN 2009).

Plant mortality is often the result of injury to several different parts of the plant, such as crown damage coupled with high cambial mortality. Death may not occur for several years and is often associated with the secondary agents of disease, fungus, or insects (FEN 2009).

Rowe (1983) defined a broad biological classification of fire vegetative responses to fire:

1) *Invaders:* Including plants like fireweed and cottonwood, these plants are highly dispersive and thrive in fire-disturbed sites.
2) *Evaders*: Species with long-lived propagules that are stored in the soil or canopy, thus evading elimination from a site.
3) *Avoiders:* Includes species like hemlocks, western juniper, and subalpine fir, these plants have no adaptation to fire and some are likely to be killed in even low-intensity fire. These species take several years to recolonize a burned area.
4) *Resisters:* Thick-barked species that can survive low to medium intensity fire, including Douglas-fir and ponderosa pine.
5) *Endurers:* Species that have the ability to resprout from the root crown, lateral roots, or the aerial crown, including many species of shrubs.

As with mortality, fire severity has a significant effect on the amount of recovery that is likely to occur after a fire event. A low-severity fire that only consumes some of the surface fuels

may kill laterally growing rhizomes, roots near the surface, or stem buds that are not well protected, yet it has little effect on most buried plant parts and can stimulate significant amounts of post-fire sprouting. A high-severity fire, however, removes the duff layer and most of the large woody debris, particularly rotten material. It can eliminate species with regenerative structures in the duff layer, or at the duff-mineral soil interface, and may lethally heat some plant parts in upper soil layers, particularly where concentrations of heavy fuels or thick duff layers are consumed. Any resprouting that does occur on heavily burned microsites can only occur from stolons and rhizomes that recolonize from adjacent areas or from deeply buried plant parts (FEN 2009).

Sprouting is a means by which many plants recover after fire. In woody plants, shoots can originate from dormant buds located on plant parts above the ground surface or from various levels within the litter, duff, and mineral soil layers. Fire initiates regeneration from buds by killing surface plant parts that inhibited their growth. The buds that become shoots are usually those nearest to the part of the plant killed by the fire (FEN 2009). Additionally, reduced understory cover following fire increases the amount of light reaching the surface and warms soil temperature, which encourages sprouting. In general, these changes and an increase in available nutrients are likely lead to increases in density of forbs and grasses after a fire event (Biondini et al. 1989).

Wildfire is also likely to facilitate the spread of invasive plant species through soil disturbances and increases in the amount of light reaching the forest floor, both of which provide favorable conditions for many exotic species (Backer et al. 2004; Charbonneau & Fahrig 2004). Keeley (2006) described how prescribed burning of wildland fuels may in some cases facilitate the establishment of invasive plant species due to the unintentional introduction of invasive seeds or spores by fire fighters and firefighting equipment. Keeley (2006) also documented how some species, such as cheatgrass (*Bromus tectorum* L.) in ponderosa pine forests, are directly

stimulated by fire. Uncharacteristic wildfire may cause some native plants to become locally extinct (Reilly et al. 2006), creating an even more favorable environment for the establishment of non-native species. However, fire may also be an extremely effective management tool to counter the spread of invasive plant species in some cases, especially when combined with an integrated vegetation management system (such as the re-seeding of a burned area with native seeds) (Ditomaso et al. 2006).

3.1.5 Wildlife

Direct effects of fire, including death or injury and emigration or immigration, may cause short-term disturbances to wildlife populations; however, the indirect effect of fire—habitat modification—influences wildlife populations and communities far more substantially (FEN 2009). Fires often cause a short-term increase in productivity, availability, or nutrient content of herbaceous wildlife foods. These short-term increases in wildlife foods can contribute to increases in herbivore populations, which in turn can allow both small and large predators to thrive (FEN 2009). However, these potential increases are moderated by the ability of the animals' to survive in an altered, and often simplified, post-fire habitat. Depending on fire severity, amphibians and reptiles typically illustrate a neutral to positive response, while insect populations typically decline immediately following a fire event, but then increase with the growth of new vegetation (Smith 2000).

Relatively few studies have documented the responses of fish to fire; however, vulnerability of fish to fire is contingent upon the quality of affected habitats, the amount and distribution of habitat (habitat fragmentation), and habitat specificity of the species in question. High intensity fires can severely damage aquatic ecosystems by increasing water temperature and killing fish and other animals or by facilitating high levels of sediment deposition, however, low intensity fires can improve aquatic ecosystems via lower levels of sediment deposition (FEN

2009). Species with narrow habitat requirements in highly degraded and fragmented systems are likely to be most vulnerable to fire and fire-related disturbance (Dunham et al. 2003). Like native fish, fire's effect on non-native fish invasions are poorly understood (Moyle and Light 1996), but limited evidence suggests that fire may facilitate invasion of non-native species by altering the habitat of native species (Dunham et al. 2003).

Many species of animals, particularly birds and insects, require burned ecosystems for their survival. For example, Hutto and Gallo (2006) report that post fire forest habitats are crucial in maintaining endemic levels of cavity nesting birds, such as the black-backed and three-toed woodpecker, while jewel beetles travel from as far as 50 miles away to mate and lay their eggs underneath charred bark (Burton 2004). Fire has also been documented as an important factor in providing food and habitat for the endangered grizzly bear (Zager et al. 1980). In their influential paper describing the intermediate disturbance hypothesis, Fox and Connell (1979) describe how low to moderate disturbances (defined in terms of both severity and frequency of the disturbance) like fire are an important regulator for a mosaic of different habitat and food types that, in turn, sustain a high diversity of plant and wildlife species. Intermediate disturbances are therefore likely to maximize biodiversity.

3.1.6 Recreation

Wildfire can have both positive and negative impacts on forest recreation opportunities. Most of the direct impacts of wildfire on recreation opportunities are likely to be short term, such as trail closures, road closures, and smoke. These direct effects may present an inconvenience to potential recreationists for the duration of the fire season, but are unlikely to affect recreational opportunities in future years. However, in some instances long-term closure of forest roads and trails may occur in badly burned areas due to safety concerns and excessive debris accumulation. Campsites and other amenities may also be destroyed, which may have cultural or sentimental

values associated with them. Wildfire can also deteriorate the aesthetic quality of a forested area, rendering a potential recreation site visually unattractive and therefore a less desirable destination for recreation.

Wildfire can also have many positive effects on forest recreation. Fire can facilitate the growth of wildflowers and grasses which are not only attractive to most forest recreationists, but also provide food to a wide variety of animals. In many cases, this can lead to a more successful wildlife viewing and hunting season. Moderate levels of wildfire may also improve aquatic habitats through sediment deposition, which typically translates into greater fishing success in the long run. Additionally, wildfire can reveal scenic vistas which were previously obstructed by tree cover and open up more land to certain winter recreation activities, like skiing, snowboarding, and snowmobiling.

3.1.7 Infrastructure

Unlike the other subjects discussed above, wildfire will undoubtedly negatively affect the infrastructure that it comes in contact with. Private homes are possibly the most obvious infrastructures at risk from wildfire, but other kinds of infrastructure, such as roads, bridges, power lines, dams, and hydroelectric power turbines can also be damaged or destroyed by wildfire. Additionally, wildfire may damage or destroy water distribution systems and increase debris in waterways, resulting in deteriorated water quality for residential and agricultural purposes following a fire.

3.2 Wildfire Policy

3.2.1 History and Evolution of Wildfire Policy

For almost a century, the central goal of American wildfire policy was to protect natural resources and human communities from damages caused by wildfire (Busenberg 2004). This approach to dealing with wildfire, however, has greatly increased the risk and severity of wildfire associated damages in recent years. Busenberg (2004) contends that there has been a policy failure (defined as cases where policies fail to achieve their central goals) in regard to wildfire in the United States, and that policy errors continue to persist with mounting impacts. The following section discusses the evolution of wildfire policy in the United States.

United States fire policy first began with the passage of the Forest Transfer Act in 1905. This act transferred federally owned forest reserves from the US Department of the Interior to the US Department of Agriculture, which granted the USDA Forest Service responsibility for the management of national forests (Busenberg 2004). The Forest Service established a strategy consistent with the Progressive Conservation Movement, which effectively sought to promote efficient use of natural resources through coordinated, centrally directed decisions made by forestry professionals (Hays 1959). An early focus of the strategy was to protect natural resources from damages caused by wildfires, and Congress gave the Forest Service the fiscal and legal means to pursue wildfire suppression on a national scale (Busenberg 2004).

In 1908, Congress passed Appropriations Bill 35 Stat. 251, which enabled the Forest Service to receive advances of funds to support forest firefighting in emergency cases. This granted the Forest Service the ability to exceed its annual budget for firefighting purposes, after which the Forest Service could ask Congress to pass additional appropriations to cover deficit spending. This allowed the Forest Service to aggressively pursue wildfire suppression throughout the nation, even when the costs of doing so exceeded the annual budget (Pyne 2001). Despite several advocates of low intensity prescribed burning at the time, the Forest Service viewed

prescribed burning as a risky practice and rejected it as a management strategy, instead opting for a policy in which most or all wildfires would be swiftly extinguished to prevent fire damages (Carle 2002).

In 1910 a disastrous fire season in northern Idaho and northwest Montana burned 1.2 million ha, resulted in the deaths of 85 people, and cost $1.1 million (approximately $251 million in 2008 inflation adjusted dollars) (Agee 1993). These fires became a symbol of the Forest Service's war on wildfire and served to perpetuate the perception that wildfires are always harmful and dangerous. After these fires, wildfire suppression became the predominant focus of wildfire policy in the United States (Pyne 2001). The passage of the Weeks Act in 1911 allowed for the purchase of lands in order to adequately protect navigable streams from fire (Agee 1993), and also enabled the Forest Service to cooperate with the states and provide matching funds for fire protection on forested lands in state or private ownership, provided that these lands were located on the watershed of navigable rivers (Busenberg 2004).

In 1924, the Weeks Act was expanded by the Clark-McNary Act, which enabled cooperative fire protection on any timbered or forest producing lands in cooperating states. By this time, cooperative fire suppression was brought to a vast range of forestlands that were not owned by the federal government, as well as other federal agencies managing public lands like the National Park Service (van Wagtendonk 1991). In 1933, the Forest Service made use of the Civilian Conservation Corps (CCC) to build a network of roads, trails, communication lines, fuel breaks, and observation posts in American forestlands, as well as to create large, organized wildland firefighting crews (Andrews 1999; Busenberg 2004). In 1935, the Forest Service set a goal of suppressing all wildfires rapidly with their "10 a.m." policy, which stipulated that a fire was to be contained and controlled by 10 a.m. following the report of a fire, and if that goal should fail, the aim would be to control the fire by 10 a.m. the next day, and so on (Pyne 1982). After World War II, the Forest Service began to use airplanes and helicopters in their

suppression efforts. The Federal Excess Property Program gave the Forest Service the ability to access federal hardware and pass that equipment on to its cooperators (Busenberg 2004).

In the 1960's, research began to surface indicating the important ecological role of fire in recycling nutrients and reducing the risk of high intensity fires. The Department of the Interior accepted the Leopold Report (Leopold et al. 1963), which recognized the important role of fires in national park ecosystems and allowed for some prescribed burning. In 1968, a new fire policy was adopted by the National Park Service that allowed natural fires to burn in some areas and permitted the use of manager-ignited fire in ecosystem restoration, which came to be known as prescribed fire (USDI 1968). Through 1978 the National Park Service and the Forest Service enacted policy reforms that allowed for some prescribed fire under certain conditions. However, during this period (1968-1978), air quality legislation, including the Clean Air Act of 1977, began to change fire liability laws that formerly required slash burning (the burning of debris piles from logging operations) in order to avoid the excessive smoke that the slash fires produced (Carle 2002). In many cases, site objectives became subsidiary to air quality goals for public and private forests (Agee 1993).

The longstanding imbalance between fire suppression and fuel reduction left an important ecological legacy that has created a policy crisis that remains essentially unresolved to this day (Busenberg 2004). Fire regimes have departed from their historical norm, and the accumulation of fuel sources over the course of a century of fire suppression have led to an increased frequency of high severity and high intensity wildfires in recent years (Agee and Huff 1987, Shang et al. 2007, Wang et al. 2007). Fire regimes specific to different forests types in Flathead County are described in chapter 2.

3.2.2 Current Wildfire Policy and Policy Failures

The most current Federal fire policy was developed in 1995, and was further evaluated and updated in the 2001 Review and Update of the Federal Wildland Fire Management Policy (FWFMP) (USDI et al. 2001, NWCG 2009). FWFMP presents 17 policy statements that should guide fire management (NWCG 2009). Some of these statements are summarized below, and all 17 policy statements are presented in Appendix B.

1) Safety: Firefighter and public safety is the first priority. All fire management plans and activities must reflect this commitment.
2) Fire management and ecosystem stability: The full range of fire management activities will be used to achieve ecosystem sustainability including its interrelated ecological, economic, and social components.
3) Response to Wildland Fire: Fire, as a critical natural process, will be integrated into land and resource management plans and activities on a landscape scale, and across agency boundaries. Response to wildland fires is based on ecological, social, and legal consequences of the fire.
4) Use of Wildland Fire: Wildland fire will be used to protect, maintain, and enhance resources and, as nearly as possible, be allowed to function in its natural ecological role. Use of fire will be based on approved Fire Management Plans and will follow specific prescriptions contained in operational plans.
5) Rehabilitation and Restoration: Rehabilitation and restoration efforts will be undertaken to protect and sustain ecosystems, public health, safety, and to help communities protect infrastructure.
6) Protection Priorities: The protection of human life is the single, overriding suppression priority. Setting priorities among protecting human communities and community infrastructure, other property and improvements, and natural and cultural

resources will be done based on the values to be protected, human health and safety, and the costs of protection.

7) Wildland Urban Interface: The operational role of federal and state agencies as partners in the WUI are wildland firefighting, hazard fuels reduction, cooperative prevention and education, and technical assistance. Structural fire suppression is the responsibility of tribal, state, or local governments. Federal agencies may assist with exterior structural protection activities under formal Fire Protection Agreements that specify the mutual responsibilities of the partners, including funding.

17) Evaluation: Agencies will develop and implement a systematic method of evaluation to determine effectiveness of projects through implementation of the 2001 Federal Wildland Fire Management Policy.

As illustrated by these policy points, FWFMP explicitly directs that fire be allowed, as nearly as possible, to function in its natural ecological role to reduce hazardous fuels in the wildlands, and that protection of property and natural/cultural resources (including non-market values) be based on the relative values to be protected and the costs of protection. However, a recent audit report of large fire suppression costs by Office of Inspector General (OIG) of the USDA suggests that, despite these mandates, this policy has largely been ignored by Forest Service managers and staff, who either believed that private property protection continues to have priority over the protection of natural resources, or said that public and political pressures required them to give property protection a higher priority (OIG 2006). According to this report, approximately 87% of Forest Service staff referenced private property protection as a major strategy for suppression effort. The OIG report also states that '50 to 95 percent of the cost for many large wildfire suppression operations are derived directly from protecting private property' (OIG 2006, p.ii), while Liang et al. (2008) found that approximately 37% of wildfire suppression expenditure can be explained by the presence of private property. Property protection continues

to dominate suppression efforts; for example, in a recent wildfire event, suppression objectives relating to private interests were met, while more than half of the known activity areas for endangered species were destroyed because private interests were given priority (OIG 2006). These motives are supported by the work of Liang et al. (2008), who studied recent large wildland fire suppression expenditures by the Forest Service and found that of 16 potential non-managerial factors, only fire size and private land significantly affected suppression expenditure.

3.3 Wildfire Economics

3.3.1 Economic Decision Support Tools

The nature of fire management is fundamentally an economic problem involving tradeoffs, including those between damage costs and mitigation costs, short-run expenditures and investments in long-term treatments, and preparedness versus suppression (Rideout and Hesseln 2001). Until recently, the core economic theory applied to wildfire management was the least cost plus loss (LCPL) model, originally described by Sparhawk (1925). Under this model, the optimal amount of protection was a function of the value of timber lands and private structures being protected and the costs of protecting them, achieved by equalizing marginal damage cost and marginal management cost. The LCPL model has been utilized in the Forest Service's National Fire Management Analysis System (NFMAS) and the Escaped Fire Situation Analysis (EFSA) (Rideout and Hesseln 2001) and was modified in the 1980's to account some of the beneficial effects of fire (Mills and Bratten 1982); however, this model was developed when the primary focus of the Forest Service was timber protection, settlement in the WUI was relatively limited, aggressive suppression was the wildfire policy mandate, and society placed relatively low values on non-market goods and services (Venn and Calkin 2009). Today, this is not the case. Indeed, the Hubbard Report (Review Team 2001) found the suite of price-based fire budget

and planning models, including NFMAS and EFSA, to be inconsistent with the 2001 Federal Wildland Fire Management Policy.

The Fire Program Analysis (FPA) was a decision support tool developed in response to the Hubbard Report that accommodated the full range of market and non-market land management objectives in evaluation of alternative fire management strategies (FPA 2006). The economic evaluation tool they developed, the expert opinion weighted elicitation process (EOWEP), essentially asked fire managers to determine the relative importance of protecting socio-economic and environmental attributes from wildfire, and their decisions dictated protection priorities (Rideout and Ziesler 2005). In effect, EOWEP is a price-based approach with expert judgment being used to derive relative prices in place of economic analysis. Rideout et al. (2008) further described this process for a small planning area in the Southern Sierra Mountains of California, but extension of EOWEP to larger scales may be difficult because of the requirement of a 'numeraire' attribute (e.g. WUI or old-growth) whose value is identical across all planning units (Venn and Calkin in press).

3.3.2 Wildfire Economics Research Review

Most fire economic research in the United States has focused on the monetary costs of suppression and prescribed burning—relatively few studies have been conducted that estimate changes in welfare after a fire event. Of those that have, most of the studies that have been conducted in North America and have focused on recreation values, private property and fuel reductions programs.

3.3.2.1 Recreation Studies

Initial studies on the effect of fire on recreation values, including Vaux et al. (1984), Flowers et al. (1985), Boxall et al. (1996b) and Englin and Cameron (1996) utilized the contingent valuation method and found that large fires have negative impacts on recreation values, but these studies largely failed to account for the temporal effect fire has on recreation values. In order to develop an understanding of these temporal effects, later research combined stated preference and revealed preference methods, as originally proposed by Englin and Cameron (1996).

Englin et al. (2001) used a combination of the travel cost and contingent valuation methods to estimate consumer surplus for hiking trips in Wyoming, Colorado, and Idaho following a fire. They found a positive annual consumer surplus for hikers in the first few years following a fire, which was attributed to the novelty of the burned landscape and increased wildlife and wildflower viewing opportunities. Consumer surplus decreased slowly for about 27 years after the fire, and then increased until steady-state values associated with a mature forest were established. In a similar study, Loomis et al. (2001) estimated temporal effects of crown fires and non-crown fires on the welfare of hikers and bikers in Colorado. They found that consumer surplus for hikers from the year of the fire to 50 years following the fire was much higher after a crown fire than after a non-crown fire or for the pre-fire forest condition, while consumer surplus for mountain bikers decreased after a crown fire. Hesseln et al. (2003) found a decrease of hiker and biker consumer surplus following either a crown or prescribed fire in New Mexico, while Hesslen et al. (2004) found that consumer surplus for hikers and mountain bikers in Montana did not change as a result of either a crown or prescribed fire.

Starbuck et al. (2006) used a pooled travel-cost contingent valuation input-output survey to estimate the effect of fire on recreation for five national forests in New Mexico and then simulated the effect that changes in recreation visits had on the local economy. They found that

catastrophic fires (described in their survey as crown fires that leave a stand of dead, blackened trees with no living vegetation) reduce the number of visits to the forests by 7%, which resulted in a loss of $81 million in output, $36.5 million in earnings (income), and 1941 jobs (authors did not specify if these were part-time or full-time jobs). On the other hand, a low intensity fire led to a 0.673% increase in the number of visits, which resulted in an increase of $7.75 million in output, $3.5 million in earnings, and an increase of 186 jobs. Boxall and Englin (2008) used a combined stated preference-revealed preference technique to model the intertemporal effect of forest regrowth following a fire on recreation values in Nopiming Provincial Park in the Canadian Shield. They found statistically significant negative parameters for areas that had been burned between 1 and 10 years ago, parameters that were not significantly different from 0 after 10 years, and statistically significant positive parameter estimates from between 30 and 65 years following a fire.

3.3.2.2 Private Property and Fuel Reductions

Fried et al. (1999) was among the earliest studies that examined willingness to pay (WTP) for wildfire risk reductions (in the State of Michigan) by employing the contingent valuation method. They found that WUI residents had a median WTP to reduce wildfire risk on private land that ranged between $200 and $500 per annum (depending on risk reduction level), but that median WTP for wildfire risk reduction on public lands was only $24 to $75 per annum. In a similar study, Winter and Fried (2001) found the average WTP of residents within a jack pine forest in Michigan to reduce wildfire risk by 50% to be about $57 per year. Loomis et al. (2005) found that residents of California, Florida and Montana had an average willingness to pay of $417, $305, and $382 (respectively) for prescribed burning programs and $403, $230, and $208 (respectively) for mechanical fire fuel reduction programs to reduce risk to WUI residences and protect forest health, recreation values, water quality and wildlife habitat. In a similar study,

Kaval et al. (2007) used a contingent valuation study to estimate a 90% confidence interval for household WTP for prescribed fire on Colorado public lands and found this to be between $545 and $1583 per annum. The authors suggest that these results indicate that Colorado residents living near public lands are aware that fire is a natural process in their area and are in favor of using prescribed burning for fire risk reduction and the conservation of forest amenities.

Walker et al. (2007) conducted another contingent valuation study for northern Colorado's urban and WUI residents and found that the mean WTP for the prescribed burning program for urban respondents was between $140 and $213 a year, while WUI residents had a mean WTP between $150 and $202. Mean WTP for thinning treatments were substantially higher, at $289-$412 per year for urban respondents and $311-$443 for WUI residents. It is important to note that the WTP of urban and WUI residents was similar for both type of fuel treatments, suggesting that urban respondents are willing to pay to protect forest amenities from wildfire even though they face minimal risk of fire-related property damages.

A small number of studies have examined the effect of wildfires on private property values with the Hedonic Pricing method. Price-Waterhouse Coopers (2001) found a 3% to 11% decline in property values in Los Alamos County, New Mexico following the Cerro Grande Fire. Huggett (2003) examined the effect of the 1994 fires in the Wenatchee National Forest in Washington and found that property prices decreased for residences near burned areas, but that prices recovered six months after the fire. However, Loomis (2004) found that property values had decreased by about 15% five years after the Buffalo Creek Fire in Colorado relative to what they would have been if the fire had not occurred. This was likely reflecting both an increase in the perceived risk of wildfire and a loss of amenity values. Kim and Wells (2005) used the hedonic price model to determine the benefits of fuel reduction treatments reflected in residential housing values in Flagstaff, Arizona. They found that the fuel reduction treatments that reduce wildfire risk by converting high canopy closure (for example, intense low thinning that removes

smaller trees and reduces canopy closure) within a 0.5 km radius of the home would increase property values by about $190 per 1,000 m^2 treated per home, however, the authors contend that the increase in property value likely reflect an increase in the aesthetical quality of the landscape rather than a reduction of wildfire risk.

Stetler et al. (in press) used the HPM to examine the effects of wildfire and environmental amenities on home values in northwestern Montana (Flathead, Lake, Sanders and Lincoln Counties, and the northern portion of Missoula County). Several environmental amenities were found to have significant and positive effects on home prices, including proximity to forests, but proximity to and view of wildfire burned areas had large negative effects on home values. Their model found that homes within 5 km of a wildfire burned area were valued 12.7% ($33,053) lower than an equivalent home at least 20 km from a wildfire burned area, while homes between 5 km and 10 km from a wildfire burned area were valued 7.3% ($18,884) lower than an equivalent home at least 20 km from a wildfire burned area. Having a view of a wildfire burned area decreased the mean sale price of a home by $6,480 relative to a home without a view of a burned area. Whether the decrease in private property values resulting from wildfire is a result of decreased quality in environmental amenities (e.g. aesthetics) or an increase in the perceived risk of wildfire, the results from Stetler et al. (in press) signify that wildfire does indeed have a significant and negative effect on private property values in northwest Montana.

3.3.2.3 Wildlife

Only two studies have been published that examine the social value of the response of wildlife to wildfire. Loomis and Gonzalez-Caban (1998) used a contingent valuation study to estimate the national WTP to protect critical old-growth forest habitat for spotted owls from wildfire in Oregon and California. They estimated average household WTP to protect 2570 acres

of this critical old-growth forest from wildfire to be $56 per household, or $1,662,000 per acre. This estimated total WTP ($4,271,340,000) exceeds the total fire suppression costs of the Forest Service in many recent high cost years, and may be over-stated due to some of the problems associated with the contingent valuation method, that are discussed in chapter 4. Loomis et al. (2002) examined increases in deer hunter welfare as a consequence of prescribed fire in the San Jacinto Ranger District of the San Bernardino National Forest in southern California. They found the initial deer hunting benefits of an additional 1,000 acres of prescribed burning are between $2,674 and $3,128 or $2–3 per acre. These benefits are greatly outweighed by the costs of prescribed burning (Loomis et al. 2002).

3.3.2.4 Smoke and Air Quality

A handful of papers have examined the economic impact of wildfire smoke on human health. Butry et al. (2001) summarized the economic health impacts of the 1998 Florida wildfires. They found that smoke exposure increased asthma-related doctor visits by between 845 and 1635 patients, and additional asthma-related health care expenditures increased by between $325,000 and $700,000. Mott et al. (2002) found that medical visits for respiratory illnesses increased by 217 visits (from 417 to 634 visits, or by 52%) over the previous year after the 1999 fire near the Hoopa Valley National Indian Reservation in northwest California, though the authors did not estimate a monetary value for the increase in visits.

Rittmaster et al. (2006) conducted a study for the 2001 fires in Chisholm, Alberta. They found the health impacts of smoke to be between $4.9 million ($10^{th}$ percentile) and $22.9 million ($90^{th}$ percentile), while other economic costs from the fire included $3 million in damages to bridges and power lines, $10 million in firefighting costs, and $20 million in lost timber. Seventy-five structures were destroyed, including 21 homes, but the authors did not derive an

economic valuation for these losses. Nevertheless, this illustrates that health effects are a significant component of the total economic impact of wildfire (Rittmaster et al. 2006).

Viscusi (1992) conducted a review of 26 'value of statistical life' (society's collective WTP to save one anonymous person's life) studies and found that the average value of mortality benefit of air-pollution control (including wildfire smoke) was $7.6 million (in 2007 inflation adjusted dollars). Dickie and Messman (2004) used a CV approach to estimate adult (18 and over) median WTP to prevent health problems resulting from air-pollution. They found that adults were willing to pay a median value of $202 to prevent a 6-day long acute bronchitis case, and a median value of $90 to prevent an acute respiratory symptom for 1-day.

3.3.2.5 Water Quality, Flooding, and Erosion

Currently, the only measures of economic value for watersheds, wetlands, and soil damaged by wildfire are in the form of spending on rehabilitation projects. Morton et al. (2003) summarized some of these restoration projects for select fires across the United States. For example, the State Government of Colorado spent over $4 million dollars on watershed restoration after the 2002 Hayman fire in Colorado. The watershed provided the city of Denver with more than 60% of its water supply, and restoration efforts focused on preventing erosion and flooding, and on sediment removal. The state of Arizona spent over $5 million on watershed and soil restoration after the 2002 Rodeo-Chediski fire, and the states of Oregon and California spent over $13 million in total on watershed restoration after the Biscuit fire of 2002. While these records may provide important insight of the costs of fire to watershed and soil, it is unclear whether spending on rehabilitation projects can be used as a proxy for the true economic costs of a wildfire on these values (Morton et al. 2003).

A limited amount of research has examined the effect of prescribed fire and wildfire on sediment levels. Wohlgemuth et al. (1999) compared sediment levels in areas that had previously

been prescribed burned prior to a wildfire event and found that one-tenth to one-twentieth as much sediment was produced in the previously prescribed burned areas as compared to areas that had not been prescribed burned prior to the wildfire. Loomis et al. (2003) conducted a multiple regression analysis of fire intervals and resulting sediment yield. They found that prescribed fire intervals of 5 years, as compared to the average fire interval of 22 years, would reduce sediment yield in the southern California watershed within the Angeles National Forest by 2 million cubic meters annually, which would have direct costs savings of $24 million dollars each year.

3.3.2.6 Timber

Wildfire is typically viewed as a natural catastrophe that can hurt timber producers by destroying or damaging timber stands. Since timber is a natural resource with relatively long regeneration periods, a wildfire that destroys a timber stand can leave the producer of that timber in economic ruin. Even timber that is only damaged by wildfire will sell at lower market price than undamaged timber. However, since the damages from wildfire are heterogenous, the economic effect of wildfire to timber producers can vary greatly depending on the nature of the wildfire event (Holmes 1991). For example, while a single wildfire will cause economic damage to a few producers, the timber market as a whole is likely to be unaffected. A large enough wildfire, however, could cause a large enough loss of inventory that market prices for timber are increased (Prestemon and Holmes 2000) and thus the remaining producers may economically benefit at the expense of consumers (Prestemon et al. 2001).

Salvage logging is the practice of logging trees in forest areas that have been damaged by a wildfire or another natural disturbance. While it is unlikely that a damaged timber stand will generate as much revenue as an undamaged timber stand, provisions for salvage logging can be used to justify cutting damaged trees in areas that are otherwise protected from logging, as salvage logging operations may be exempt from many of the environmental laws that restrict

'traditional' logging operations (such as the Endangered Species Act, the Wild and Scenic Rivers Act, the National Forest Management Act, the National Environmental Policy Act, and the Safe Drinking Water Act) in accordance with the "Salvage Rider" bill (PL. 104-19) passed in 1995 by President Clinton (Sampson and DeCoster 1998). Calloway (2008) described how wildfire can actually be beneficial to the logging operations within Flathead County because wildfire can open up acres for salvage logging that would have otherwise been inaccessible. Salvage logging, however, is thought to have many negative ecological effects, including reducing or eliminating biological legacies, modifying rare post-disturbance habitats, influencing wildlife populations, altering community composition (both flora and fauna), impairing natural vegetation recovery, facilitating the colonization of invasive species, altering soil properties and nutrient levels, increasing erosion, modifying hydrological regimes and aquatic ecosystems, and altering patterns of landscape heterogeneity (Lindenmayer and Noss 2006). Recent evidence also suggests that wildfire burned areas that were previously salvage logged and replanted burn more severely than areas that are left to regenerate naturally if another wildfire occurs on the same area. Thompson et al. (2007) examined areas of the Biscuit Fire of 2002 that burned in southwest Oregon and found that fire severity was 16 to 61 percent higher in wildfire-burned areas that were salvage logged and replanted, compared to those that had burned severely 15 years earlier and were left to regenerate naturally.

3.4 Summary

In conclusion, fire is often a controversial and hotly-debated topic with short and long-run biological and anthropological consequences that are still not well understood. In order to provide management strategies to fire managers that are both more economically and socially efficient, a greater comprehension of the social preferences regarding wildfire needs to be attained. Unfortunately, there have been relatively few studies that have examined changes in social welfare as a consequence of wildfire to date, and most of the studies that have been conducted can only provide limited insight of social values because they fail to account for a suite of temporal, ecological, economic, and social concerns.

4. NON-MARKET VALUATION AND THE CHOICE MODELING METHODOLOGY

The purpose of this chapter is to highlight benefits of utilizing the choice modeling method as a means for evaluating society's willingness to pay (WTP) for different amenities associated with the environment. Section 4.1 presents an overview of non-market valuation and introduces economic non-market valuation techniques. Section 4.2 describes choice modeling in detail. Section 4.3 presents some of the relative advantages and disadvantages of the choice modeling method when compared to other non-market valuation methods, particularly the contingent valuation method. Section 4.4 details how a choice modeling study is conducted and includes information pertinent to survey design/development and model estimation. Lastly, section 4.5 presents a review of existing CM applications specific to natural resource management.

4.1 Overview of Non-Market Valuation Techniques

Traditional economics is inherently limited in assuming that markets provide the most reliable measurements of value in society. In reality, people value many things that markets cannot put a price on; our friends and families, our accomplishments, and the quality of our environment are just a few examples of things in life that "money can't buy." Obviously, these things have a value associated with them, yet there is no straight-forward way to measure these values because no market exists for them.

The environment produces many goods and services that are desired by society, and in many cases, it is nearly impossible to create a market that would capture all of the values that the environment provides. For example, Champ et al. (2003) described three direct service flows a forest provides to people. First, forests provide a source of material inputs, such as wood,

minerals, and fish to the economy that can be valued in a relatively straight-forward manner. Second is the provision of life-supporting services such as a breathable atmosphere and a livable climate, otherwise known as ecosystem services. Third, forests provide a wide variety of amenity services, including recreation opportunities, wildlife observation, and aesthetic values. These non-market values cannot be directly observed, yet they are as important to society as market values (Rideout and Hessln 2001). Over-hunting, over-fishing, over-developing, over-grazing, and over-polluting are just a few activities that occur in the environment that affect our interests, yet without solid information about the benefits and costs of these activities, we cannot make good policy decisions about them (Kanninen 2007). In forestry, information on resource values and quantities is essential to rational decision making because the management of both private and public forests involves critical decisions that rely on such information (Rideout and Hessln 2001). There is a trade-off associated with the choices we make in the management of our natural resources; increased utilization or protection of a natural system results in less of something else. In order to effectively manage forest land, forest managers must account for both the market and non-market values in their valuation of forests. Non-market valuation studies attempt to obtain such information.

Economists have devised two primary methods to estimate non-market values. The first involves the analysis of the choices people make in markets specifically related to the non-market value of interest. This is known as the revealed preference approach, and includes the hedonic pricing and travel cost methods. The second involves asking people to state their values for particular non-market goods and services, usually in the form of a questionnaire. This is known as the stated preference approach, and includes contingent valuation and choice modeling.

The fundamental theory behind hedonic pricing is that people value a good because of the different characteristics or attributes of that good, not because they value the good directly (Lancaster 1966). For example, people value the different attributes of a home, like the number of bedrooms and bathrooms, square footage, and lot size rather than the 'home' itself. Statistical analysis can be used to separate the effects of the attributes of the good in a way which demonstrates how changes in the levels of each attribute affect an individual's utility (Garrod and Willis 1999). This can be used to estimate the willingness to pay for each of the attributes independently.

The travel cost approach uses questionnaires to collect information on the costs that people have to pay to get to and recreate at a particular recreation site, and the number of visits they make (Garrod and Willis 1999). Using statistical techniques, a demand curve for the site can be estimated based on the survey results, and ultimately a value of the site can be estimated.

Though revealed preference techniques have been extensively applied and have established theoretical and practical credentials, they have not been able to satisfy all the demands for non-market valuation (Bennett and Blamey 2001). This is largely because these techniques can only be applied in situations where non-market values are associated with some marketed good (usually in the form of a positive or negative externality) and in situations where the market transactions have already transpired and quantitative data has been recorded. When policy makers or resource managers are making management decisions, preferences revealed in the past may have limited relevance. Revealed preference techniques also have limitations in that they can only estimate use vales, like recreational and aesthetic values, but cannot estimate non-use (also called passive use) values. Non-use values, first defined by Krutilla (1967) in a highly influential article, include option value (the value attributed to knowing that resources will be

available for future use), bequest value (the value derived from knowing that the resource will be available to future generations) and existence value (the value obtained by knowing that something exists even if the individual will never use the resource directly). These values cannot be estimated by revealed preference techniques. Carson et al. (2001, pp.100) defined passive use values as, "Those portions of total value that are unobtainable using indirect measurement techniques which rely on observed market behavior."

Stated preference techniques are the second suite of methods used by economists to estimate non-market values. Because respondents are stating their preferences in a hypothetical market, these methods can overcome the limitations associated with revealed preference analysis and estimate non-use values and preferences associated with natural resource management scenarios that have not come to pass. According to Harrison and List (2004), stated preference studies represent an important form of experimentation that lies somewhere along the spectrum between laboratory experiments and observational studies, because these survey based "field experiments" represent a practical mix of control and realism where control comes from the design of the survey sample and the structure of the survey instrument (Kanninen 2007). Currently, the two most popular forms of stated preference valuation are contingent valuation (CV) and choice modeling (CM).

4.1.1 Contingent Valuation

The term contingent valuation is derived from the nature of the method: responses are sought from individuals regarding their preferred actions contingent on the occurrence of a particular hypothetical situation (Garrod and Willis 1999). Davis (1963) was the first to conduct a CV study in his estimation of the value of big game hunting in Maine. CV is a direct approach

to estimate consumer preferences via an appropriately designed questionnaire in which a hypothetical market is described where the good or service in question can be traded (Mitchell and Carson 1989). The CV survey is designed to elicit a willingness to pay (WTP) for the good or service or a willingness to accept compensation (WTA) to relinquish the good or service. For example, a survey might be constructed to estimate a person's WTP to enter a National Park or WTA to allow a nearby company to emit more pollution into the atmosphere. Mitchell and Carson (1989) provided the first attempt to develop detailed recommendations for CV survey design and started a new wave of validity research. They defined three types of validity which must be considered when assessing the validity of a CV study: content validity, which involves whether the measure adequately covers the constructs domain; Criterion validity, which is concerned with whether the measure of the construct is related to other measures which may be regarded as criteria; and construct validity, which involves the degree to which the measure relates to other measures as predicted by theory. Later, Loomis (1993) described three key features which must be included in the hypothetical market: a description of the resource being evaluated, how payment would be made, and elicitation procedure, which refers to how the respondent would bid on the resource.

There are three elicitation procedures common in CV studies. The first, open-ended WTP, was the most commonly used procedure in early CV studies because the answers were straight-forward and easy to analyze. This procedure simply required a respondent to state their maximum WTP or WTA for the good or service. The second procedure, closed-ended iterative bidding, provided respondents with a hypothetical starting price and asked them if they were willing to pay that amount or not. If they answered yes, then the price was raised incrementally until the respondent answered no. Problems began to arise with both the open-ended and closed-

ended iterative bidding procedures when evidence of strategic and protest bidding emerged, where an individual respondent would significantly inflate or deflate their 'true' WTP to sway the results of the survey in the direction they preferred (Diamond and Hausman 1994).

The third procedure, dichotomous choice, is the most recent and involves asking respondents one yes-or-no question about their WTP. In this procedure, there are multiple versions of the CV survey with payment levels that cover a wide range of possible values (e.g. 0 to 100 dollars in 10 dollar increments). Loomis (1988) described a logistic regression that is then used to estimate WTP. However, an increasing number of empirical studies have started to reveal that WTP from dichotomous choice CV studies tend to be significantly larger than open-ended results, probably due to yea-saying (Hanley et al. 2001). Yea-saying occurs when respondents agree to pay the amount they are presented to avoid the embarrassment of saying 'no' (Merino-Castello 2003). Hypothetical bias—the bias that arises when respondents view the survey and their stated payment as hypothetical—also contributes to yea-saying, because respondents recognize that they will probably never have to pay the amount listed in the survey. Hypothetical bias proves to be a problem for all stated-preference survey techniques, and will be discussed in greater detail section in 4.2.1.

Before 1989, contingent valuation studies dominated the stated preference environmental economics literature (Kanninen 2007). Many environmental economists still held that the data derived from CV surveys was legitimate and provided sound estimates of non-market amenity values. However, when the Exxon-Valdez oil tanker spilled 11 million gallons of oil into Prince William Sound, Alaska, and environmental economists were asked to assess the extent of the damages, the CV method was called into question (Kanninen 2007). A 133 page report to the Attorney General of the state of Alaska was prepared by a group of environmental economists

that estimated the loss of non-market values that resulted from the oil spill to be 2.8 billion dollars (Carson et al. 1992). This questionably high estimate of amenity valuation was disputed by the oil companies, who believed the techniques and procedures used in CV were illegitimate and erroneous. They argued that estimates generated by such means were misleading, and forced environmental economists to ask questions about the quality of their data.

Garrod and Willis (1999) suggested that one of the reasons CV studies generate such high WTP values is because of an "embedding effect," where the summation of the value of the individual components of the good exceeds the value when the good is valued holistically. For example, two surveys may be implemented to calculate the WTP for preservation of spotted owl habitat and grizzly bear habitat as separate 'goods', and a separate survey may be used to estimate the WTP for preservation of old growth forest habitat suitable for both spotted owls and grizzly bears. An embedding effect exists if the sum of the WTP for spotted owl habitat and grizzly habitat is considerably greater than the WTP to conserve the old growth forest habitat valued independently.

Another possible explanation for the high WTP values typically obtained by CV studies is the unfamiliarity of the decision making method: most respondents are not accustomed to making value decisions outside of a market. The unfamiliar nature of a simple question like, '*How much would you be willing to pay to conserve grizzly bear habitat?*' may lead to inaccurate estimates of WTP, since most people will have difficulty accurately assessing this value monetarily. Diamond and Hausman (1994) elaborated on more of the problems with the CV method, and concluded that the methodology is deeply flawed and should not be used to make policy decisions. Nevertheless, CV remains a popular environmental valuation method, and the criticisms of the method continue to be addressed by economists.

4.2 The Choice Modeling Method

Partly in response to some of the criticisms of CV, researchers developed a new stated choice methodology called Choice Modeling (CM). Like hedonic pricing, CM utilizes the theory of consumer behavior described by Lancaster (1966). Choice models define goods or services (including policy or management options) as a collection of attributes (usually including a payment mechanism like cost to the consumer), and assign each attribute several alternative levels of achievement. Using an experimental design, the researcher can vary the levels of the attributes to create a series of goods, services, or management options (Kanninen 2007). Typically, two to four of these created options are collated into what is known as a choice set. The respondent then chooses the option that they most prefer. This method draws information from the hypothetical tradeoffs that respondents are making when choosing one good, service, or management option over another, allowing researchers to learn about the preference of use and passive use values, as well as to estimate a "market value" or WTP for those attributes. The resulting sequence of choice outcomes enables the probability of an alternative being chosen to be modeled in terms of the attributes used to describe the alternatives (Bennett and Blamey 2001). The higher the level of a desirable attribute in an alternative, the greater the utility associated with that option would be (*ceteris paribus*) and the more likely the option will be chosen.

Around the same time Lancaster (1966) published his theory of value, Luce and Tukey (1964) wrote about consumer demand being driven by commodity attributes and devised a new measurement technique in mathematical psychology called "conjoint measurement," which decomposed overall judgments regarding a set of complex alternatives into the sum of weights on attributes on the alternatives (Champ et al. 2003). Conjoint analysis became popular in the

field of marketing research, where respondents rated the attractiveness of different products and their preferences were modeled (Cattin and Wittink 1982). This methodology also suffered from several obstacles, however, including the difficulty of respondents ranking large numbers of alternatives, the challenge faced by researchers in making interpersonal comparisons of ranking or rating data, and the theoretical critique that rating tasks involved a departure from the contexts of the choices actually faced by consumers (e.g. consumers do not usually rank goods, they choose whether or not to buy a good) (Morrison et al. 1996). Though modern CM techniques are similar to conjoint techniques, they differ in that conjoint techniques require respondents to rank or rate alternatives, while CM techniques require respondents to choose between alternatives, thus avoiding the critiques associated with the conjoint techniques.

To illustrate that people make decisions based on the many different attributes of a good, examine the example of purchasing an automobile. Many different attributes are considered when purchasing a vehicle, including the model and make, gas mileage, comfort features like air conditioning, and aesthetic attributes like color, wheel design, and decaling. In a choice modeling framework, a researcher could conduct a survey that included all of these attributes. Respondents would then choose from a selection of hypothetical automobiles available for purchase, and their choices could be used to estimate a WTP for different makes, models, comfort features, and even colors of the automobile. Though standard hedonic analysis would allow us to estimate the same things using existing sales data, because the CM analysis can describe innovative new attributes that have not yet been marketed, limit the choice set, and posit hypothetical markets, it offers possibilities for market valuation beyond those available with revealed preference methods (Champ et al. 2003). In an environmental management context, the environmental 'good' of interest (say, for example, a forest) can be compared to the car in the

previous example, and the different amenities that the forest provides (recreation, wildlife habitat, aesthetic value, etc) are the attributes that are valued.

4.3 Advantages and Limitations of Choice Modeling

Choice modeling, like its stated preference counterpart contingent valuation, offer a few major advantages over revealed preference analysis. First, revealed preference (RP) analysis requires some marketed good to be directly correlated with a non-market good. We assume that, ceteris paribus, RP analysis captures the marginal benefit of the non-market good in question; however, there are other possible confounding variables that either may not have been accounted for by the researcher or are impossible to account for, and are thus added into the valuation estimate for the non-market good (e.g. Stetler et al. (in press) estimated the effect of wildfire on property values, but it was unclear whether the loss in property values was due to lost aesthetic valuation or perceived wildfire risk). Since the experimental stimuli are under the control of the researcher in stated preference (SP) analysis, researchers are not burdened by the lack of control afforded by observing the real market place (Champ et al. 2003). Second, SP techniques are not limited to situations in which market transactions have already occurred as revealed preference (RP) techniques are. Since existing market data may be several years old, RP analysis may not reflect current consumer preferences. Third, RP techniques do not allow researchers to estimate non-use values. Non-use forest values are presumably held by more people in society than individuals that have a direct use value for the same forest. Estimation of non-use values are therefore very important in estimating the total non-market value of an environmental amenity to a community. The remainder of this section will be aimed at discussing the relative advantage of the choice modeling method in comparison to the contingent valuation method.

4.3.1 Advantages of the Choice Modeling Method

4.3.1.1 Robust Data

Bennett and Blamey (2001) contend that the most significant strength of the CM technique is its ability to produce a rich database on people's preferences, and to generate statistically robust models of choice. Since the output of a CM application contains considerable information about respondents preferences, CM can produce a model from which demand can be estimated for several different 'goods' or policy options simultaneously, while the CV can only provide estimates for the goods or policy options independently. The ability of the CM method to generate multiple value estimates from a single application is derived from CM's focus on the attributes that constitute a non-market good or policy option, rather than the good or policy option itself (Bennett and Blamey 2001). The prices for the attributes (or the marginal rates of substitution of each attribute) also provide policy makers with detailed information about preferences for management strategies: greater emphasis can be placed on the attributes with the highest price, while the emphasis on attributes with low prices may be reduced or eliminated in future management policies. This is particularly valuable because different management options usually focus on marginal change of attribute levels rather than the total-gain or total loss of non-market values (Champ et al. 2003).

4.3.1.2 Framing

One of the major criticisms of stated preference valuation methods, and particularly the contingent valuation method, is the potential for consumer budget constraints to be violated. This is an unfortunate consequence of the hypothetical nature of stated preference studies, however, there are many advantages particular to the choice modeling method that serve to minimize the

likelihood of these violations occurring. One major advantage lies in the design of the questionnaire: choice modeling studies attempt to minimize violation of consumer budget constraints through a process called 'framing'. Framing is designed to address the problem of respondents giving unrealistic weight toward the issue in question (the embedding effect) by *framing* the issue in an array of substitute and complimentary goods. Since respondents are provided with an adequate amount of 'background information' to ensure that every individual answering the survey has at least some base level of understanding of the environmental problem at hand, basic framing information can easily be incorporated into the survey. Though CV studies may be similarly framed prior to the completion of the questionnaire, CM essentially builds a frame of competing goods and services directly into the choice sets.

An appropriately designed frame will make respondents aware of competing demands for public funds and remind them of their own budget constraint and other potential uses of their money. Carson et al. (2000) stated the importance of framing in affecting individuals' perceptions of their choices. In addition, framing allows for the survey designer to address the potential hypothetical bias—the bias that arises when respondents don't take the survey seriously because they do not think they have to pay any money—by stressing the possibility that the results of the survey may be utilized by policy makers for future management decisions. Lusk and Schroeder (2004) illustrated how statements of accountability can minimize hypothetical bias and lead to more accurate measures of WTP.

4.3.1.3 Familiar Decision Procedure

Another advantage of the choice modeling method is the familiar decision making procedure that respondents use to complete the choice tasks of the survey--dichotomous choice. The contingent valuation method, and particularly open-ended valuation procedures, may be more likely to violate consumer budget constraints because the valuation procedure for CV surveys requires respondents to make hypothetical judgments about their valuation of, or WTP for, the environmental amenity in question. Since consumers are not accustomed to making valuation decisions for a characteristic of the environment, there is concern about the legitimacy of their responses (Diamond and Hausman 1994). However, CM presents consumers with a more familiar method of choosing between alternatives based on their assessment of the value of the attributes of each alternative, including price. Thus, the decision making process consumers are subjected to in CM is the same as in regular consumer markets where the individual has no price setting ability.

4.3.1.4 Strategic Response

In CV, the respondent has the potential to behave strategically or yea-say. Since CM choice sets are not open-ended or "all or nothing", there is less potential for a respondent to behave strategically (Brown et al. 1996; Ready et al. 1996; Hanley et al. 1998). CM also offers the advantage of minimizing the embedding effect inherent with the CV method, since the amenity in question is framed in terms of several different independent attributes and tests of scope (i.e. that willingness to pay increases with the size of the commodity being valued) are essentially built into the method (Bennett and Blamey 2001). CV estimates in many cases cannot be adjusted for a change in the scope of the attribute being valued, and tests for scope effects in

CV involves comparing stated values for different amounts of the attribute. Arrow et al. (1993) recommended that tests of scope be conducted on all CV studies because of their concern about the embedding effect, and in many cases this requirement adds to the cost of CV applications or is not possible (Bennett and Blamey 2001).

4.3.1.5 Experimental Design

Champ et al. (2003) contend that the utilization of statistical design theory in CM yields greater statistical efficiency and eliminates collinearity between explanatory variables. Also, since the same respondent answers multiple different choice sets, tests of consistency can be conducted with CM that cannot be conducted with CVM (Hanley et al. 2001).

4.3.1.6 Benefit Transfer

Stated preference studies can be very expensive and time consuming, and in many situations there are not enough available resources to conduct a study specific to the area of interest. In these instances, it is common to transfer the results of existing non-market valuation studies to the new project to support management or policy making. This process is referred to as benefit transfer, whereby economic information captured at one place and time is used to make inferences about the economic value of environmental goods and services at another place and time (Wilson and Hoehn 2006). However, many concerns about the validity of benefit transfer have been presented in the literature, specifically that the data is sensitive to the context in which they are collected and that differences between study sites or the preferences of respondents from different regions could lead to errors when transferring estimates (Morrison et al. 2002).

Currently, most tests of benefit transfer validity have focused on CV studies (Morrison et al. 2002; Morrison and Bergland 2006). Morrison et al. (2002) contend that one of the major limitations in transferring CV benefit and cost estimates is that CV only values discrete holistic changes in environmental quality specific to the context of its site and population, which makes elicited value estimates less adaptable to other sites. Findings from choice modeling studies may be more amenable to benefit transfer than contingent valuation because of the ability to decompose the welfare effects of a change in environmental quality into marginal values associated with changes in the levels of the individual environmental attributes being valued (Morrison et al. 2002). Estimation of marginal value change better facilitates cost or benefit transfer when the extent of environmental change is different between the non-market valuation study site and the new site.

In a recent review of thirteen choice modeling studies that aimed to test the validity of benefit transfer techniques, Morrison and Bergland (2006) described four main types of benefit transfer and summarized their validity by examining existing cases in the literature. Validity was measured by comparing the equality of parameter estimates, the estimates of implicit prices, and where applicable, the surplus estimates for different valuation studies.

Type 1 benefit transfers occur when there is one study site and estimates are transferred between different populations. Results for these types of benefit transfer were mostly supportive of the validity of transferring implicit prices, however, value transfers may be less appropriate between those living within the study area and those living outside the study area.

Type 2 benefit transfers occur when values for a single population are transferred to multiple sites. Evidence from the existing literature is mostly supportive of the validity of transferring implicit prices for this type of benefit transfer as well.

Type 3 benefit transfers involve transferring values from different, but similar, populations to different but similar sites. These types of transfers are likely to be valid unless the natural resource being valued or the populations sampled are sufficiently different. For example, value estimates for two similar natural resources, such as rivers that provide similar ecological and economic benefits, are likely to be transferable between different rural communities but non-transferable between a rural community and a metropolitan city. Value estimates are also likely to be non-transferable if the natural resource is sufficiently different (rivers that provide different ecological and economic benefits) even if the populations are similar.

Lastly, type 4 benefit transfers involve a transfer of values across different geographic scales, for example, from a local or regional level to national level. This type of study was conducted by Van Bueren and Bennett (2004), and they found that implicit prices at a regional level exceeded the implicit prices at a national level. Therefore, these types of benefit transfer are not supported by the existing literature.

The results from Morrison and Bergland (2006) suggest that CM benefit transfers are likely to be appropriate unless the populations are sufficiently different (e.g. rural and metropolitan populations) the natural resource is sufficiently different (e.g. rivers that provide different ecological and economic services) or the transfer is to a different geographic scale (e.g. transferring value estimates from a regional to a national level). However, sophisticated benefit transfer methods, such as meta-analysis (Bergstrom and Taylor 2006) and Bayesian benefit transfer (Morrison and Bergland 2006) are emerging that may reduce transfer error in these more difficult situations.

4.3.1.7 Data Stacking

CM analysis also presents researchers with a unique opportunity to 'stack' data sets, whereby the data collected in CM surveys can be combined with revealed preference data. While most applicable in marketing research, this procedure can enhance the effectiveness of both SP and RP valuation models (Bennett and Blamey 2001). While data stacking can be performed with both CV and CM data, CM data more closely resemble the market transactions that comprise RP data. Carlsson and Martinsson (2001) conducted an external test of validity of choice modeling by comparing the hypothetical and the actual (revealed) willingness to pay for donations to environmental projects. They found that there was no significant difference in preferences between the hypothetical and the revealed data.

4.3.1.8 Inclusion of the Public

Both CV and CM require public participation in the decision making process, but CM offers respondents a greater degree of participation relative to a CV study. Respondents may feel as if they have a 'stronger voice' in the potential outcome (Bennett and Blamey 2001). This can be attributed the less hypothetical nature of CM surveys compared to CV surveys, increased potential to frame the survey and include statements of accountability, and because respondents make multiple decisions for each CM survey. Additionally, since participants are asked to effectively 'vote' for their preferred management outcomes, they may feel that they are being consulted earlier in the decision making process (Bennett and Blamey 2001). This could also be advantageous to policy makers in fulfilling legislative requirements for public participation.

4.3.1.9 Valuation of Cultural Heritage and Other Non-Use Values

While cultural heritage is difficult to value directly, due to the flexibility of the choice modeling method, it is possible to include attributes in the survey that serve as proxies of cultural heritage. For example, if a choice modeling survey was to be conducted in a rural community with strong cultural values for hunting, fishing and mining, then the survey designer could pose potential changes to these attributes in the questionnaire and derive the community's willingness to pay or willingness to accept for the proposed changes to the attributes. If done carefully and correctly, this will capture the value the community places on these cultural activities. When this information is combined with basic background information, it would be possible to estimate the cultural heritage value for different demographic groups. Given proper survey design, the choice modeling method is also capable of providing estimates for non-use values, like bequest value, option value, and existence value. CV, on the other hand, provides only 'lump sum' valuation estimates, so it is not possible to break those valuation estimates in constituent parts that may comprise cultural heritage.

4.3.2 Disadvantages of the Choice Modeling Method

4.3.2.1 Cognitive Burden

The most significant disadvantage of any stated preference method is the cognitive burden faced by the respondents. In order to complete a choice set, respondents must complete a variety of tasks, including comprehension, construction, translation, and editing (Bennett and Blamey 2001). The cognitive burden faced by respondents in the CM method is considerably larger than the burden of the CV method, since respondents must understand the problem, the attributes, the levels of the attributes, and how different levels of attributes reflect alternative

resource use options. The CM method also requires respondents to make several different responses, and requires the respondent to do a considerable amount of reading before answering the survey.

Cognitive burden can lead to a host of complications. Tversky and Shafir (1992) described how both learning and fatigue effects can occur that may lead to apparently irrational choices, while Adamowicz, Louviere and Swait (1998) explained how, in the presence of complex choices, respondents use heuristics or "rules of thumb" to simplify the decision task. Mazotta and Opaluch (1995) found that increased complexity leads to increased random errors, and Swait and Adamowicz (1996) found an inverted U-shaped relationship between choice complexity and variance of underlying utility amounts, where too simple or too complicated choices resulted in random choice behavior. Chapman and Staelin (1982) and Hausman and Ruud (1987) found evidence of increasing random effects with increased depth of a ranking task, and Ben-Akiva et al. (1991) and Foster and Mourato (1997) detected significant numbers of inconsistent responses even in simple ranking tasks.

4.3.2.2 Framing Challenges

Bennett and Blamey (2001) contend that another major weakness of the CM method is the difficulty of establishing an appropriate frame for the value being estimated. For example, 'framing exercises' only allow a respondent to choose one environment protection option from the array presented, when their actual preference may be to support a number of different options or an option that has not been presented. Also, respondents may wish to divide the amount they are willing to pay overall between varying combinations of the alternatives (Bennett and Blamey 2001). Designing an adequately framed survey is difficult for researchers, because a host of

strong substitutes and compliments must be encompassed within a choice set that remind the respondent of their budget constraint. However, the more information that is provided, the longer and more complicated the survey becomes.

Hanley et al. (2001) described how the welfare estimates obtained with CM are sensitive to the study design. In other words, preference data is significantly impacted by the choice of attributes and the levels used to represent them, the way in which choices are presented to respondents, the background information provided, and other similar design issues. For example, Hanley et al. (2000) found that changing the number of choice tasks produced significant impacts on the model of preferences, while Carson et al. (1997) demonstrated that including more than two alternatives in a choice set provides respondents with an additional degree of freedom in strategic behavior.

4.3.2.3 Technical Complexity

The technical complexity involved in the design and analysis of CM application compared to that of a CV application is another disadvantage (Bennett and Blamey 2001). As discussed above, the structure of the choice sets can present researchers with a unique host of challenges, and economists are largely unfamiliar with experimental design and survey development, since most tend to favor the analysis of existing social data instead of collecting their own data (Bennet and Blamey 2001). The analysis of CM data also requires the utilization of complex multinomial logit models such as nested and random parameters logit, while the CV method utilizes a simpler binomial logit model.

4.3.2.3 Assumptions

Some of the underlying assumptions of the CM method may present other potential weaknesses in CM analysis. For example, the CM method is founded upon Lancaster's (1966) theory of value that states that the value of a whole is equal to the sum of the parts, yet many economists have raised objections about this assumption (Hanley et al. 2001). Some choice experiment studies (e.g. Gleave 2000) have found that values of whole bundles of improvements are valued less than the sum of component values. Also, many economists are debating the degree to which violations of the IIA (independence of irrelative alternatives) assumption impact the technique's viability (Bennett and Blamey 2001).

4.4 Implementation of a Choice Modeling Study

To achieve meaningful models of preferences, WTP, and costs of environmental quality change, Adamowicz et al. (1998b) described 7 steps necessary to conduct a choice modeling survey:

1. Characterization of the decision problem;
2. Attribute and level selection;
3. Experimental design development;
4. Questionnaire development;
5. Sample sizing and data collection;
6. Model estimation; and
7. Policy analysis.

4.4.1 Characterizing the Decision Problem

This step involves clearly identifying the environmental problem at hand and characterizing the problem in terms that will be understood by the respondent. This requires thinking about two key issues: the geographic and temporal scope of the change in environmental quality, and the types of values that are associated with changes in environmental quality (Champ et al. 2003). This requires that the biological relationships of the environmental problem and the geographic region are thoroughly understood and presented to respondents in an understandable fashion. The effective presentation of biological information will require close contact between biological and social scientists and may require an iterative approach to determining appropriate representation and quantification (Adamowicz et al. 1998b).

Once a certain level of familiarity with the problem is obtained, the framework of the CM application must allow the researcher to establish the CM survey in accordance with the concept of marginal change, since environmental policy making is concerned with marginal cost-benefit analysis (Bennett and Blamey 2001). In order for CM results to be consistent with marginal values, the problem must be defined in terms of a change from the 'status quo', where the 'status quo' represents a neutral position. This can include choosing the current scenario instead of opting for different proposed scenarios, or can include choosing not to purchase any of the proposed goods in question. In order to effectively describe the status quo and the proposed alternatives, the researcher must be able to clearly define the problem in question. A strong level of familiarity with the problem will also help ensure that the scenarios presented are understandable and that the respondents have confidence in the authenticity of the proposed alternatives.

4.4.2 Attribute and Level Selection

This step involves identifying the most important attributes of the decision problem, and determining which and how many levels each attribute can take. The attributes are selected to describe or characterize important effects of alternative policies relative to the continuation of the status quo (Bennett and Blamey 2001). Focus groups, or structured conversations with a representative sub-sample of the population of interest, are used to identify the attributes that are most important to the respondents (Champ et al. 2003). Attributes that are relevant to the population of interest are more likely to increase response rate and increase the validity of the responses (Bennett and Blamey 2001). Attributes also need to be consistent with the possible policy decisions that policy makers can choose between in order for the results of the CM study to be useful for policy-making. It is important to limit the number of attributes included in a CM survey to approximately 4-6 independent attributes, including the price attribute (Srinivasan 1982, Erikson and Johansson 1985). Including more than 6 attributes can lead to information overload for the respondents, where individuals are overburdened by too much information and begin simplifying their decision tasks, thus eliciting inaccurate preferences (Wright 1975). Including too few attributes will cause problems with estimation and reliability (Garrod and Willis 1999). Independence of the attributes is necessary to avoid the problem of multicollinearity.

Once the attributes are defined, the levels, or the range over which the attributes vary, must be decided. Levels can be either qualitative or quantitative, but the quantitative expression of levels offers many advantages in modeling and value estimation (Bennett and Blamey 2001). Levels must vary across the attribute realistically, must be large enough to reflect the possible future values the attribute could assume under the possible policy options, and should be feasible

and non-linearly spaced (Hanley et al 2001). The selection of the range of levels for the financial attribute level is particularly important, so it is necessary to establish the upper bound for this level in the focus groups (Bennett and Blamey 2001).

The way that the attributes and their levels are portrayed is also very important; attributes can be described using words or graphic displays like maps, photographs, and line drawings, and often times the extra clarification provided by these visuals is required to enable respondents to fully grasp the implications of the choices offered (Garrod and Willis 1999).

4.4.3 Experimental Design Development

After the attributes and levels have been determined, experimental design procedures are used to construct the alternatives that will be presented to the respondents. Different combinations of attribute levels are called profiles, while a design is a sample of profiles which have a particular set of statistical properties that determines the utility specification that can be estimated (Adamowicz et al. 1998b). In other words, a design is the way the alternatives' levels are set and structured into the choice set (Bennett and Blamey 2001). Since CM studies are particularly useful for their ability to allow the researcher to manipulate the set of explanatory variables associated with the attributes of the environmental valuation problem, the design of the survey determines both the types of effects that can be identified in the data and the interpretation of those effects (Champ et al. 2003). Improperly designed models will result in biased parameter estimates and collinear variables.

For a model to be able to separate out the effects of choice on individual attributes, numerous choices between alternatives which incorporate different combinations of attribute levels will need to be observed (Bennett and Blamey 2001). Bennett and Blamey (2001)

described the 'full factorial' as the array of all possible combinations. For example, if a CM survey had two attributes that each varied over three levels, the full factorial would consist of nine possible combinations (3^2). This is referred to as an L^n design, where L refers to the number of levels and *n* refers to the number of attributes (Champ et al. 2003). As the number of attributes and levels increases, say to 6 and 4, respectively, the size of the full factorial grows rapidly (4^6=4096) and both exceeds the ability of respondents to cope with interpreting that many options and the capacity of the researcher to interpret that many parameter estimates, as well as adding to the computational difficulty of the model. Since it is impossible to present all possible combinations of attributes and levels in most environmental applications, experimental design must be used to identify subsets of possible combinations that will best identify preferences and WTP (Champ et al. 2003). Two strategies are used to overcome this problem: the use of a 'fractional factorial' and the 'blocking' of the experimental design (Bennett and Blamey 2001).

A fractional factorial is simply a subset of the available combinations that comprise the full factorial. Fractional factorials must maintain the orthogonality property of the full factorial, meaning that there is no correlation between the attributes (Bennett and Blamey 2001). The benefit of the fractional factorial is that there are fewer choice sets for respondents to choose between, however, the limited number of combinations makes it difficult to identify all possible interactions between the attributes and the model may not accurately represent the relationships between choice probabilities and attribute levels (Bennett and Blamey 2001). Unfortunately, the sacrifice of information of the fractional factorial design leads to a confounding effect where the effect that one attribute has on utility cannot be separated from the interactive effect that the attribute has on utility. For example, if we have three attributes A, B and C, the effect that A has on utility cannot be separated from the interactive effect that A*C has on utility (Kanninen

2007). To get rid of this confounding effect, we assume that the attributes enter the utility function as independent effects. In other words, we assume the main effects, β_A and β_C, fully describe the impact on utility and that the interactive effect, β_{AC}, has no effect. Fractional factorial designs require that we make this assumption (Kanninen 2007).

An orthogonal main-effects plan sampled from the complete factorial design selects the profiles to be used in the choice experiment and is used to reduce the number of scenario combinations presented so that the coefficients of the main-effects can be estimated (Garrod and Willis 1999, Kanninen 2007). For example, 27 options can be reduced to 9 using a main-effects design (Hanley et al. 2001). These designs are available in specialized software packages like SAS and LIMDEP. The orthogonal matrix design eliminates collinearity between attributes and implies that only strictly additive main effects be evaluated in the choice experiment (Garrod and Willis 1999). Louviere (1988) contended that main effect designs account for as much as 80% of the explained variance in choice models, while second and third-order interactions explained less than 10% of the remaining variation, so the tradeoff between potential bias and reasonably sized designs is not extremely consequential. Simple, main effect designs predict choices fairly well (Kanninen 2007).

An important design feature for statistical efficiency is level balance, meaning that each of the attribute levels occur the same number of times. For example, if an attribute has two levels, A and A', and A occurs four times, it is important to make sure that A' occurs four times as well to ensure that there is an equal number of observations for each attribute level. Imbalance would provide additional information about one parameter at the expense of another (Kanninen 2007).

The second strategy used to handle large numbers of choice sets is blocking, where the fractional factorial is segmented into blocks. For example, if the main-effects fractional factorial called for 30 options, the 30 options could be blocked into 5 blocks of 6 options, 3 blocks of 10 options, 2 blocks of 15 options, etc. When fractional factorials are blocked, each respondent is only responsible for answering one block of the fractional factorial. For example, if the fractional factorial is divided into five blocks, then it will take five respondents to cover all the alternatives that are created under the fractional factorial. There is a tradeoff, therefore, between the number of choice sets, the number of blocks, and sample size.

Once all the alternatives that will be used in the choice sets have been determined, they must be combined together to form complete choice sets. Commonly, two or more alternatives that involve varying attribute levels are compared against a status quo option that stays the same across all choice sets, and experimental design is used to provide the combinations of alternatives (Bennett and Blamey 2001).

4.4.4 Questionnaire Development

The next step of conducting a CM experiment is developing the survey instrument. How the survey is designed will depend on how it will be administered (e.g. mail-out surveys, telephone surveys, and internet surveys), and how the survey is administered is usually based on pragmatic concerns such as geography, characteristics of the population, and budget constraints (Champ et al. 2003).

Bennett and Blamey (2001) described a standardized pattern that CM questionnaires tend to follow:

1) *Introduction:* The purpose of the introduction section is to introduce the respondents to the issue under investigation, explain the purpose of the exercise, and stress the importance of the information being collected so that participation will be encouraged. Other functions of the introduction include stating the credentials of the research team so as to increase respondent confidence, stating respondent selection method (sampling frame), providing contact information so questions can be asked, assuring confidentiality and anonymity, and stating the potential time commitment for completing the survey.
2) *Framing:* The framing section of the survey is designed to address the problem of respondents giving unrealistic weight toward the issue in question by *framing* the issue in an array of substitute and complimentary goods. An appropriately designed frame will make respondents aware of competing demands for public funds and remind them of their own budget constraint and other potential uses of their money. Carson et al. (2000) stated the importance of framing in affecting individuals' perceptions of their choices; if respondents view the process as hypothetical, then their responses will not be economically meaningful.

   One way CM questioning can frame a survey is to ask respondents to rank competing spending options, with one option relating to the issue at hand. This establishes a reference frame in the respondent's minds, and serves as a good "warm-up" question before completing the choice sets. Ranking is especially recommended for the framing section to get the respondents to start thinking about making tradeoffs between competing interests.

3) *Statement of the Issue:* Whereas the purpose of the introduction is to provide a broad picture of the issue at hand to give the respondents a base level of knowledge, section 3 of the questionnaire precisely states the dilemma that is being addressed and describes the severity of the issue. This includes stating some basic details about the environment, such as the current condition and what will happen if the status quo prevails. Sometimes this is accomplished via a separate pamphlet with photographs, graphs, and other illustrative figures and tables.
4) *Statement of a Potential Solution:* In this section, the potential solutions are introduced. This includes illustrating the different attributes and levels that will comprise alternative management strategies and the status quo (possibly using visual aids). A payment mechanism must be introduced here, since the solutions will only be possible if there is funding to pay for them. In order to discourage strategic responding, it is important to state the compulsory nature of the payment attribute.
5) *Introducing Choice Sets:* This section is designed to help respondents understand their task and the choice set questions. Typically, this involves stating that they are having a say in future policy decisions and stresses that peoples' opinions are important to the policy determination. An example of a choice set and a sample answer should be given. Lastly, respondents should again be reminded of their budget constraints to ensure the survey is properly framed.
6) *The Choice Sets:* This section is where the actual choice sets are presented to the respondents. It is important that the choice sets are presented over multiple pages and uncluttered. Babbie (2007) stated that surveys that try to incorporate too much information into one page to minimize the perceived length actually introduce more

error into the responses because respondents may miss questions, fail to understand abbreviations, or be discouraged by the time it takes to complete each page. Surveys that are spread out over multiple pages are less likely to encounter error problems and encourage participation because respondents feel as if they are completing the survey more quickly.

The researcher needs to decide whether or not alternatives should be labeled or unlabeled. A labeled choice set is alternative specific and will relate to the policy that gives rise to the most important attribute. For example, in a forestry survey, options could include 'current policy' '10% increase in forest land' and '10% decrease in forest land'. While labels may serve to easily characterize the most important attribute, they can also lead to respondents making choices based on the label alone without considering the tradeoffs associated with the decision. Generic, or unlabeled, choice sets typically include labeling the alternatives 'current policy' 'option 1' and 'option 2'. Generic labels should be used when the survey is not interested in any one particular attribute. An important component of a CM study is the ability to choose not to choose, or to choose the status quo. This is inherently important because choosing not to choose is an obvious element of real market behavior (Adamowicz et al. 1998b) and individuals should have the option of forgoing all the proposed alternatives to the status quo.

Another decision faced by the researcher is determining how many choice sets to present in the survey. While there are no set rules for handling this issue, Adamowicz et al. (1998b) stated that it is important to consider respondent fatigue by balancing the number of choice sets and the amount of 'learning' (introduction, framing, etc.)

the respondent is faced with. Typically, a CM survey will include around 8 choice sets for the respondent to answer (Adamowicz et al. 1998b). If the survey presents too many choice sets, the whole survey may be rejected or false answers may be given because respondents could answer randomly, take short cuts, or use patterns or heuristics.

7) *Follow-up Questions*: This section includes a series of questions that explore the motivations for responses and ask about problems that respondents faced in dealing with the choice sets. Motivational questions should be designed to pick up responses such as the protesting of the payment vehicle (always choosing the status quo to avoid additional payment) and lexicographic preferences (always choosing a response based on a single characteristic, such as the highest level of one attribute). Other questions designed to determine difficulties respondents had completing the survey can include questions about the understandability of questions, tasks and background material, and whether the information provided was sufficient and plausible or biased and confusing.
8) *Socio-economic and Attitudinal Data:* This section is designed to obtain valuable information about the demographic characteristics of the sample, including age, gender, education, and income and to collect information about attitudinal information pertinent to the survey. This information is used in econometric analysis and to verify that the sample is representative of the population of interest.
9) *Thank You*: A brief section thanking the respondent for their time and reminding them of the value of their input is a courteous way to end the survey.

4.4.5 *Sample Size*

It is necessary to keep in mind a desired sample size while designing a CM survey. Although there are no hard rules that set a particular sample size requirement, Louviere et al. (2000) recommended that there be at least 50 respondents per block of the survey. For example, if a CM survey is blocked into four sections, then there should be approximately 50 respondents for each block, yielding a recommended total of at least 200 respondents. However, Bunch and Batsell (1989) demonstrated that the properties for maximum likelihood-based inferences are satisfied with as few as six respondents per block.

4.4.6 Model Estimation

Once the survey is completed, the data must be coded. Each choice set only provides one data point. For modeling, the choice data must be combined with information about the levels of the attributes of the alternative chosen, the levels of the attributes not chosen, and the socio-economic and attitudinal data relating to the person who made the choice (Bennett and Blamey 2001). For example, for a choice set that has three alternatives, three lines of data are required, where each data line depicts the attribute levels of one of the alternatives, whether or not the alternative was chosen, and the characteristics of the respondent.

The theory used in the estimation of choice models is derived from two major economic theories; Lancaster's characteristics theory of value (Lancaster 1966) and random utility theory. Random utility theory derives from Luce (1959) and McFadden (1973), and is based around an alternative theory of choice to that used to derive conventional demand curves (Bateman et al. 2002).

Random utility theory holds that a person's preferences can be illustrated by the following utility function:

$$U = V + e \tag{4.1}$$

where *U* represents utility, *V* represents the observable (deterministic) component of total utility and *e* represents the unobservable (random) component of total utility.

In choice modeling, respondents are asked to choose between two or more alternative goods (designated by *g* and *h,* where *h* represents all other alternatives), which are differentiated by the levels of their attributes. The respondent compares the two alterative goods, and is assumed to choose the good that maximizes their utility. An error term is introduced because the respondents may assess the options according to information other than that shown (Bateman et al. 2002). Given this error term, predictions cannot be made with absolute certainty, so probabilistic choice must be used to analyze the models. The probability that a respondent (*i*) prefers option *g* in the choice set to any alternative option *h* can be expressed as the probability that the utility associated with option *g* exceeds that associated with all other options, as stated in equation 4.2:

$$\Pr\left[(V_{ig} + e_{ig}) > (V_{ih} + e_{ih})\right] = Pr[(V_{ig} - V_{ih}) > (e_{ih} - e_{ig})] \tag{4.2}$$

This says that respondent *i* will choose option *g* over option *h* if the difference in the deterministic parts of their utilities exceeds the difference in the error parts.

In order to derive an explicit expression for this probability, it is necessary to know the distribution of the error terms (*e*). A typical assumption is that the error terms are IID (independently and identically distributed) with an extreme value (Gumbel) distribution. The Gumbel is similar to the Normal distribution in shape, but the mathematics associated with it are more tractable (Bateman et al. 2002). This distribution is illustrated by equation 4.3:

$$\Pr\,(e_{ij} \leq x) = F(x) = \exp^{-\exp^{x}} \tag{4.3}$$

where *j* refers to the different alternatives in the choice set, exp refers to the mathematical constant *e*, and $x \in (-\infty;+\infty)$.

This distribution of the error term implies that the probability of any particular alternative *g* being chosen as the most preferred of alternatives *j* can be expressed in terms of the logistic distribution model (McFadden 1973). This specification is known as the conditional logit model:

$$\Pr\big(U_{ig} > U_{ij}\big) = \frac{\exp\,(\mu V_{ig})}{\sum_j \exp\,(\mu V_{ij})} \tag{4.4}$$

where μ is a 'scale parameter' which is inversely proportional to the standard deviation of the error distribution. In a single data set, this parameter cannot be separately identified and is therefore implicit in the terms estimated. The value of μ is irrelevant to calculate relative welfare estimates if the utility function is linear in income, since it weights everything the same (Bateman et al. 2002).

If respondents are choosing between two alternatives, then a binary logit model is required; if the respondent is choosing between three or more alternatives, then a multinomial logit (MNL) model is required (Bateman et al. 2002).

The conditional multinomial logit model can be estimated by conventional maximum likelihood procedures using software packages like LIMDEP, Stata® and SAS®. Equation 4.5 states the respective log-liklihood functions used in the estimation, where y_{ij} is an indicator variable which takes a value of one of respondent *i* chose option *j* and zero otherwise:

$$\log L = \sum_{j=1}^{N} \sum_{i=1}^{I} y_{ij} \log \left[\frac{\exp^{(V_{ij})}}{\sum_{i=1}^{I} \exp^{(V_{\mathrm{ij}})}} \right] \tag{4.5}$$

The model is usually specified as being linear-in-parameters. If *X* is a vector of independent variables upon which utility is assumed to depend, and if β is a vector of parameters, then

$$\Pr(choose\ g) = \frac{\exp^{\beta' x_{ig}}}{\sum_j \exp^{\beta' x_{ij}}} \quad (4.6)$$

Socio-economic variables can be included along with choice set attributes, but since they are constant across choice sets for the individual, they can only be entered as interaction terms (Hanley et al. 2001).

An important implication of this specification is that selections for the choice set must obey the Independence from Irrelevant Alternatives (IIA) property. IIA states that adding another alternative does not affect the relative odds of the other alternatives being chosen. In other words, if A is preferred to B out of the choice set {A,B}, then introducing a third alternative X, thus expanding the choice set to {A,B,X}, must not make B preferable to A. This is a typical assumption for many CM studies (Kanninen 2007), however, many examples exist where this assumption may be violated (Debreu 1960; Luce and Suppes 1965; Tversky 1972; McFadden 1974). If violation of the IIA hypothesis is observed, then more complex statistical models are necessary that relax some of the assumptions used. These include the multinomial probit, the nested logit, and the random parameters logit model. IIA can be tested using a procedure suggested by Hausman and McFadden (1984).

The validity of the model can be assessed in three ways: checking for significance of the t-statistics, by making sure the equations estimated accord with any priors established in theory, and by examining the explanatory power of the model using the log-likelihood statistics and the McFadden's R^2 (Bennet and Blamey 2001). The McFadden's R^2 is a pseudo- R^2 measure of fit that is also known as the likelihood-ratio index. It compares the likelihood for the intercept only

model to the likelihood for the model with the predictors (equation 4.7). McFadden's R^2 can be as low as zero but can never equal one (values between .2 and .4 are considered adequate).

$$R^2_{McF} = 1 - \frac{lnL(M_{full})}{lnL(M_{int})} \quad (4.7)$$

4.4.7 Policy Analysis

The final step of the CM process is to present the results of the analysis in a context that is useful to policy makers and natural resource managers. Once the parameter estimates have been obtained, the rate of tradeoff between any two attributes is the ratio of their respective β coefficients. When one of the attributes is the monetary attribute, the trade-off estimated is known as the 'part-worth' or 'implicit price' (Hanley et al. 2001, Kanninen 2007). This is the amount of money that respondents are willing to pay in order to receive an additional unit of the attribute, and is illustrated in equation 4.8, where β_A designates the coefficient on an attribute and β_C designates the coefficient on the monetary attribute.

$$Implicit\ price = -\frac{\widehat{\beta}_A}{\widehat{\beta}_C} \quad (4.8)$$

Estimates of implicit prices are made *ceteris paribus*. These prices can be thought of as measures of the importance of the attributes to the population of interest—high implicit prices suggest that the attribute is relatively important. By comparing the estimates for implicit prices, policy makers are able to design management alternatives that favor the attributes that have higher relative prices.

To calculate the increment to implicit price when there is an interaction variable, equation 4.9 must be used:

$$Increment\ to\ implict\ price\ for\ interaction\ variable = -\frac{\widehat{\beta}_a}{\widehat{\beta}_C + \widehat{\beta}_{Ca}} \quad (4.9)$$

where $\hat{\beta}_a$ equals the coefficient of an attribute interacted with a socio-economic variable and $\hat{\beta}_{Ca}$ equals the coefficient of the cost attribute interacted with the same socio-economic variable. This produces the difference in marginal WTP for that particular socio-economic group from the status quo. To calculate total marginal WTP for the interaction terms, the base case marginal WTP and the interaction marginal WTP must be summed.

Total willingness to pay for each attribute can be estimated using an aggregation formula described by Bateman et al. (2002).

$$Aggregate\ WTP = N * \sum_{i=1}^{n} w_i \hat{WTP}_i \tag{4.10}$$

where N equals the population and w_i equals the analytical weight for each socio-economic variable i. This equation can thus be expanded to the following:

$$TWTP\ X_k = N * [-\frac{1}{\beta_C}\ (\beta_{X_k} + \sum_l \gamma_k \bar{R}_l)] \tag{4.11}$$

where β_{X_k} denotes the coefficient of the attribute, γ_k denotes the coefficient of the attribute interacted with the socio-economic variable, and $\bar{R}_l$ denotes the population mean values of demographic covariates *l*.

Because the CM method results in specification of indirect utility functions and the specification of the indirect utility function will dictate the difference between WTA and WTP, if income effects are assumed to be zero, then we have to assume there is no difference between WTA and WTP[2]. It is standard in CM to assume that there are no income effects, however, if income effects are estimated it is possible to estimate the difference between WTA and WTP (Champ et al. 2003).

Compensating surplus (CS) is described as the amount of money given (taken away) that makes a person as well off as they would be before (after) a change (Bennett and Blamey 2001).

[2] For the purposes of this study, it is assumed that WTP=WTA; however, the discrepancy between WTA and WTP is an issue of considerable debate within the literature (Champ and Loomis 1998, Brown and Gregory 1999).

This can also provide valuable information to policy makers, and is expressed algebraically in equation 4.12.

$$U(\mathrm{M}, 0) = \mathrm{U}(\mathrm{M} - \mathrm{CS}, 1) \tag{4.12}$$

where U is utility, M is income, CS is compensating surplus, and the second argument in the utility function is 0 for the base situation and 1 for the 'changed' situation. CS is the amount of money that is taken away from the person to make the utility with the environmental improvement equal to the utility before the change.

There are two main types of welfare measurements that can be derived from CM applications. The first, 'State of the World' approach, only examines the difference between the utility achieved by the individual under the status quo and some other alternative (Bennett and Blamey 2001). Therefore, it is a means of considering the marginal value of change away from the status quo. Economic surplus (ES) in this case is described by equation 4.13.

$$\mathrm{ES} = -(1/\beta_{\mathrm{C}})\ (\mathrm{U}_1 - \mathrm{U}_2) \tag{4.13}$$

where U_1 represents the utility associated with the status quo option and U_2 represents the utility associated with the alternative. A negative value for this surplus estimate would indicate that respondents are willing to pay the amount of the surplus in order to experience an improvement in their well-being caused by a re-allocation of resources from the status quo to the alternative, while a positive value would indicate that respondents need to be compensated by the indicated amount due to a decrease in their well-being resulting from the re-allocation of resources.

The second type of welfare measurement derived from CM studies is useful when there are multiple alternatives available. The welfare measure involves the expected value of utility arising from each alternative (the utility for each alternative times the probability of choosing each alternative) (Bennett and Blamey 2001). The expected value of the status quo is compared

to the expected value of the alternative case. For MNL models, the expected value across the alternatives can be expressed as the 'log-sum' or $ln \sum_{j=1}^{J} \exp(U_i)$, where 'ln' is the natural logarithm, 'exp' is the mathematical constant 'e', the summation is over all of the alternatives in the choice set and U_i is the conditional indirect utility associated with alternative i, and the superscript 1 indicates the base situation and the superscript 2 indicates the 'changed' situation (Bennett and Blamey 2001). The expression for economic surplus in these cases is described by equation 4.14.

$$ES = -(1/\beta_C)\ (\ln\sum\exp(U_i^1) - \ln\sum\exp(U_i^2)) \quad (4.14)$$

CM applications can also be used to estimate market shares, or the amount of 'support' that any given alternative would generate. The percentage of the total of the utility that was contributed by each of the alternative management options would represent the percentage support that the alternative would generate. This could be used by policy makers to predict voter support that would be generated by alternatives.

4.5 Examples of Choice Modeling Studies That Have Supported Natural Resource Management

Choice Modeling experiments have been used to provide valuable information on public preferences for many different types of natural resource management policies. A review of CM studies that address various natural resource management problems follows.

4.5.1 Recreation-Oriented CM Studies

One of the most common uses of CM is to provide information on public preferences for various recreation-related amenities to help guide more efficient management of recreation

resources. Recreation managers are often interested in how public evaluations or preferences are likely to change as a function of the features of recreation facilities. Understanding how choices are influenced by these changes is useful to making informed policy decisions. Since CM has the ability to consider alternatives that are radical, new, or very different from the status quo, the information provided in a CM study is much more informative than the information provided by revealed preference analysis (Louviere and Timmermans 1990).

Many of the earlier CM studies (e.g. McLeod et al. 1993; Boxall et al. 1996a; Adamowicz et al. 1997; Adamowicz et al. 1998a; Bullock et al. 1998; Boxall & Macnab 2000) examined characteristics of hunting trips that were most valued by the general public. Typically, these surveys included attributes that measured species health and abundance and ease of access to the sites. Several other studies have examined preferences for water-based recreation. Adamowicz et al. (1994) studied management preferences for water based recreation in Alberta, and Oh et al. (2005) examined angler's preferences for management options for coastal waters in Texas.

Other examples of recreation CM studies include Hanley et al. (2001), who conducted a CM study to evaluate public preferences for rock climbing sites in Scotland. Louviere and Woodworth (1985) examined how 15 attributes influenced park choice in Johnston County, Iowa, while Louviere and Hensher (1983) and Hensher and Louviere (1984) who modeled choices among possible international expositions proposed for the Australian bicentennial celebrations in 1988. Louviere and Timmermans (1988) examined recreational choice behavior in the Eindhoven region of The Netherlands, and Morey et al. (2002) examined consumer preferences for mountain biking access and fees. Christie et al. (2007) conducted a CM experiment on different types of forest recreationists (cyclists, horse riders, nature watchers, and

general forest users) in Great Britain, while Lindberg and Fredman (2005) conducted a CM experiment on different types of winter recreationists in Scandinavia (snowmobilers and cross-country skiers) to determine how WTP for different attributes of the destination varied between user groups.

While the studies above illustrate public preferences for specific recreation activities, other studies have used choice modeling to illustrate how changes in characteristics of a natural environment will affect recreation preferences. Nielsen et al. (2007) examined the effect of variation in forest diversity, including tree species composition, tree height structure, and presence of dead trees left for natural decay on public preferences for forest recreation. Lawson & Manning (2002), Lawson & Manning (2003), and Newman et al. (2005) studied visitor preferences concerning tradeoffs between social, resource, and managerial conditions of backcountry campsites and trails, while Cahill, Marion & Lawson (in press) looked at similar tradeoffs for front-country trails. Unbehaun et al. (2008) surveyed climate change impacts on winter sport tourists' activity and destination choice to estimate shifts in customer demand and to provide recommendations and decision support for destination management. Bullock and Lawson (2008) assessed visitors' preferences for alternative management options for the "commons" of Cadillac Mountain of Acadia National Park. Crouch et al. (2007) used a choice modeling experiment to examine the decisions of consumers to spend money on recreational tourism relative to other potential uses of their monetary resources.

4.5.2 Water Quality and Supply Management

Though many existing choice modeling studies have focused on the management of recreation resources, another common use of the CM methodology has been to address different

management options for wetland and water management. The following examples are illustrative of recent applications of CM to water management issues.

Birol et al. (2006a) used a CM study to examine public preferences for several efficient and sustainable wetland management policies in accordance with the Ramsar convention and the European Union Water Framework Directive for the Chimaditida wetland in Greece. Birol & Cox (2007) used a similar approach to investigate several proposed wetland management programs for the Severn Wetland Estuary in the UK. A CM analysis was used by Bennett et al. (2001) to look at preferences for wetland protection in the Macquarie Marshes in central western New South Wales, Australia, when different management options had the potential to affect jobs and regional income. In a similar analysis, Carlsson et al. (2003) examined which attributes of wetland management have the biggest positive impact on public welfare. Burton et al. (2000) studied public preferences for catchment management plans in the Moore Catchment in Austrailia, and Hanley et al. (2006) examined the value of improvements in river Ecology within the European Union. In order to assess different management options for the water supply of Canberra, Australia, which was experiencing difficulty meeting demand for water under the current management trends, Blamey et al. (1999) and Gordon et al. (2001) conducted a CM experiment to help policy makers arrive at a socially desirable management alternative. Torpen & Hearne (2008) looked at stakeholder's preferences for water management alternatives in the Red River Basin in the United States and Canada. The CM methodology has also been used to address management options for controlling water pollution and quality: Herberling et al. (2000) studied preferences for reducing pollution from acid mine drainages in western and central Pennsylvania, and Abou-Ali and Carlsson (2004) examined preferences for improvements in human health and disease prevention via improved water quality.

4.5.3 Wildlife and Biodiversity Conservation

Several CM studies have examined preferences for wildlife and biodiversity conservation, but most of the existing studies only included conservation as a single attribute amidst a host of other distinctly separate attributes. Nevertheless, a few studies have devoted entire CM studies to examining preferences for different wildlife and biodiversity conservation management strategies. Garber-Yonts et al. (2004) looked at public preferences for different biodiversity conservation policies in the Oregon coast range, and Horne, Boxall and Adamowicz (2005) estimated the value of biodiversity of forest stands for recreational forests in Finland. Sorice et al. (2005) examined scuba divers preferences for coral reef conservation in Texas, and Hanley et al. (2003) used a CM analysis to look at wild geese conservation strategies in Scotland.

4.5.4 Soil Erosion, Agriculture, and Farming

The CM methodology has also been used to address several management issues regarding soil erosion, agriculture, and farming. For example, Colombo et al. (2005) examined the importance of on-site private costs and off-site social costs to design efficient erosion management policies. Birol et al. (2006b) used a CM to estimate farmers' valuation of agrobiodiversity on Hungarian small farms, while Zander and Drucker (2008) conducted a CM experiment with local livestock breeders in Eastern Africa to determine local preferences for different breeds of cattle and the different characteristics associated with them. Hanley et al. (2007) used a choice experiment study to estimate willingness to pay for different landscape features in four severely disadvantaged areas (areas where farming is more difficult because of poor climate, soils and terrain) of England.

4.5.5 Waste Management

CM applications have also been used to design waste-management policies. Jin et al. (2006) looked at alternative solid waste management policy changes in Macao, China, where solid waste accumulation was creating a host of environmental and health problems. In another example, Hiselius (2005) examined public preferences for railway transport of hazardous materials.

4.5.6 Green Products and Services

Other environmental applications of the CM method have examined the demand for 'green' (environmentally friendly) services and products. Bergmann et al. (2006) looked at the public value and demand for attributes of renewable energy investments in Scotland, while Brey et al. (2007) estimated the value of CO_2 sequestration (in addition to recreation amenities and the consequences of soil erosion) for an afforestation program in northeastern Spain. In a more traditional marketing CM analysis, Blamey et al. (2001) estimated demand for different types of environmentally friendly toilet paper.

4.5.7 Environmental Quality Applications

There are several examples in the CM literature that are related to environmental management issues, but do not fit into any of the categories mentioned above. For example, Carlsson et al. (2004) analyzed marginal willingness to pay for changes in noise levels related to changes in the volume of flight movements at a city airport in Stockholm, Sweden. Diener et al. (1998) estimated willingness to pay for improved air quality in Hamilton-Wentworth in southern Ontario. A CM experiment has even been used to estimate the value of reducing several different

types of mortality risks, including those associated with environmental quality. This information was used to calculate the "Quantity-based" Value of a Statistical Life (Tsuge et al. 2005).

4.6 Summary

Society values many goods and services that cannot be measured via traditional economic methods. Economists have developed several methodologies for estimating non-market values, including multiple revealed preference and stated preference techniques. The choice modeling method is a relatively new economic tool that allows for estimation of both use and non-use values, and while it is clear that the choice modeling method is not without flaw, it is also apparent that the technique has some advantages over revealed preference techniques (e.g. ability to estimate passive-use values) and contingent valuation (e.g. fewer and less prominent biases). Moreover, many of the problems associated with the technique are amenable to research (Bennett and Blamey 2001). That research should focus on improving the accessibility of the technique to practitioners and policy makers and work toward lowering the 'technical hurdles'.

This chapter has presented a detailed overview of the choice modeling method, and has highlighted several applications of the method specific to natural resource management. While these studies have provided a valuable context for which this study has been conducted, this study is unique in that it is the first study to apply a CM framework to the complex problem of wildfire management. Given the wide variety of management issues for which choice modeling has previously been applied, and the possibility to estimate passive-use values that cannot be estimated with revealed preference techniques, CM is the best method to estimate social values for amenities at risk from wildfire in northwest Montana.

5. APPLICATION OF CHOICE MODELING TO NORTHWESTERN MONTANA

This chapter explains how the survey and the choice models were developed and applied to Flathead County. The first two sections describe how the questionnaire was developed and how data were collected, with section 5.1 discussing attribute and level selection, and section 5.2 discussing survey design, survey testing, and data collection. In section 5.3, the variables used in the choice models are explained, and in section 5.4 the choice models are analyzed and applied to Flathead County.

5.1 Attribute and Level Selection

In order to determine a list of amenities at risk from wildfire that were most 'important' to residents of Flathead County, a focus group was held in April of 2008. This meeting, held in Kalispell, Montana, included representatives from several key stakeholder groups, including the USDA Forest Service and Flathead County Sheriff's Office (see Appendix C for a full list of focus group participants). The first half of this meeting was spent bringing focus group members up to speed with the management problem this study addresses and introducing the participants to the choice modeling methodology. After the participants were briefed on this information, the participants were asked to list several attributes at risk from wildfire that they felt were important to Flathead County residents. After much discussion, the group agreed on the following list of the six attributes they felt were most important:

1) The number of homes requiring evacuation;
2) Acres of timber land burned by wildfire;
3) Number of smoky days during the fire season;

4) Effect of wildfire on recreation opportunities;
5) Forest and watershed health; and
6) Cost to the respondent to manage wildfire fires in Flathead County.

Focus group participants also identified a list of several demographic and 'warm up' questions to be included in the survey, however, there was insufficient time to discuss level selection for the selected attributes at this first focus group meeting. Ongoing E-mail communications with several focus group members assisted in quantification and level selection for the six selected attributes. Alternate wildfire management strategies are likely to require several years to affect wildfire behavior and the effect wildfire has on resources, therefore, it was decided that levels for all attributes should be described as average expected per-year outcomes for the next ten years. While an appropriate timeframe for Montana may be greater than 10 years, 10 years was chosen in the interest of having a timeframe that is relevant and meaningful for the average respondent. The attributes and their quantification are now discussed.

5.1.1 The Number of Homes Requiring Evacuation

This attribute was selected to assess the perceived social value of protecting homes from wildfire. It was recommended by focus group participants that this attribute be quantified as the number of homes requiring evacuation rather than the number of homes destroyed by wildfire, since no homes have been destroyed by wildfire in Flathead County since 1988 (Chute 2008). Chute (2008) determined that the number of home evacuations in Flathead County due to the threat of wildfire in 2007 was 130 homes. Chute asserted that 2007 was a representative year for

wildfire related home evacuations in Flathead County in recent years, and 130 homes was adopted as the "status quo" for this attribute in the choice sets.

In recent years, large fires have threatened an increasing number of WUI residences, and more Forest Service resources have been devoted to structure protection (OIG 2006). This attribute, therefore, was thought to be especially pertinent to policy makers within the Forest Service and other wildfire management agencies. Six levels were included in the final versions of the questionnaire: 70, 100, 130, 170, 260, and 400, with the 400 level designed as a 'choke' level to test sensitivity to this attribute. These levels were approved for use in the survey by the members of the focus group.

5.1.2 Acres of Timberland Burned by Wildfire

Given the importance of timber extraction to the economy of Flathead County, it is not surprising that focus group participants identified this attribute as likely one of the most important attributes to residents of Flathead County.

In order to quantify this attribute, the number of acres of private, state, and 'suitable base' (timber harvest is the dominant use) Forest Service land was assessed. It was found that only 132 acres of private and state timberland were burned on average each year by wildfire between 2003-2007 (DNRC 2009). Cathy Calloway, a Forest Silviculturalist from the Flathead National Forest, calculated that 85,636 acres of suitable base forest service lands burned between 2000-2007 in Flathead County. This averaged to be 12,234 acres of suitable base Forest Service land burned per year (Calloway 2008). The average number of acres of private, state, and federal timberland burned per year was summed, which produced the status quo level of 12,600 acres of

timberland burned per year in Flathead County. Three alternative levels were included in the final version of the choice modeling survey: 7,500 acres, 10,000 acres, and 15,000 acres.

5.1.3 Number of Smokey Days During the Fire Season

This attribute was thought to be the most important wildfire attribute to residents of Flathead County by many of the focus group participants. Smoke, like wildfire, can occur at various severity levels, and it was hypothesized that social preferences would differ depending on the severity of the smoke. Thus, this attribute included two different severities of smoke: moderate smoke and unhealthy smoke.

The Montana Department of Environmental Quality (MDEQ 2008) describes several levels of health effect categories for wildfire smoke and the visibility guidelines associated with each category (available in Appendix A). Their website also contains an archived database of smoke updates, which (at the time of questionnaire development) contained the number of smoky days by health effect category for the 2005-2007 fire seasons.

For the purposes of our study, 'moderate smoke' included both the 'moderate' and 'unhealthy for sensitive groups' health effect categories from MDEQ. Adapting the MDEQ definitions for 'moderate' and 'unhealthy for sensitive groups' smoke levels, 'moderate smoke' was defined as smoke that can been seen and may be smelled, and poses a health risk to sensitive individuals, including those with lung, heart, or reparatory diseases, the elderly, and children. Visibility for 'moderate smoke' ranged between 5 and 13 miles. The 'unhealthy smoke' category in our study included the 'unhealthy' and 'very unhealthy' health effect categories from MDEQ. Adapting the MDEQ definitions for these two categories, 'unhealthy smoke' was defined as smoke that can affect the respiratory health of the general population and significantly increase

health effects for sensitive individuals. Visibility for unhealthy smoke ranged between 2 and 5 miles.

Using the data archived for 2005-2007 for the city of Kalispell in Flathead County, the average number of 'moderate' and 'unhealthy' smoky days per year was calculated to be 25 and 6, respectively. The focus group participants agreed to adopt these levels as the status quo for Flathead County. Four levels of smoke were included in the final versions of the questionnaire, which were presented as the average number of moderate/unhealthy smoky days per year for the next 10 years: 25/6, 25/1, 50/6, 50/1. For example, 25/1 would imply 25 days of moderate smoke and 1 day of unhealthy smoke each year for the next 10 years.

5.1.4 Effect on Recreation Opportunities

The potential effect of fire on recreation was highlighted by the focus group as being particularly important to residents of Flathead County. Much of the county's economy is tied to summer tourism, which is heavily associated with outdoor recreation (Flathead County Planning and Zoning 2009).

Since people enjoy many different types of outdoor recreation activities, it was difficult to quantify this variable. For example, wildfire can negatively affect recreation opportunities by closing forest roads, hiking trails, and fishing and floating areas, leading to the prohibition of campfires due to associated wildfire risk, and increasing exposure to smoke. Fire can also have substantial long-run impacts on recreation, if, for example, a favorite recreation destination is burned by wildfire, or trails and roads are closed for many years because of safety concerns due to snags and unstable roads or trails. However, wildfire may also encourage wildflower growth and create new scenic views previously obstructed by tree cover. Increased browse availability

and decreased tree density usually leads to greater hunting success, and a burned forest might open more terrain to snowmobiling and skiing.

The original intent was to quantify this attribute as the number of forest acres closed each year to recreation due to wildfire or its associated effects. While most forests have records of the number of acres of forestland burned by wildfire, most forests did not have records of the number of acres of forestland closed to recreation, so a 'status quo' level proved impossible to obtain. Moreover, the 'area closed' quantification might facilitate an unintended negative perception of wildfire effects within the respondent and distract from the potential positive effects that wildfire can have on recreation.

In order to overcome these two difficulties, this attribute was quantified as the "chance per year that your forest recreation opportunities will be substantially affected by wildfire." With the help of focus group participants, we estimated that approximately 15% of recreation plans have been substantially affected by wildfire each year in recent years, which became the status quo for this attribute. Three other levels were selected: 5%, 25%, and 40%.

5.1.5 Forest and Watershed Health

Like recreation, this attribute proved particularly challenging to quantify. Focus group participants voiced their desire to include an attribute that captured the effect of fire on amenities such as water quality, wildlife habitat, and other ecological variables that effectively constitute 'ecosystem health', but the group members had few suggestions on how such an attribute should be quantified. Discussions with the USDA Forest Service Regional Office, particularly George Weldon, Deputy Director Fire, Forest Service Region 1, revealed that the best way to capture most of this information in a single variable was fire size, with small and medium sized fires

(less than 5000 acres[3]) being more consistent with the historic fire regimes of Flathead County. Historically, these fires ranged from low to high severity, and were more likely to be beneficial to wildlife and forest stands due to the creation of a mosaic of different habitat types. These fires maintained winter range for various wildlife species, and increased long-run aquatic habitat quality through periodic, small deposits of woody material and sediment into streams and lakes. Today, large fires greater than 5000 acres are common in Flathead County. These fires are typically high intensity, stand replacing fires that are less consistent with the historic fire regime of the area (Weldon 2008). These fires create large stands of even-aged regrowth that do not support as many species of wildlife as smaller, 'patchier' fires. These fires also typically burn at severities that are damaging to watersheds and can lead to severe soil erosion, flooding, and increased debris in rivers and lakes, which can have detrimental effects on aquatic habitats.

This attribute was quantified as the percent of forest acres burned in large fires. We specified in the questionnaire that large fires were more likely to have the negative ecological consequences described above, whereas smaller fires were more likely to have the positive ecological benefits previously discussed. Using wildfire GIS data, it was determined that 91% of wildfire burned acres in Flathead County between 2003-2007 were burned in large fires greater than 5000 acres (USDA 2008). The level 90% became the status quo for this attribute, and three other levels were included in the final choice sets: 70%, 80%, and 95%.

5.1.6 Cost to the Respondent

In order to calculate shadow prices for the other attributes in the survey, cost to the respondent needed to be included as the final attribute. Since individuals do not pay directly for fire management services but instead pay for fire protection via federal, state, and local taxes,

[3] The Forest Service typically considers fires greater than 100 acres to be "large".

this attribute was quantified as how much the respondent would pay in state and local taxes to fund wildfire management in Flathead County.

In calculating the average household contribution to wildfire management in Flathead County, federal taxation was not accounted for. Even though the Forest Service bears a substantial proportion of wildfire management costs in Montana, these costs are funded by federal taxes paid by all residents of the nation, so the marginal monetary contribution of a household in Flathead County to federal wildfire management in the county is negligible. Additionally, the 2001 FWFMP specifically emphasizes the need for greater state and local contribution to wildfire management in the future (OIG 2006, NWCG 2009).

State wildfire management expenses in Montana are primarily funded by the state general fund, which is the primary account that funds a significant portion of the general operations of state government. Using data from the Legislative Fiscal Division (LFD 2008), it was determined that nearly 61% of total general fund revenues came from state income and property taxes, while the remaining revenue came from other sources such as corporate income taxes, vehicle taxes, and investment earnings. For the purposes of this study, it was assumed that an 'average' Montana citizen would only contribute to the state general fund via state income and property taxes.

Wildfire management in Montana is also funded by the state preparedness budget (an approximately $10 million/year emergency fund) and by the forest fire assessment program. The forest fire assessment program requires owners of forested land to pay a "wildfire assessment fee" (a $41.65 flat fee for each landowner plus a $0.22/acre fee for each acre over 20 acres) to fund wildfire management in Montana. Data obtained from the DNRC Fire Protection Assessment System (2008) allowed for the calculation of an average $27.89 assessment fee that

is paid by each household in Flathead County and an average $8.60 fee that is paid by each household in the state of Montana.

Using data on state expenditure for fire protection obtained from the Legislative Fiscal Division (LFD 2008) the 2006-2008 inflation adjusted average annual expenditure on wildfire management for the state of Montana was calculated (including preparedness and forest fire assessment spending) to be approximately $45 million (Table 5.1). This number was divided by the population of the state of Montana (935,670)[4] and multiplied by the average household size (2.45)[4] to obtain the average level of state taxation for fire management per household of approximately $115. Average county level taxes (approximately $10 per household (Chute 2008)) specific to Flathead County for fire management were added to the state average, yielding a final status quo average cost of $125 per household per year for wildfire management in Flathead County. Six cost levels were included in the final version of the survey: $70, $125, $180, $250, $325, $450, with $450 set as a choke level to test the respondents' sensitivity to the cost attribute.

Table 5.1 Summary of 2006-2008 Montana State Wildfire Suppression Expenditure Used to Calculate Status-Quo Cost Level.

Fiscal Year	Inflation Adjusted Fire Suppression Costs (2008 dollars)	Preparedness Budget	Forest Fire Asssesment Program Fees	Total Expenditure (2006-2008)
2006	$5,416,629	$10,000,000	N/A	
2007	$41,297,766	$10,000,000	N/A	
2008	$48,856,285	$10,000,000	$3,283,853	
2006-2008 Average	$31,856,893	$10,000,000	$3,283,853	$45,140,746

[4] Population and household size estimates provided by the US Census Bureau (2009).

5.2 Survey Design, Testing, and Data Collection

After the final list of attributes and their levels were approved by focus group members, the choice set profiles used in the questionnaire were constructed. An orthogonal main-effects experimental design was developed using SAS® (Statistical Analysis Software) and the macros developed by Kuhfeld (2004) (see section 4.4.3 for a discussion on experimental design. Eight versions of the survey were produced, with each survey version containing a different block of six choice sets and each choice set containing a status quo option and two alternative wildfire management options. This yielded a total of 48 choice sets which included 96 different management options to be compared to the status quo. Each survey version contained the same background information and warm-up and demographic questions.

In July 2008, focus group participants were consulted a second time at another workshop in Kalispell. This meeting was spent discussing and refining the background information, the attributes and their levels, and the warm-up and demographic questions. After incorporating feedback from this focus group into the survey, a "pre-test" of the survey was conducted at the Southgate Mall in Missoula, Montana in August. Forty-seven adult participants of different sex and age groups were encouraged to participate by being offered a $10 gift card to retailers in the Southgate Mall for completing the survey and providing feedback. This pre-test was held to elicit information regarding an average person's ability to understand the survey material, evaluate the choice sets, and answer the demographic and warm-up questions. Participants were also given an opportunity to provide any general comments that they felt would improve the quality of the final version of the survey. Several changes were made as a result of this pre-test, including many changes in diction and the inclusion of a simplified example page for completing the choice sets.

After the suggested changes from the pre-test were incorporated into the survey, final approval of the survey's content from focus group participants was obtained. The 19 page questionnaire included five sections and a cover letter that introduced the wildfire management problem, provided instructions for an adult head of the household to complete the survey, and stressed the potential for the results to influence wildfire management in Flathead County to encourage participation and to minimize hypothetical bias. A pre-survey notification that informed respondents that they were randomly selected to participate in the survey was mailed to respondents a few days preceding the mailing of the full survey. Copies of the pre-survey notification, cover letter, the full-length survey, and the follow-up letter are provided in Appendix D.

Section 1 of the survey asked respondents a host of questions about their residence, and also inquired about different attitudes and perceptions of wildfire and wildfire management in Flathead County. A 'framing' question was included in this section to remind the respondent about their budget constraint and to consider other possible uses of their tax dollars (including programs such as education, healthcare, and national defense) when completing the choice sets.

Section 2 discussed several aspects of wildfire and wildfire management. The purpose of this section was to bring each respondent up to the same minimum level of understanding of the many issues targeted in our survey in order to ensure they were making informed decisions in the choice sets. This background information introduced historic and contemporary wildfire regimes in Flathead County, and the costs and benefits of wildfire management, including the effects of wildfire on forest and watershed health, human lives, homes, and infrastructure, air quality, recreation, timber, and monetary costs. This section also included two half-page color photos of

a mosaic wildfire and a stand-replacing wildfire to illustrate the difference between these two wildfire types.

Section 3 defined each of the six attributes specifically in context of the choice sets, and provided several bullet-points of facts for the respondent to consider and make more informed decisions. Each attribute was represented by a single full-color photo to lessen cognitive burden and make the survey more aesthetically pleasing.

In section 4, respondents were presented with the instructions for completing the choice sets, an example choice set, and six wildfire management choice sets. Each choice set included the status quo wildfire management option and two different hypothetical wildfire management options from which the respondent could select their preferred option.

In section 5 of the survey, respondents were asked a variety of different demographic questions, including questions about gender, age, race, marital status, income, education, length of residency in western Montana, employment status and industry, and special group or organization membership, such as environmental groups or multiple use groups.

The survey was sent to the Bureau of Business and Economic Research (BBER) at the The University of Montana for printing and delivery to Flathead County households. Since Flathead County has a high proportion of older and rural households, an internet-based survey would not have been appropriate. Given the large amount of information included in the survey, the number of visual aids included, and the estimated time of completion of the survey (between 30-40 minutes) we opted to conduct the survey via random mailings, despite potential non-response problems associated with this method in comparison to telephone surveys and personal interviews (Arrow et al. 1993). Random mailings were stratified by rural and urban residences to ensure a balanced proportion of urban and rural households received the survey.

In October of 2008, the survey was mailed to a total of 1,200 households within Flathead County, drawn from a postal mail address database obtained by BBER. A $2 bill was included with the survey as an incentive payment to complete the survey, along with contact information for BBER if respondents needed assistance with the survey. Of the 1,020 deliverable surveys (180 were returned by the post office as non-deliverable) 642 were returned, yielding an effective 62.9% response rate. Response rates for CM studies are typically around 20%-40%, so this relatively high rate of response suggests that wildfire management is an important area of interest for many citizens of Flathead County.

5.3 Geo-spatial Data and Variable Descriptions

Geospatial information about respondents' homes was provided by BBER contingent upon a legal agreement that respondents' information would only be used for analysis for the purposes of this research and that information about any individual respondent would not be presented or disclosed to any party not involved in this research. Of the 642 returned the questionnaires, 137 were delivered to a PO Box and were deleted from the geospatial database, leaving 505 unique geospatial points to analyze. Home locations were used in a spatial analysis to determine distance from the household to a large forested area (a block of forest greater than 1000 acres in size) (RMRS 2007), population density with a 250 and 500 meter radius of the home (NRIS 2009), canopy cover surrounding the home (Landfire 2007), and distance from the home to a wildfire over 100 acres in size (GEOMac 2009).

This geospatial data was used to create a host of variables examined in the choice models, including whether or not the respondent lived in the WUI (household was located within 1.5 miles of a large forested area) and the mean and median canopy cover within 250 and 500 meters

of the home. Several interaction variables were also created by using this data to identify unique groups of respondents, though only two interaction variables, *intermixforbig* and *intermixsmall*, were used in the final versions of the choice models. The variable *intermixforbig* entails that the household is located within 1.5 miles of a large forested area, population density is less than 72 people within a 250 meter radius of the home, median canopy cover is greater than 35% within 500 meters of the home, and the respondent's lot size is greater than 1 acre. These respondents are thus rural residents that own large parcels of forested land within the WUI. The variable *intermixsmall* entails that the household is located within 1.5 miles of a large forested area, population density is less than 72 people within a 250 meter radius of the home, and the respondent's lot size is less than 1 acre. These respondents are thus rural residents who own small parcels of land (that may or may not be forested) within the WUI.[5] These *intermix* variables were included because it was hypothesized that individuals living within the intermix would have different wildfire management preferences than individuals living outside the intermix. The *intermix* variables, along with the other socio-economic variables included in the choice models, are defined in table 5.2.

[5] Wildfire management preferences did not significantly differ between small landowners of forested land and small landowners of non-forested land, so the two groups were combined for the *intermixsmall* variable.

Table 5.2 Variables Included in Final Analysis

Variable	Definition
Intermixforbig [#*]	Reside within the WUI (within 1.5 miles of large forested area)
	Population density <72 people within 250 meter radius of residence
	Median cannopy cover greater than 35% within 500 meter radius of residence
	Residence lot size >1 acre
Intermixsmall [#*]	Reside within the WUI (within 1.5 miles of large forested area)
	Population density <72 people within 250 meter radius of residence
	Residence lot size <1 acre
Secondhome [#*]	Respondents who indicated the survey was mailed to their second home
Female [#*]	Individuals identifying as female
Young [#*]	Individuals between 18 and 49 years of age
NativeAmerican [#]	Individuals identifying as Native American
Newres [#]	Individuals who indicated having lived in northwestern Montana for between 0 and 5 years
Medres [#]	Individuals who indicated having lived in northwestern Montana for between 5 and 20 years
Poor [#*]	Individuals reporting a total household income (before taxes) of between $0 and $34,999 in 2007
Rich [#*]	Individuals reporting a total household income (before taxes) of greater than $75,000 in 2007
Elem [*]	Individuals with no high-school degree (or equivalent)
Bach [*]	Individuals that had obtained an associate's or a bachelor's degree
Grad [*]	Individuals that had obtained a graduate degree (master's, doctorate, or professional)

designates variables included in the full model
* designates variables included in the total willingness to pay model

Variable selection for the choice model proved to be a difficult task for two reasons. First, inclusion of additional variables reduced the number of useable observations for analysis. This is because observations which include missing data are removed entirely from the analysis. For example, if a respondent answered every question (including the choice models) except income, but income was included in the model, then that individuals' response would not be included in the analysis of that model. This proved challenging because many respondents failed to complete the entire survey (see section 6.3 for observation numbers for the various choice models). Additionally, for the purposes of the full model, the 137 questionnaires that were mailed to PO boxes had to be deleted from the geospatial database, so information from these respondents could not be included in the full model.

Second, inclusion of a geospatial or demographic variable greatly reduced the number of respondents included in the base case. The base case represents all the individuals which are not uniquely identified by the included categorical variables; in other words, the base case is the subset of the sample for which all categorical variables are equal to 0. The base case is designated by the non-interacted attribute variables in the model output, and serves as the point of reference from which marginal estimates for included variables are based. For example, if a model were estimated where female was included as the only demographic variable (where female=1 if the respondent is female and 0 if otherwise), then only respondents identifying as male would be included in the base case and the interaction terms *female_homes* would represent the value that females place on homes relative to the base case. Inclusion of too many variables could quickly reduce the base case to a small number of observations, which jeopardized the statistical soundness of the model.

Due to these factors, the number of interaction variables that could be include in the full model was limited. Variables were ultimately selected based upon their perceived importance, potential relevance to policy makers, and the results from several likelihood-ratio tests[6].

5.4 Choice Models Fitted to Survey and Geospatial Data

5.4.1 Model Estimation

The choice models were analyzed using conventional maximum likelihood procedures (see section 4.6 and equation 4.6). Alternative specific conditional logit models were fitted to the data using the software package Stata® 10.1 (Data Analysis and Statistical Software). Three models were accepted to be the most useful for explaining resident preferences for wildfire management in Flathead County. The first model (Base Model) included all of the wildfire

[6] Likelihood-ratio tests are used to compare the fit of two models, of which one is nested in the other.

choice attributes but did not include any socio-economic or geospatial variables. The purpose of this model was to determine the willingness to pay for the wildfire attributes for the entire sample when socio-economic and geospatial variables were not accounted for.

The second model (Full Model) was a variation of the base model which included several socio-economic and geospatial characteristics of the respondents interacted with the choice attributes (see Table 5.1 for a listing of variables used in the full model). The purpose of this model was to determine how WTP varied across several different socio-economic and geospatial groups of respondents.

A third model (TWTP model) was analyzed for the purposes of estimating total willingness to pay (TWTP) for the alternatives that could comprise alternative wildfire management strategies in Flathead County. This model was necessary because some of the variables included in the full model could not be scaled up to the county level due to insufficient information about the population characteristics of those variables. For example, it is not possible to scale the TWTP estimate to account for the proportion of the population that has a second home because this data is not available for the population.

5.4.2 Welfare Estimation

Marginal willingness to pay for the choice attributes was calculated via equation 4.8. For the interaction terms, marginal willingness to pay was calculated via equation 4.9, which produced the difference in marginal WTP for that particular socio-economic group from the status quo. To calculate total marginal WTP for the interaction terms, the base case marginal WTP and the interaction marginal WTP must be summed. For example, if the base marginal WTP to protect timber is $5 per 1000 acres, and the marginal WTP of females to protect timber

is -$1.50 per 1000 acres, then females have a total marginal WTP to protect timber of $3.50 per 1000 acres. Data is presented in this manner so that policy makers can estimate total marginal WTP for groups of respondents that include more than one demographic or geospatial variables (e.g. young females living in the intermix). Total willingness to pay for each attribute was calculated via equation 4.10.

5.4.3 Mini-Models

These mini-models are variations of the choice models described in section 5.4.1, where each mini-model examines the effect of one socio-economic variable on wildfire management preference at a time. There are two main advantageous of these mini-models: First, since only one variable is being examined at a time, creation of multiple mini-models allow for the analysis of multiple variables without sacrificing the number of observations included in the model (as discussed in section 5.3), thus, wildfire preferences can be estimated for potentially every socio-economic variable described by the questionnaire. Since the inclusion of additional variables limited the predictive power of the full model, the mini-models offer insight as to how other socio-economic variables not included in the full model contribute to wildfire management preferences.

Secondly, interpretation of the marginal WTPs from the mini-models may be more straight-forward than either the full or TWTP models. Recall from section 5.3 that the marginal WTPs for the interacted socio-economic variables reflect how the identified group's marginal WTP differs from the base case of the model and that the base case depends on the interaction variables included in the model. Because the base case is narrowly defined in these models, interpretations of the marginal WTPs for each socio-demographic group may be challenging.

The mini-models, however, examine a single socio-economic variable at a time, which eliminates the need for a base case. Using this method, it is possible to make a direct comparison of wildfire management preferences for different socio-economic groups that are easy to interpret.

Mini-models were developed for several socio-economic and geospatial variables and are presented in Appendix E.

5.4 Summary

This section first described the how the choice modeling survey used for this research was constructed. Attributes, attribute levels, and warm-up and demographic questions were developed via collaboration with a focus group that was comprised of representatives from several important stakeholder groups within Flathead County. Choice sets were constructed with an orthogonal main effects design using the statistical software package SAS® and the choice modeling macros developed by Kuhfeld (2004) to ensure statistical efficiency in choice set design. The survey was pretested in August 2008 and mailed to a stratified random sample of Flathead County residents in October of 2008. A 62.9% response rate was achieved.

Three alternative specific multinomial logit models were estimated using the statistical software package Stata®. The base model provides average marginal willingness to pay estimates across all households of Flathead County. The full model provides average marginal WTP estimates that vary according to several different geospatial and socio-economic characteristics, including age, gender, income, and whether or not the individual lived in one of the defined wildland-urban intermix categories. The total willingness to pay model is the model used to estimate total WTP for attributes at risk from wildfire in Flathead County.

6. SOCIAL TRADEOFFS BETWEEN MARKET AND NON-MARKET FOREST RESOURCES IN NORTH WEST MONTANA

This chapter reports findings from the survey questions and the results from the choice models presented in the previous chapter. The first section summarizes responses to the warm-up and demographic questions in the questionnaire. The second section presents the results and shadow prices for the base, full, and TWTP models, and the third section presents the results for total WTP for alternative fire management strategies for Flathead County as a whole. Section four summarizes the chapter.

6.1 Responses to Warm-up and Demographic Questions

While the choice modeling results are the main focus of this research, analysis of respondents' answers to the residential, attitudinal and demographic questions from the survey provide valuable insight into the attitudinal and socio-economic characteristics that comprise the sampled population. This not only aids in the interpretation of the choice modeling results, but also provides information about public preferences for wildfire management in Flathead County.

6.1.1 Residential and Attitudinal 'Warm-up' Questions

The majority of survey respondents (93.0%) indicated that the questionnaire was mailed to their primary residential address. Only 5.7% of respondents said their primary residence was located in another part of Montana, and 1.3% of respondents said their primary residence was located in another state. The proportion of out-of-state second home owners is lower than anticipated, given that Flathead County is a popular location for many out-of-state residents to own a second home. However, this can likely be explained by the fact that the survey was mailed

in October, and many-out-of state home owners had probably returned to their primary out-of-state residence. Indeed, Flathead County experiences a 45% increase in its population during the summer months (Flathead County Planning and Zoning 2009). The preferences of out-of-state residents may thus be under-represented in the results of the choice models; however, the choice models should provide a satisfactory representation of the preferences of permanent Flathead County residents.

When asked about home ownership, 87.6% of respondents indicated that they owned their home, while only 9.6% said that they rented their residence (1.2% of respondents indicated that they did not know whether they owned or rented their residence). According to 2007 Flathead County census data (US Census Bureau 2009), 73.1% of housing units are owner-occupied, while 29.1% of housing units are renter-occupied. This suggests that results from this survey may be biased in favor of home owners; however, home-ownership did not prove to be a statistically significant variable in determining wildfire management preferences for Flathead County.

Lot size proved to be a significant variable in the choice models, and was incorporated into the wildland-urban intermix variables that comprised the full choice model. Responses indicated that 48.3% of respondents lived on a home with a lot size of one acre or less, while 42.5% of respondents lived on a home with a lot greater than one acre. Respondents who lived in an apartment, townhouse, or condominium comprised the remaining 9.2% of responses.

When describing the area around their home, 52.6% of respondents indicated that they lived in an ‘urban’ or ‘suburban’ area, while 17.0% of respondents indicated living in an area comprised of rural cropland or grassland and 30.5% of respondents indicated living in rural forestland. This variable was manually validated by checking a subset of responses against the

respondents' geospatial data, and many respondents incorrectly classified themselves as 'rural' or 'urban'. This can perhaps be attributed to the nature of growth in Flathead County; for example, a respondent may have moved from a busier metropolitan area to the city of Kalispell and (subjectively) identified their neighborhood setting as 'rural,' or likewise a longtime Flathead County resident living on the outskirts of a city like Whitefish may have identified their neighborhood setting as 'urban' because they felt they felt the growth experienced in the area in recent years made their neighborhood feel like a 'major metropolitan area'. While these respondent opinions are interesting in their own right, they did not prove to be very helpful in explaining wildfire management preferences, probably due to the large degree of subjectivity associated with this variable. Population density surrounding the home proved to be a good proxy variable for urban versus rural households, and was used in the creation of the wildland-urban intermix variables used in the full choice model.

Unlike neighborhood setting, respondents appeared to accurately assess their proximity to large forested areas: 56.3% of respondents indicated that they lived within the political definition of a WUI (1.5 miles of a large forested area), while geospatial data indicated that 57.3% of respondents lived within a WUI. Of the respondents that lived in the WUI, 59.8% of respondents indicated that they had forest on their land, and 79.6% of the WUI residents who had forest on their land reported having performed timber harvesting, thinning, or fuel reduction treatments in their forests to reduce wildfire risk. Interestingly, 52.1% of forest land owners within the WUI indicated that surrounding landowners (either public or private) had performed timber harvesting, thinning, or fuel reduction treatments to reduce wildfire risk, while only 30% indicated that their neighbors had not conducted risk mitigation activities (17.9% of these respondents did not know). This may support the wildfire risk externalities research done by

Shafran (2008), which found that homeowner's decisions about risk mitigation behavior depends on their neighbors' decisions, and that households are more likely to perform risk mitigation when their neighbors do.

The level of risk mitigation performed on the respondents' property, however, appears to be somewhat contradicted by respondents' risk mitigation relating to their home structure. Of the respondents that indicated they lived in a WUI, only 33.1% of respondents indicated that the exterior of their home was built out of fire resistant material, and just over half (54.2%) indicated that they had any kind of fire insurance that could compensate them for wildfire-related damages to their home. This seems to indicate that fire risk perception is relatively low, and perhaps justifiably so: only 3.8% of all respondents indicated that they had ever been evacuated from their home due to the threat of wildfire (which seems reasonable given the status quo level of 130 homes per year) and the fact that not even a single home has been destroyed by wildfire in Flathead County since 1988 (Chute 2008). This does, however, support the conclusions of Shafran (2008) and Mcgee et al. (2009), which suggests that WUI residents largely do not perform risk-mitigation on their house structures, due to financial costs, inconvenience, low risk perception, and a low cost to benefit ratio. However, this relatively low perception of wildfire risk is potentially concerning, given the changing fire regimes of Flathead County and the increasing rate of residential development within the WUI (see chapter 2).

Only 47.7% of respondents indicated that their recreation plans had been negatively affected by wildfire in the past two years. Given the large amount of public land available to Flathead County residents for recreation (see chapter 2), this can perhaps be attributed to the substitutability of recreation sites in the area. Table 6.1 summaries the proportion of respondents who indicated they participated in various recreation activities.

Table 6.1: Recreation activity participation rates for Flathead County residents

Camping	60.90%	Skiing/Snowboarding	26.95%	Cross-country skiing/Snowshoeing	25.55%
Pickniking	54.21%	Snowmobiling	12.77%	Rafting/Canoeing/Kayaking	33.64%
Hiking/Biking	60.12%	Off-road driving	22.74%	Motor boating	39.25%
Hunting	45.17%	Horseback riding	13.24%	Wildlife viewing/Bird watching	37.38%
Fishing	59.03%	Rock climbing	3.89%	Mushroom or berry picking	41.12%

In order to account for the possibility that some individuals may either profit from or incur a monetary loss as a result of wildfire on the landscape, respondents were asked how they felt wildfire would affect their income. Almost 77% indicated that a wildfire would not affect their income or that they were not sure how wildfire would affect their income, while 21.5% of respondents said that wildfire would decrease their income. Only 1.6% of respondents felt that wildfire would increase their income, and half of these respondents reported being employed in fire management industries.

Respondents were also asked for their opinions regarding several management objectives for forests in Flathead County. When asked about the emphasis that public land managers should place on fire management and suppression, 45.6% of respondents said that they felt the current emphasis was about right, while 30.4% said there was not enough emphasis on this objective and 9.3% said that they felt there was too much emphasis on fire management and suppression (14.8% said they didn't know). When asked about timber harvesting and resource use, only 20.1% of respondents indicated that the current emphasis was about right and 8.4% indicated that there was too much emphasis on this objective. This compares to 57.1% of respondents who felt there was not enough management emphasis placed on timber harvesting and resource use (14.4% indicated they didn't know). When asked about environmental protection, 39.4% of respondents indicated there was too much emphasis on this objective, while 17.9% said that there

was too little emphasis and 28.7% indicated that the emphasis on environmental protection was about right (14.01% indicated they didn't know).

Respondents were also asked about their tolerance of wildfire on the landscape; 26.4% said that they felt current wildfire management was not aggressive enough and that all wildfires should be actively suppressed, 10.4% said they felt current wildfire management was too aggressive and more wildfires should be allowed to burn, and 63.3% said that current wildfire management, which allows for some wildfires to burn under certain conditions, is about right. This seems to indicate that there is some potential public support for wildland fire use as a wildland fire management option.

When respondents were asked who they felt was primarily responsible when a wildfire destroys a home, 74.3% of respondents indicated that the responsibility falls on the individual homeowner, while 21.9% said that this responsibility rests with fire management agencies (only 3.8% indicated that they didn't know). Interestingly, and perhaps counter-intuitively, when responses to this question are broken down into WUI and non-WUI respondents, 77.9% of WUI respondents felt that responsibility primarily belonged to the homeowner, while only 72.41% of non-WUI respondents felt this way.

The last "warm-up" question that respondents were asked served to frame the respondents' budget constraint and remind them of other possible uses of tax dollars. Other possible uses presented to the respondent included health care, the education system, addressing global warming, addressing rising energy costs, and national defense. Respondents were asked to rank the top three issues that were of greatest importance to them, where a score of 1 indicates the issue that is most important, 2 of second most importance, and 3 of the third most

importance, while a score of 0 indicates the issue was not chosen. The responses to this question are summarized in table 6.2.

Table 6.2: Issues of concern to residents of Flathead County

Issue	0	1	2	3
Fuel/gas/energy costs	49.84%	17.45%	17.91%	14.80%
Education system	51.87%	19.78%	14.64%	13.71%
National defense	56.54%	24.45%	8.26%	10.75%
Quality of the healthcare system	57.94%	10.28%	19.31%	12.46%
Preserving rural landscapes and lifestyles	73.83%	6.70%	8.10%	11.37%
Economic development	74.77%	6.54%	9.81%	8.88%
Public land management, including wildfire management	79.91%	1.71%	7.17%	11.21%
Unemployment	89.88%	2.02%	3.58%	4.52%
Climate change	92.06%	3.27%	1.71%	2.96%

6.1.2 Choice Set 'Closing' Questions

After respondents had completed the choice sets, respondents were asked to complete a brief set of questions designed to assess their opinions about the choice modeling component of the survey. The first question in this section asked respondents if they felt like they needed more information than was provided to adequately answer the choice set section of the survey. Despite the five pages of background information presented in the survey, 33.8% of respondents felt that they needed more information than was provided. Respondents were also asked if they felt that the information provided to them was biased against traditional wildfire suppression strategies; 18.3% said there was bias in the information, while 44.9% said the information presented was not biased against traditional wildfire suppression strategies (36.8% said they didn't know). When asked about how confusing the survey was, 37.3% of respondents indicated that the survey was confusing to them. Although statistical analysis of the survey data revealed that respondents who indicated that the survey was biased or confusing did not have statistically significant

different wildfire management preferences, this information should be considered when interpreting the results from the choice models.

Respondents were also asked about the level of realism regarding the alternative management scenarios; 19.5% of respondents indicated that the scenarios seemed unrealistic, while 34.0% said that the scenarios were not unrealistic (46.5% said they didn't know if the scenarios were unrealistic or not). When asked if there were other attributes that should have been included in the choice modeling section of the survey, 24.1% said that they felt there was at least one other attribute that should have been included. However, when asked to specify what these attributes were, an overwhelming majority listed an irrelevant attribute or provided a comment that did not make sense in context of the question (e.g. "Education smoky bear type" and "The future of all and everything"). Job creation and job loss were frequently mentioned as an alternative attribute that should have been included, as were attributes that more directly captured the effect of wildfire on wildlife. Logging was also frequently mentioned; however, 'logging' and 'acres of timber burned' are probably highly correlated, so a separate logging attribute is probably not warranted (see Appendix F for a full list of responses to this question, as well as general comments about the survey). Findings from this question appear to indicate that the attributes included in the survey represented most of the public's concerns about wildfire management in Flathead County.

Lastly, respondents were asked two questions to assess their sensitivity to the payment attribute in the choice sets. The first question asked respondents if they opposed any additional taxation to support government programs; 48.8% of respondents answered 'yes' to this question, while 38.4% said they did not oppose additional taxation to support government programs. The second of these questions asked respondents whether or not they distrusted the government to

properly manage their tax dollars; 60.53% said they distrusted the government to appropriately manage their tax dollars, while only 28.60% said they trusted the government to manage their money properly. These responses seem to indicate that a high proportion of Flathead County residents oppose extra taxation and distrust the government to manage their money properly, which likely affected their willingness to pay for alternative wildfire management strategies. Indeed, the status quo option was selected 61.4% of the time in the choice sets, perhaps because of these sentiments.

6.1.3 Demographic Questions

The final section of the survey asked respondents to complete several demographic questions. The purpose of this section was two-fold. First, the responses to many of these questions could be compared to the results from the US Census Bureau to determine how representative the sample is to the population of Flathead County. Second, many of these questions could be used to create interaction variables used in the choice models. Table 6.3 compares population data from the Flathead County 2007 population estimates (US Census Bureau 2009) to the data from the sample.

Table 6.3 Demographic information for sample and Flathead County

Demographic		Sample	Population	Population age 18 and over[1]
n or population		642	84,693	
Gender	Male	73.5%	49.8%	
	Female	26.5%	50.2%	
Age	Under 5 years		6.3%	
	5 to 9 years		6.0%	
	10 to 14 years		6.7%	
	15 to 19 years		7.0%	
	20 to 24 years*	0.8%	5.8%	7.8%
	25 to 29 years	4.4%	12.5%	16.9%
	30 to 34 years	2.9%	13.2%	17.8%
	35 to 39 years	6.0%		
	40 to 44 years	6.8%	17.0%	23.0%
	45 to 49 years	10.8%		
	50 to 54 years	12.4%	7.5%	10.1%
	55 to 59 years	13.2%		
	60 to 64 years	9.8%	5.1%	6.9%
	65 to 69 years	11.4%	7.0%	9.5%
	70 to 74 years	8.1%	4.1%	5.5%
	75 to 79 years	5.4%		
	80 to 84 years	4.3%	2.0%	2.7%
	85 years +	3.7%		
	Median Age	55-59	39.6	
	18 years and over	100%	76.5%	
Marital Status				
(Males 15 and older)	Single/Never married	5.2%	28.5%	
	Now married	81.1%	51%	
	Divorced	9.9%	1.3%	
	Separated	1.4%	2.5%	
	Widowed	2.5%	16.7%	
(Females 15 and older)	Single/Never married	6.7%	23%	
	Now married	49.7%	51.2%	
	Divorced	16.4%	1.7%	
	Separated	0.6%	10.1%	
	Widowed	26.7%	13.9%	

Children	Have children under 18	23.7%	30.3%
Race	White/Caucasian	95.9%	94.7%
	Black/African American	0.0%	0.6%
	Native America	3.4%	2.0%
	Asian	0.0%	0.6%
	Hispanic/Latino	0.8%	0.8%
	Other	0.0%	0.2%
Education	No high school diploma	2.4%	12.6%
	High school diploma / GED	40.6%	58.0%
	Associate's degree	17.1%	7.0%
	Bachelor's degree	28.3%	16.1%
	Graduate Degree	11.6%	6.4%
Income	Less than $10,000	1.8%	6.1%
	$10,000 to $14,999	3.6%	4.8%
	$15,000 to $24,999	8.4%	13.9%
	$25,000 to $34,999	12.0%	12.3%
	$35,000 to $49,999	18.8%	17.9%
	$50,000 to $74,999	26.8%	22.4%
	$75,000 to $99,999	10.4%	11.1%
	$100,000 to $149,999	10.0%	7.3%
	$150,000 to $199,999	3.6%	2.2%
	$200,000 +	4.7%	2.0%
	Mean income (dollars)	$50,000 to $74,999	$66,777
	Median income (dollars)	$50,000 to $74,999	$52,420

* Ages 18-24 for sample

1 Population ages 18 and over was used to scale TWTP estimates up to the county level

As reported, response rates for the choice modeling survey appear to be biased towards males, but this can probably be explained by the instructions in the survey which asked any adult head of the household to complete the questionnaire, and perhaps in northwest Montana this would typically be regarded as the male head of household. Response rates also appear to be biased in favor of older respondents, respondents who are married, respondents who are highly educated, and respondents who have higher than average household incomes. This trend is common in many choice modeling and contingent valuation surveys (Bateman et al. 2002), and is well documented in many different types of mail-in surveys (Kulka 1994; Singer et al. 1999; Martin et al. 2001). These discrepancies in characteristics between the population of Flathead County and the sample (with the exception of marital status, which was not a significant predictor of wildfire management preferences in the choice models) were corrected for in the calculation of total willingness to pay.

Several other questions were included in the demographic section of the survey. The overwhelming majority of survey respondents indicated that they were either employed full or part time (53.7%) or retired (35.8%). "Other" was the third most frequently selected employment status category at 5.8% of respondents, and most of these individuals identified as either self-employed or a small business owner.

Of the respondents polled, 55.5% indicated that they were long-time residents and had lived in northwest Montana for more than 20 years, 22.8% had lived in northwest Montana for 10-20 years, while 13.1% had lived in northwest Montana between 5-10 years, and 8.7% between 0-5 years.

Respondents were asked to indicate how they felt forest and watershed health had changed in the time they have lived in northwest Montana; 52.9% said that they had noticed a

decline in health since they had lived here, while 22.6% said that forest and watershed health had stayed about the same. Only 9.1% felt that forest and watershed health had improved, and 15.4% had no opinion. When this question was broken into 'long term' (10 years of residency or more) and 'short term' (less than 10 years of residency), 60% of long term residents said that forest and watershed health had declined, while only 29% of short term respondents indicated that forest and watershed health had declined.

Lastly, respondents were asked about their industry of employment and whether they were members of any type of special-interest group or organization. These variables did not prove to be statistically significant in affecting respondent's wildfire management preferences (probably due to small numbers of observations for each category) and were not included in the choice models. The results from these questions are summarized in Tables 6.4 and 6.5.

Table 6.4 Industries of employment

Industry	**Frequency**
Wood products, mining, farming, or ranching	7.89%
Fire fighting or fire management	0.69%
Insurance or real estate	2.92%
Recreation or tourism	3.43%
Health care	5.32%
None of the above	79.76%

Table 6.5 Membership in special interest groups

Organization Type	**Frequency**
Federal land management agency	0.62%
State land management agency	0.16%
Tribal land management agency	0.16%
Montanan's for Multiple Use	2.49%
Other multiple use organizations	1.40%
Montana Logging Association	1.71%
Wildlife or fisheries group	10.44%
Environmental group	6.07%
Local citizen land trust and local land management groups	2.65%
None of the above	70.87%

6.2 Choice Modeling Results

The results from the base, full, and TWTP choice models are listed in Table 6.6. The coefficients, their respective Z-statistic, and the shadow price (calculated using equations 4.7 and 4.8) are presented in Table 6.6. A single asterisk (*) designates statistical significance of the variable at the 10% level, a double asterisk (**) at the 5% level, and a triple asterisk (***) at the 1% level. Equations 4.7 and 4.8 produce the WTP for a marginal increase in any given attribute; however, because an increase in any wildfire attribute included in the survey would make the respondent worse off (e.g. increased levels of home evacuations or increased number of smoky days), the inverse of the shadow price is presented. This represents the WTP for a one-unit decrease in the wildfire attributes.

For *protect homes*, the shadow price designates the WTP to reduce the number of annual home evacuations by one evacuation per year. For *recreation*, the shadow price designates the WTP to reduce the percentage chance that wildfire substantially affects recreation plans by one percentage point. For *moderate* and *unhealthy smoky days*, the shadow price designates the WTP to reduce the number of moderate and unhealthy smoky days experience each year by one. For *timber*, the shadow price designates the WTP to reduce the number of acres of timberland burned by wildfire each year by 1000 acres. For *forest health*, the shadow price designates the WTP to reduce the percentage of acres burned annually by wildfires greater than 5000 acres in size by one percentage point.

Table 6.6 Choice Modeling Results for Base, Full, and TWTP Models

Variable	Base Model				Full Model				TWTP Model			
	β	Z-Stat	Shadow Price		β	Z-Stat	Shadow Price		β	Z-Stat	Shadow Price	
homes	-0.00145	-4.78	$0.28	***	-0.00143	-1.97	$0.19	**	-0.00097	-1.51	$0.17	
recreation	-0.00984	-3.97	$1.90	***	-0.01240	-2.00	$1.65	**	-0.01003	-1.84	$1.77	*
moderate smoke	-0.01669	-6.52	$3.23	***	-0.01976	-3.23	$2.63	**	-0.00932	-1.76	$1.65	*
unhealthy smoke	-0.06916	-5.26	$13.36	***	-0.06916	-2.25	$9.20	**	-0.04914	-1.81	$8.68	*
timber	-0.06930	-5.88	$13.39	***	-0.10801	-3.50	$14.37	**	-0.06320	-2.34	$11.17	**
forest health	-0.02338	-6.69	$4.52	***	-0.02742	-3.06	$3.65	**	-0.01334	-1.70	$2.36	*
cost	-0.00517	-14.69		***	-0.00751	-7.93		***	-0.00566	-7.04		***
intermixforbig_homes					-0.00374	-2.45	$0.48	**				
intermixforbig_recreation					-0.00091	-0.08	$0.12					
intermixforbig_moderatesmoke					-0.01216	-1.10	$1.57					
intermixforbig_unhealthysmoke					0.01889	0.36	-$2.44					
intermixforbig_timber					0.03722	0.70	-$4.80					
intermixforbig_foresthealth					-0.00403	-0.26	$0.52					
intermixforbig_cost					-0.00024	-0.16						
intermixsmall_homes					0.00033	0.27	-$0.08					
intermixsmall_recreation					0.00043	0.04	-$0.10					
intermixsmall_moderatesmoke					0.00250	0.26	-$0.59					
intermixsmall_unhealthysmoke					0.00740	0.15	-$1.76					
intermixsmall_timber					-0.00329	-0.06	$0.78					
intermixsmall_foresthealth					0.01582	1.11	-$3.75					
intermixsmall_cost					0.00330	2.67		**				
sechome_homes					0.00120	0.68	-$0.30					
sechome_recreation					0.01066	0.75	-$2.69					
sechome_moderatesmoke					-0.01827	-1.15	$4.62					
sechome_unhealthysmoke					0.10444	1.30	-$26.40					
sechome_timber					-0.08360	-1.02	$21.14					
sechome_foresthealth					0.03176	1.49	-$8.03					
sechome_cost					0.00356	2.31		**				

NativeAmerican_homes		-0.00017	-0.06	$0.09					
NativeAmerican_recreation		0.01812	0.86	-$9.73					
NativeAmerican_moderatesmoke		0.02408	1.14	-$12.93					
NativeAmerican_unhealthysmoke		0.02306	0.22	-$12.38					
NativeAmerican_timber		-0.00493	-0.04	$2.65					
NativeAmerican_foresthealth		-0.02016	-0.67	$10.82					
NativeAmerican_cost		0.00565	2.07		**				
newres_homes		-0.00264	-1.87	$0.24	*				
newres_recreation		0.00753	0.67	-$0.67	*				
newres_moderatesmoke		0.00200	0.18	-$0.18					
newres_unhealthysmoke		-0.12634	-2.27	$11.24	**				
newres_timber		0.12048	2.16	-$10.72	**				
newres_foresthealth		-0.00989	-0.59	$0.88					
newres_cost		-0.00373	-2.06		**				
medres_homes		0.00011	0.14	-$0.02					
medres_recreation		0.01191	1.77	-$1.97	*				
medres_moderatesmoke		0.00968	1.48	-$1.60					
medres_unhealthysmoke		0.02275	0.69	-$3.76					
medres_timber		0.01528	0.45	-$2.52					
medres_foresthealth		0.01584	1.66	-$2.62					
medres_cost		0.00146	1.56						
female_homes		0.00166	1.87	-$0.23	*	0.00120	1.63	-$0.23	
female_recreation		-0.00577	-0.77	$0.79		-0.00359	-0.57	$0.69	
female_moderatesmoke		-0.01784	-2.40	$2.45	**	-0.01030	-1.67	$1.97	*
female_unhealthysmoke		-0.00425	-0.12	$0.58		-0.01848	-0.60	$3.53	
female_timber		0.02204	0.58	-$3.03		0.01175	0.38	-$2.25	
female_foresthealth		-0.00341	-0.32	$0.47		0.00103	0.12	-$0.20	
female_cost		0.00025	0.23			0.00042	0.49		

Variable	Base Model			Full Model				TWTP Model			
	β	Z-Stat	Shadow Price	β	Z-Stat	Shadow Price		β	Z-Stat	Shadow Price	
younguns_homes				0.00083	1.06	-$0.09		0.00072	1.12	-$0.09	
younguns_recreation				0.00145	0.22	-$0.16		0.00023	0.04	-$0.03	
younguns_moderatesmoke				0.00039	0.06	-$0.04		0.00107	0.20	-$0.13	
younguns_unhealthysmoke				-0.01422	-0.45	$1.57		-0.06084	-2.29	$7.37	**
younguns_timber				-0.01551	-0.47	$1.71		-0.00785	-0.29	$0.95	
younguns_foresthealth				-0.02622	-2.80	$2.89	**	-0.02282	-2.95	$2.77	**
younguns_cost				-0.00155	-1.62			-0.00259	-3.28		**
poor_homes				-0.00245	-2.47	$0.42	**	-0.00171	-2.03	$0.34	**
poor_recreation				-0.00694	-0.87	$1.20		-0.00161	-0.23	$0.32	
poor_moderatesmoke				0.00822	1.06	-$1.42		0.00231	0.35	-$0.46	
poor_unhealthysmoke				-0.02927	-0.74	$5.05		-0.00355	-0.10	$0.70	
poor_timber				-0.00516	-0.13	$0.89		-0.02104	-0.61	$4.18	
poor_foresthealth				0.01082	0.93	-$1.86		0.00474	0.48	-$0.94	
poor_cost				0.00171	1.45			0.00063	0.63		
rich_homes				-0.00090	-1.04	$0.17		-0.00072	-1.00	$0.22	
rich_recreation				-0.01859	-2.57	$3.55	**	-0.01329	-2.23	$4.12	**
rich_moderatesmoke				0.00030	0.04	-$0.06		-0.00766	-1.29	$2.37	
rich_unhealthysmoke				-0.01405	-0.40	$2.68		-0.03504	-1.19	$10.85	
rich_timber				0.01455	0.41	-$2.78		0.00560	0.19	-$1.74	
rich_foresthealth				-0.00598	-0.58	$1.14		-0.00287	-0.34	$0.89	
rich_cost				0.00228	2.26		**	0.00243	2.95		**
elem_homes								-0.00797	-2.26	$1.30	**
elem_recreation								0.01610	0.71	-$2.62	
elem_moderatesmoke								-0.04604	-1.89	$7.49	*
elem_unhealthysmoke								-0.09066	-0.79	$14.75	
elem_timber								0.03753	0.33	-$6.11	
elem_foresthealth								-0.03889	-1.16	$6.33	
elem_cost								-0.00049	-0.15		

bach_homes			-0.00023	-0.34	$0.04	
bach_recreation			0.00477	0.85	-$0.94	
bach_moderatesmoke			-0.00608	-1.11	$1.19	
bach_unhealthysmoke			0.01605	0.57	-$3.15	
bach_timber			-0.02720	-0.96	$5.34	
bach_foresthealth			-0.01151	-1.43	$2.26	
bach_cost			0.00056	0.70		
higher_homes			-0.00255	-2.17	$0.47	**
higher_recreation			0.00670	0.76	-$1.25	
higher_moderatesmoke			-0.00948	-1.10	$1.76	
higher_unhealthysmoke			0.01449	0.34	-$2.69	
higher_timber			0.01184	0.27	-$2.20	
higher_foresthealth			-0.01277	-1.02	$2.37	
higher_cost			0.00028	0.23		
Observations	10,149	6,615	8,992			
McFadden's R^2	.0432	.4129	.1747			

6.2.1 Base Model

Since the base model does not include any socio-economic or geospatial interaction terms, the results presented represent the average marginal WTPs for the entire sample. Each attribute and coefficient is significant at the 1% significance level and has the expected sign. The McFadden's R^2 for this model is .0432, which is to be expected for a simplified model of this nature.

6.2.2 Full Model

The results presented in the full model account for several socio-economic variables. For the purposes of this model, the base case is defined as urban male residents age 50 and older with an annual household income between $35,000 and $75,000 who have lived in northwest Montana for at least 20 years, are not Native American, and received the survey at their primary residence.

As depicted in Table 6.6, the full model produced several interesting results. All attributes for the base case have the expected sign and are significant at the 5% level, while cost is significant at the 1% level. The McFadden's R^2 for this model is .4129, which indicates an excellent fit. Respondents who live in the intermix and have large (>1 acre) forested lots have an additional positive willingness to pay to protect an additional home from evacuation of $0.48 (bringing their total WTP to $0.67 = $0.48 + $0.19). Perhaps this is not surprising, given that this group of individuals and their properties are likely to experience a greater risk of wildfire damages than individuals in the base case. This result indicates that these individuals perceive the increased wildfire risk from living in the interface and have a higher willingness to pay to support private property protection. However, this group did not have a statistically significant coefficient for any other attribute.

Cost was the only statistically significant attribute for a number of socio-economic groups, including respondents who live on small lots (<1 acre) in the intermix (on either forested or non-forested land), respondents who indicated that their Flathead County residence was their second home, and respondents who identified as Native American. The positive coefficient on this attribute suggests that individuals who belong to these socio-economic groups expressed a preference for management scenarios that decreased the level of taxation that they had to pay for wildfire management, which implies that these groups of individuals are unwilling to pay additional taxes to support alternative wildfire management strategies.

Relative to the base case, respondents who had only lived in northwest Montana for between 0-5 years expressed a statistically significant negative coefficient (implying a willingness to pay) to protect homes, with an additional WTP of $0.24 per home (bringing their total WTP to $0.43 = $0.24 + $0.19). These respondents also had a positive WTP for a one day reduction in the number of unhealthy smoky days of $11.24 (bringing their total WTP to $20.44 = $11.24 + $9.20). However, relative to the base case, these individuals expressed a significant positive coefficient (implying an unwillingness to pay) for recreation with a WTP of -$0.67 (bringing their total WTP to $0.98) and an unwillingness to pay to protect timber of -$10.72 (bringing their total WTP to $3.65). Respondents within this socio-economic group were also more supportive of paying additional taxes for alternative wildfire management strategies than respondents in the base case.

Relative to the base case, respondents who had lived in northwest Montana between 5 and 20 years expressed a statistically significant positive coefficient to protect recreation, with an additional WTP of -$1.97 (bringing their total WTP for recreation to -$0.32). This negative value suggests that respondents belonging to this socio-economic group would actually like to be

compensated if protection of recreation opportunities was increased.

Relative to the base case, females expressed a statistically significant positive coefficient to protect homes, with an additional WTP of -$0.23 (bringing their total WTP to -$0.04). This suggests that they would like to receive compensation if the level of structure protection was increased. Females also expressed a statistically significant negative coefficient to decrease exposure to moderate smoke, with an additional WTP of $2.45 (bringing their total WTP to $5.08). Young respondents (between 18-49) have a statistically significant negative coefficient to improve forest heath, with an additional WTP of $2.89 (bringing their total WTP to $6.54).

People who identified as having an annual household income of less than $35,000 expressed a statistically significant negative coefficient to protect homes, with an additional WTP of $0.42 (bringing their total WTP to $0.61), while people who had an annual household income greater than $75,000 expressed a statistically significant negative coefficient to protect recreation opportunities, with an additional WTP of $3.55 (bringing their total WTP to $5.20). However, these wealthier than average households also expressed an unwillingness to pay for alternative wildfire management strategies in general (positive and statistically significant coefficient on the cost attribute).

6.2.3 The Total Willingness to Pay Model

For the purposes of this model, the base case can be defined by male respondents over age 50 who have an annual household income between $35,000-$75,000 and who have a high-school (or equivalent) degree. As listed in Table 6.6, all of the attributes (with the exception of homes) are statistically significant at at least the 10% level for the base case. The McFadden's R^2

for this model is .1747, which signifies a fairly good fit and is expected given that this model contains fewer socio-economic explanatory variables than the full model.

As with the full model, females expressed a negative WTP to protect homes, but the coefficient was not statistically significant in the TWTP model. Females did, however, still express a statistically significant negative coefficient to decrease moderate smoke exposure, with an additional WTP of $1.97 (bringing the total WTP to $3.62).

In comparison to the full model, preferences for respondents under the age of 50 changed noticeably; while these respondents still expressed a positive additional WTP for forest health of $2.77 ($5.13 total) in the TWTP model, the respondents also expressed a statistically significant coefficient for a reduction in unhealthy smoke, with an additional WTP of $7.37 ($16.05 total) and a statistically significant coefficient on the cost attribute in the TWTP model.

As with the full model, respondents who identified as having an annual household income of less than $35,000 expressed a significant negative coefficient to protect homes, with an additional WTP of $0.34 for the TWTP model ($0.51 total), while people who had an annual household income greater than $75,000 expressed a significant negative coefficient to protect recreation opportunities, with an additional WTP of $4.12 for the TWTP model ($5.89 total), but also expressed a significant positive coefficient on the cost attribute (an unwillingness to pay for alternative wildfire management strategies in general).

Respondents who did not complete high-school and respondents who had obtained at least a master's degree had a negative and significant coefficient for protecting homes, with an additional WTP of $1.30 ($1.47 total) and $0.47 ($0.64 total), respectively. Respondents who did not obtain a high-school degree also expressed a significant negative coefficient to reduce exposure of moderate smoke, with an additional WTP of $7.49 ($9.14 total). Respondents with

either a bachelor's or associate's degree did not have any wildfire management preferences that were statistically significantly different from the base case.

Table 6.7 summarizes ranges (lowest and highest total WTP) for marginal WTP estimates from the full and TWTP models discussed above, and presents the range of WTP estimates from the various mini-models presented in Appendix E.

Table 6.7 Summary of WTP estimates for full model, TWTP model, and mini-models

Attribute	Full Model		TWTP Model		Mini-Models	
	Low	High	Low	High	Low	High
Homes	-$0.11	$0.67	-$0.04	$1.49	-$0.15	$0.83
Recreation	-$8.08	$5.20	-$0.85	$5.89	-$0.46	$5.38
Moderate Smoke	-$10.30	$7.25	$1.19	$9.14	$0.70	$10.18
Unhealthy Smoke	-$17.20	$20.44	$5.53	$23.43	-$9.19	$27.85
Timber (1000 acres)	$3.65	$35.51	$5.06	$16.51	-$6.84	$43.71
Forest Health	-$4.38	$14.47	$1.42	$8.69	$1.40	$16.91

6.3 Total Willingness to Pay to Protect Attributes at Risk from Wildfire in Flathead County

Total willingness to pay for each of the six attributes included in the questionnaire was calculated via the aggregation formula (equation 4.11) described in chapter 4.6. This formula yielded a per-household marginal WTP for each wildfire attribute. The weights used to calculate total marginal household WTP were taken from the US Census Bureau 2007 population estimates for Flathead County (see descriptive statistics, Table 6.3) and are summarized in table 6.8. The equation used to estimate household marginal WTP for each attribute, X, is summarized by equation 6.1, where β designates the coefficient from the TWTP model.

Table 6.8 Variable weights used to calculate TWTP

Variable	Weight
Female	.502/.265
Young *	.654
Poor	.371
Rich	.266
Elem	.096
Bach	.255
Grad	.072

* The weight for age was calculated excluding the proportion of the population under the age of 20 from Table 6.3. (74.2% of the population was over age 20; the weight for individuals between 18 and 49 thus became .485/.742 = .654).

$$Household\ WTP_X = -(1/\beta\_Cost) * (\beta\_X + ((\beta\_femaleX) * .502) + (\beta\_YoungX * .654) + (\beta\_PoorX * .371) + (\beta\_RichX * .226) + (\beta\_ElemX * .096) + (\beta\_BachX * .255) + (\beta\_GradX * .072)))$$

(6.1)

The per-household marginal WTP's were then multiplied by 30,521, the estimated number of households in Flathead County (US Census Bureau 2009) to provide an adjusted total marginal WTP estimate for Flathead County as a whole.

As described in Section 5.3, TWTP estimates are weighted in accordance with the population proportion for the socio-demographic variable of interest. While this proved to be straight-forward for most variables included in the TWTP model, it was unclear on how to appropriately weight the 'female' variable to calculate TWTP. As described in Section 6.1, the proportion of female respondents who completed the survey was significantly under representative of the true population proportion. Females proved to have significantly different wildfire management preferences than males in the choice models; however, it was unclear whether this was a function of female gender in general, or if those preferences were specific to females who identified as the head of the household. Two TWTP models have been fitted to account for females in general having the documented preferences (female = .502) and for

females who identify as the head of the household having the documented preferences (female = .265). These results are summarized in Table 6.8 below.

Table 6.8 Adjusted TWTP for Attributes at Risk from Wildfire in Flathead County

	Female = .502		**Female = .265**	
Attribute	Marginal Household WTP	Total Marginal Household WTP	Marginal Household WTP	Total Marginal Household WTP
Homes	$0.30	$9,156	$0.35	$10,682
Recreation	$2.13	$65,010	$1.98	$60,432
Moderate Smoke	$3.77	$115,064	$3.34	$101,940
Unhealthy Smoke	$19.62	$598,822	$18.84	$575,016
Timber (1000 acres)	$12.63	$385,480	$13.12	$400,436
Forest Health	$6.05	$184,652	$6.09	$185,873

While respondents expressed a positive aggregate WTP for increased levels of protection for each attribute, two attributes appeared to have particular importance for residents of Flathead County. Unhealthy smoke appears to be an important wildfire attribute to residents of Flathead County, as each household is willing to contribute an additional $19.62 ($18.84 in female=0.265 model) in tax revenue to reduce the number of days of unhealthy smoke experienced each fire season from 6 days to 5 days. This aggregates to a total value of $598,822 ($575,016). While this value may appear large, wildfire smoke was thought to be the single most important attribute to residents of Flathead County by several members of the focus group, and this result confirms those assertions. This may, in part, be attributed to the prevalence of asthma in the state of Montana; over 14.5% of Montana residents were affected by asthma in 2002, which was the highest proportion in the country at the time (Medscape 2004). Additionally, young adult residents, rich residents, and residents that did not obtain a high-school degree had a comparatively high value for unhealthy smoke relative to many other socio-economic groups,

which are accounted for in these TWTP estimates. Young individuals in particular comprise a significant proportion (65.4%) of adults in Flathead County.

Timber was the second most valued attribute, as the average household value of reducing the number of acres of timberland burned by wildfire from 12,600 acres to 11,600 acres was $12.63 ($13.12), which aggregates to a total of $385,480 ($400,436) for Flathead County as a whole. This is perhaps not surprising, given the importance of timber extraction on the economy of Flathead County (Sections 2.2, 3.2 and 5.1) and the level of general support for timber operations discussed in Section 6.1.

The number of homes evacuated each year was the lowest valued attribute to residents of Flathead County. Respondents were only willing to pay $0.30 ($0.35) to reduce the number of homes evacuated each year from 130 to 129. This aggregates to a total value of $9,156 ($10,682) for each home protected from evacuation due to the threat of wildfire.

6.4 Summary

This chapter summarized the findings from the questionnaire and reported the results derived from choice models of public preferences for wildfire management strategies in Flathead County. Variable coefficients were interpreted and shadow prices were derived for these choice models. Total willingness to pay to protect attributes at risk from wildfire was calculated in accordance with population parameters provided by the US Census Bureau. It was found that unhealthy smoke days and timber burned by wildfire were the highest-valued attributes to residents of Flathead County, while the number of annual evacuations was the lowest valued attribute.

7. Implications for Economically Efficient Wildfire Management and Policy in Flathead County

This chapter explores potential policy implications arising from the choice models presented in the previous chapter, summarizes the research, and discusses future directions for wildfire economics research.

7.1 Discussion and Policy Implications

Comparison of the shadow prices for the models listed in Table 6.6 and the adjusted TWTP estimates from Table 6.8 provides information on the relative value that Flathead County residents place on the six attributes at risk from wildfire. In the base choice model, Flathead County residents indicated the highest WTP to reduce the number of acres of timber burned by wildfire by 1000 acres. When the choice model estimates were adjusted to account for the socio-economic weights in accordance with the population of Flathead County, reducing the number of unhealthy smoky days from 6 to 5 became the most highly valued attribute. Reducing the number of evacuations from 130 to 129 elicited the lowest average WTP in the choice models and the TWTP estimates.

The results from the choice models indicate that private property protection is not highly valued by residents of Flathead County—a finding that is further confirmed by the fact that a majority of respondents indicated that it is the responsibility of the individual homeowner to protect their residence from wildfire. This result seems to indicate that Flathead County residents largely do not wish to use their state and property tax dollars to support the protection of private structures at risk from wildfire. This suggests that current wildfire management is not socially-efficient; a significant proportion of wildfire management resources are utilized protecting

private property (OIG 2006, Liang et al. 2008), an attribute that, according to this study, has a low social value. With this much of the Forest Service's wildfire management budget dedicated to protection of private structures, other attributes that society highly values are not receiving proper attention by wildfire managers (OIG 2006). The major policy implication of this research is that the Forest Service could increase social welfare by devoting less wildfire management resources to private property protection. This would free up resources to use on other attributes at risk, and could lead to increased economic efficiency for wildfire management.

It must be acknowledged, however, that it is possible that 'the number of homes requiring evacuation' is not an appropriate proxy for structure protection/structure loss. As mentioned in chapter 5, the attribute was quantified this way because no private residences have been destroyed by wildfire in Flathead County since 1988, and evacuation was identified by the focus group to be an alternative indicator of wildfire risk to private structures. While the questionnaire directed respondents to interpret this attribute such that evacuated homes were in danger of being damaged or destroyed by wildfire, it is possible that the 'number of homes evacuated' may not have resonated as strongly with respondents as 'number of homes destroyed by wildfire.' Nevertheless, results for this attribute seem consistent with the general attitude of Flathead County residents revealed in the survey, and are consistent with the opinions presented by focus group members.

The most highly-valued attribute identified by this study in the TWTP estimates was the number of unhealthy smoky days experienced each fire season. While the smoke arising from a wildfire may be difficult to manage directly, it is possible to manage the severity of smoke in the long run through management strategies like prescribed burns. The results from this study may also be helpful in determining how to efficiently spend management resources when two or more

wildfires are burning simultaneously. Given the relative values of unhealthy and moderate smoke, it would be socially efficient to suppress the fire(s) that are most contributing to poor air quality for affected residents. Evidence from this study suggests that management activity that reduces unhealthy and moderate smoke exposure should be high priority for wildfire managers in Flathead County.

Acres of timber land burned by wildfire was another highly valued attribute, with WTP estimates up to $385-$400 per acre protected from wildfire. This is, presumably, due to the important role that the timber industry plays in the economy of Flathead County. In addition to being an important contributor to the economy of Flathead County, respondents may perceive the timber industry as being indicative of rural, natural-resource dependent livelihoods, something that residents of Flathead County have stated they wished to see preserved (Flathead County Planning and Zoning 2009). As described in Section 6.1, approximately 57 percent of respondents indicated that they wished to see land managers place more emphasis on timber extraction and resource use. If this is the case, then this suggests that residents of Flathead County are willing to pay extra taxes in order to support the industries that embody the livelihoods that they value. Social welfare in Flathead County, then, could be increased if land managers were to increase protection of timber land from wildfire.

The relative value of forest and watershed health to residents of Flathead County is intermediate relative to the value of other attributes, but residents on average still express a positive WTP to reduce the proportion of large (5000+ acres) wildfires that burn on the landscape. This suggests that residents of Flathead County would support management activities that would return the forests to a fire regime more consistent with the historical fire regime of Flathead County, however, the findings from this research do not detail how residents would like

to see this achieved. One possible way this could be achieved would be to let more fires burn, rather than aggressively suppressing the vast majority of fires. Though current wildfire management policy does allow forest managers to utilize wildland fire use as a wildfire management tool, the degree in which wildland fire use is actually employed in the field is questionable (Dale 2006; Steelman and Burke 2007). For example, operational clarification number two to the 2001 FWFMP states that: "Human caused wildland fires will be suppressed in every instance and will not be managed for resource benefits" (NWCG 2009), however, between 50 to 90 percent of wildland fires are human caused (Interfire 2009). Wildland fire use may be an economically affordable management tool that would help return forests to a historic fire regime. Increased emphasis on wildland fire use may be a cost-effective management strategy to satisfy public demand for this attribute (as long as the fire does not conflict with other social values, such as air quality or timber).

Residents of Flathead County placed the second lowest value on protecting recreation opportunities. Perhaps one explanation for the comparatively low value respondents placed on recreation in the choice models is the degree of substitutability between affected recreation sites; if fire is negatively affecting a recreation opportunity in one area, there are likely to be several other areas that an individual can recreate in that aren't being affected. It is also possible that respondents were accounting for the possible positive effects of wildfire on recreation opportunities (e.g. greater hunting success, wildflower viewing, etc), since the questionnaire did not explicitly instruct respondents that recreation plans would be negatively affected. Even though this attribute was not as highly valued as moderate and unhealthy smoke, timber, and forest and watershed health, the marginal WTP for protecting recreation opportunities was between 5.5 to 6.5 times greater than the marginal WTP to protect private structures, suggesting

that protection of recreation opportunities (i.e. recreation destinations) should be an emphasis of wildfire managers in Flathead County.

7.2 Limitations of this Research

Given the general aversion of Flathead County residents to state income and property tax increases highlighted in Chapter 6, and the numerous competing demands for tax revenues, the magnitude of the estimates for TWTP for the attributes in the survey must be carefully considered. Also, since the derived marginal values represent the value for a one-unit increase in attribute levels, the analysis of these models requires the assumption that the negative marginal value for a one-unit increase in attribute levels is equivalent to the positive value that respondents would be willing to pay to see a one-unit decrease in the attribute level. This assumption has been called into question by previous choice modeling research (Champ and Loomis 1998, Brown and Gregory 1999) but is standard practice for the choice modeling method (Bennett and Blamey 2001, Hanley et al. 2001, Bateman et al. 2002, Garber-Yonts et al. 2004, Kanninen 2007).

The status quo effect (a bias where respondents always select the status-quo option even when this leads to conflicting preferences) is another factor that should be considered when interpreting these results. In this study, approximately 60% of choice set responses were in favor of the status quo. There are many reasons why the status quo effect may be present in this research. First, it is possible that the status quo option was chosen by individuals who didn't have strong wildfire management opinions, perhaps because they felt the survey was confusing or because not enough information was provided.[7] Second, favor of the status quo could be a

[7] Approximately 60% of responses from individuals who said that the survey was confusing or that they needed more information were in favor of the status quo, which is consistent with the overall average of the survey.

consequence of the opposition to additional taxation, however, there were alternatives that would have kept taxation equivalent to status quo levels or reduced the level of taxation that would not be consistent with always choosing the status quo. Third, distrust of the government could lead respondents to favor the status quo because they feel that fire managers may not be capable of actually changing wildfire management strategies for political or other reasons. The prevalence of the status quo effect, lexicographic preferences (always choosing a profile based on the highest or lowest level of one attribute even when this leads to conflicting preferences), and their effect on the value for the attributes at risk should be considered when interpreting these results.

Despite these potential problems with the calculation of marginal and TWTP, the relative value of each of the attributes to residents of Flathead County is consistent with many of the opinions of several focus group members, and should be useful for providing guidance to policy makers and fire managers regarding public preferences for wildfire management in Flathead County.

7.2 Concluding Comments and a Call for Future Research

Reducing wildfire management and suppression costs is a top priority for the US Forest Service, and given the projected growth of residential development in the WUI and the trend of increasingly large and more severe wildfires, it seems unlikely that the Forest Service will be able to reduce wildfire management costs if they continue to uphold the current paradigm of aggressively defending private property. The results from this survey indicate that the private property protection focus of the Forest Service does not align with social preferences for wildfire management in Flathead County. Residents largely do not wish to subsidize the protection of private property, and feel that other attributes, such as air quality, timber protection, forest and

watershed health, and recreation, should receive greater management attention from fire managers. However, according to a recent audit report of the Forest Service (OIG 2006) these attributes are largely being ignored in favor of protection of private property. In order to maximize social welfare, fire managers need to place a greater emphasis on the wildfire attributes identified in this study.

Further research could include examining the effect of the status quo bias and lexicographic preferences on the results presented from the choice models and correcting for these effects in the calculation of TWTP. Also, the marginal WTP estimates for attributes in this study are for changes from the status quo level. Determining how marginal WTP changes at alternative levels of each attribute would provide greater insight into social preferences for wildfire management.

Another potential call for research could include examining wildfire management preferences of US Forest Service and other federal fire managers to determine the relative value that fire managers themselves have for various attributes at risk from wildfire. A comparison from the proposed study and this research would provide valuable insights into the possible discrepancy between social values for attributes at risk from wildfire and the values that wildfire managers attribute to attributes at risk from wildfire. This research could also investigate why fire managers make the management decisions that they do, and test to see whether political pressure factors into the decision making process.

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APPENDIX A – MDEQ WILDFIRE SMOKE GUIDELINES

Visibility Ranges

Health Effects Categories	Visibility Ranges (miles)[3]
Hazardous	< 1.3
Very Unhealthy	2.1 - 1.3
Unhealthy	5.0 - 2.2
Unhealthy for Sensitive Groups	8.7 - 5.1
Moderate	13.3 - 8.8
Good	> 13.4 +

The procedure for making personal observation to determine the forest fire smoke index value for local areas without National Weather Station (NWS) or Department of Environmental Quality (DEQ) monitors is:

1. Face away from the sun.
2. Determine the limit of your visible range by looking for targets at known distances (miles).
3. Visible range is that point at which even high contrast objects totally disappear.
4. Use the values above to determine the local forest fire smoke category.

Health Effects Categories

Air Quality Index (AQI) for BAM-2.5 24-Hour [1]

Health Effects Categories	Health Effects	Cautionary Statements
Hazardous	Serious aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; serious risk of respiratory effects in the general population.	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly, and children should remain indoors.
Very Unhealthy	Significant aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; significant risk of respiratory effects in the general population.	People with respiratory or heart disease, the elderly, and children should avoid any outdoor activity; everyone else should avoid prolonged exertion.
Unhealthy	Increased aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; increased respiratory effects in the general population.	People with respiratory or heart disease, the elderly, and children should avoid prolonged exertion; everyone else should limit prolonged exertion.
Unhealthy for Sensitive Groups	Increasing likelihood of respiratory symptoms in sensitive individuals, aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly.	People with respiratory or heart disease, the elderly and children should limit prolonged exertion.
Moderate	Possibility of aggravation of heart or lung disease among persons with cardiopulmonary disease and the elderly.	None

[1] Guideline For Reporting Of Daily Air Quality – Air Quality Index (AQI), EPA-454/R-99-010, July 1999, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 27711.

APPENDIX B – 17 POLICY STATEMENTS TO GUIDE WILDFIRE MANAGEMENT, FROM THE 2001 REVIEW AND UPDATE OF THE FEDERAL WILDLAND FIRE MANAGEMENT POLICY

1) Safety: Firefighter and public safety is the first priority. All fire management plans and activities must reflect this commitment.
2) Fire management and ecosystem stability: The full range of fire management activities will be used to achieve ecosystem sustainability including its interrelated ecological, economic, and social components.
3) Response to Wildland Fire: Fire, as a critical natural process, will be integrated into land and resource management plans and activities on a landscape scale, and across agency boundaries. Response to wildland fires is based on ecological, social, and legal consequences of the fire.
4) Use of Wildland Fire: Wildland fire will be used to protect, maintain, and enhance resources and, as nearly as possible, be allowed to function in its natural ecological role. Use of fire will be based on approved Fire Management Plans and will follow specific prescriptions contained in operational plans.
5) Rehabilitation and Restoration: Rehabilitation and restoration efforts will be undertaken to protect and sustain ecosystems, public health, safety, and to help communities protect infrastructure.
6) Protection Priorities: The protection of human life is the single, overriding suppression priority. Setting priorities among protecting human communities and community infrastructure, other property and improvements, and natural and cultural resources will be done based on the values to be protected, human health and safety, and the costs of protection.

7) Wildland Urban Interface: The operational role of federal and state agencies as partners in the WUI are wildland firefighting, hazard fuels reduction, cooperative prevention and educations, and technical assistance. Structural fire suppression is the responsibility of tribal, state, or local governments. Federal agencies may assist with exterior structural protection activities under formal Fire Protection Agreements that specify the mutual responsibilities of the partners, including funding.
8) Planning: Every area with burnable vegetation must have an approved Fire Management Plan. Fire management plans are strategic plans that define a program to manage wildland and prescribed fires based on the area's approved land management plan.
9) Science: Fire management plans and programs will be based on a foundation of sound science. Research will support ongoing efforts to increase our scientific knowledge of biological, physical, and sociological factors. Information needed to support fire management will be developed through an integrated interagency fire science program.
10) Preparedness: Agencies will ensure their capability to provide safe, cost-effective fire management programs in support of land and resource management plans through appropriate planning, staffing, training, equipment, and managing oversight.
11) Suppression: Fires are suppressed at minimum cost, considering firefighter and public safety, and all values to be protected, consistent with resource objectives.
12) Prevention: Agencies will work together and with their partners and other affected groups and individuals to prevent unauthorized ignition of wildland fires.

13) Standardization: Agencies will use compatible planning processes, funding mechanisms, training and qualification requirements, operational procedures, values-to-be-protects methodologies, and public education programs for all fire management activities.

14) Interagency Cooperation: Fire management planning, preparedness, prevention, suppression, fire use, restoration and rehabilitation monitoring, research, and education will be conducted on an interagency basis with the involvement of cooperators and partners.

15) Communication and Education: Agencies will enhance knowledge and understanding of wildland fire management policies and practices through internal and external communication and education programs.

16) Agency Administrator and Employee Roles: Agency administrators will ensure that their employees are trained, certified and made available to participate in the wildland fire program locally, regionally, and nationally as the situation demands. Employees with operational, administrative, or other skills will support the wildland fire program as necessary.

17) Evaluation: Agencies will develop and implement a systematic method of evaluation to determine effectiveness of projects through implementation of the 2001 Federal Wildland Fire Management Policy.

Appendix C – Focus Group Participant List

Name	Organization
Catherine Barbouletos	US Forest Service, Flathead National Forest
Joe Brenneman	Flathead County
Cathy Calloway	Forest Silviculturalist, Flathead National Forest
Dan Cassidy	Montana Department of Natural Resource Council
Lincoln Chute	Flathead County Fire Manager
Ann Dahl	Swan Ecosystem Center
Carol Daly	Flathead Economic Policy Center
Jeff Harris	Flathead County Planning
Tim Manley	Montana Fish Wildlife and Parks
Keith Olsen	Montana Logging Association
Mark Peck	Flathead Emergency Management Director
Jack Potter	Glacier National Park
Bill Swope	Northwest Montana Regional Resource and Development Council
Paul Uken	Montana Logging Association
George Weldon	US Forest Service Regional Office, Deputy Director Fire
Marilyn Wood	Flathead Landtrust

APPENDIX D – PRE-NOTIFICATION LETTER, COVER LETER, CHOICE MODELING QUESTIONNAIRE, AND REMINDER LETTER

The University of Montana

College of Forestry and Conservation
Montana Forest & Conservation Experiment Station
The University of Montana
Missoula, Montana 59812

Phone: (406-243-5521)
FAX: (406-243-4845)

August 13, 2008

Address of recipient
....
....

A few days from now you will receive in the mail a request to fill out a questionnaire for an important research project being conducted by the College of Forestry and Conservation, The University of Montana.

This project concerns public preferences for wildfire management in Flathead County.

I am writing in advance to inform you that your residence has been randomly selected as one of 1200 Flathead County residents to receive the questionnaire. This study is an important one that will help the Forest Service and other government agencies understand your opinions about wildfire and how you think wildfire should be managed. The results of this study could influence the way wildfire is managed in Flathead County and the greater Rocky Mountain west.

Thank you for your time and consideration. It is only with the generous help of people like you that our research can be successful.

Sincerely,

Tyron Venn.
Assistant Professor of Natural Resource Economics

P.S. We will be enclosing a small token of appreciation with the questionnaire as a way of saying thanks.

The University of Montana

Bureau of Business and Economic Research
Gallagher Business Building
The University of Montana
Missoula, Montana 59812-6840
Phone: 1-877-700-2237
Email: janet.stevens@business.umt.edu

Dear survey recipient,

The Yellowstone fires of 1988 marked the beginning of an era of large wildfires in the western United States that have threatened lives, destroyed homes, changed landscapes and stretched fire suppression resources thin. The U.S. Forest Service's annual fire suppression expenditures have dramatically increased in recent years, exceeding $1 billion in five out of the last eight fire seasons.

Scientists and land managers are debating whether wildfires are being managed appropriately. The Forest Service and other government agencies would like to know how residents and landowners think wildfires should be managed in Flathead County, and you have been randomly selected as one of 1200 Flathead County residents to participate in a survey. It is important that your views are recorded so that the opinions of Flathead County residents are represented in the survey.

We would like any adult head of your household (18 years or older) to complete this survey. We expect completing the survey should take about 30 minutes of your time. Your responses will be strictly confidential, as no personal identification information is requested, but the overall results of the survey will be made public.

The information you and other survey participants provide may influence the way wildland fire is managed in Flathead County and the greater Rocky Mountain west, so please carefully consider your responses to questions in this survey.

This survey is being conducted by Dr. Tyron Venn and Mr. Derek O'Donnell from the College of Forestry and Conservation at The University of Montana in cooperation with the Forest Service. If you require any further information about the survey, please feel free to contact Janet Stevens at the toll-free phone number 1-877-700-2237.

We have included a stamped and addressed envelope for you to return your completed survey. If you misplace this envelope, please return the completed survey to Bureau of Business and Economic Research, Gallagher Business Building, The University of Montana, Missoula, Montana 59812-6840.

We encourage you to return your completed survey as soon as you can. Thank you for your cooperation. It is sincerely appreciated.

TyronVenn

P.S. As a token of our appreciation for completing the survey, we have enclosed a $2 bill.

Public wildfire management agencies, including the Forest Service, Montana Department of Natural Resources and Conservation (DNRC), and local fire departments are exploring alternative wildfire management strategies that may better protect human life, structures and the environment. To improve future management of wildfire, these agencies would like to learn more about how you would like to see wildfire managed in Flathead County. We would like any adult head of your household (18 years or older) to complete this survey.

The survey has three parts. The first asks about your residence and your opinions about wildfire and its management. The second part presents you with several different possible wildfire management strategies for Flathead County and asks you to select your preferred strategies. The last part of the survey asks for basic background information about you to ensure we have obtained opinions from a representative portion of Flathead County residents. Please complete all three parts of the survey.

The University of Montana

College of Forestry
and Conservation

PART 1: Your Residence and Opinions about Wildfire and its Management

If you have more than one residence, **please answer the following questions about the Montana residence the survey was mailed to.**

1) Was this survey mailed to your primary residence?
   - ☐ Yes (Go to Question 2)
   - ☐ No (Please answer question A)
     - A) Is your primary residence in:
       - ☐ An urban area in Montana
       - ☐ A rural area in Montana
       - ☐ An urban area in another state or country
       - ☐ A rural area in another state or country

2) Do you own or rent this residence?
   - ☐ Own
   - ☐ Rent
   - ☐ Don't know / Neither

3) Which of the following best describes your residence:
   - ☐ An apartment, condominium, or townhouse
   - ☐ A home on a lot of 1 acre or less
   - ☐ A home on a lot between 1 and 10 acres
   - ☐ A home on a lot greater than 10 acres

4) How would you best describe the setting around your residence?
   - ☐ Urban or suburban
   - ☐ Rural cropland or grassland
   - ☐ Rural forestland

5) Have you ever evacuated or been advised to evacuate your residence because of the threat of wildfire?
   - ☐ No
   - ☐ Yes

6) Do your property taxes include the Montana State Wildfire Assessment Fee?
   - ☐ No
   - ☐ Yes
   - ☐ Don't know
   - ☐ I do not pay property taxes, I rent my residence

7) Is your residence within approximately 1.5 miles of a large forested area?
   - ☐ No (Go to Question 8)
   - ☐ Yes (Please answer items i-v)
   - ☐ Don't know (Please answer items i-v)

   i. Do you have forest on your land?
      - ☐ No
      - ☐ Yes (Please answer question a)
        a. Have you performed timber harvesting, thinning, or other fuel reduction treatments to reduce wildfire risk?
           - ☐ No
           - ☐ Yes

   ii. Have any of your neighbors, either private or public land owners, performed timber harvesting, thinning, or fuel reduction treatments to reduce wildfire risk?
      - ☐ No
      - ☐ Yes
      - ☐ Don't know

   iii. Is the exterior of your residence built with fire resistant material?
      - ☐ No
      - ☐ Yes
      - ☐ Don't know

   iv. Do you have fire insurance that could compensate you for wildfire-related damage to your residence?
      - ☐ No
      - ☐ Yes
      - ☐ Don't know

   v. Have you participated in at least one of the following Montana State University (MSU) extension forestry courses: *Forest Stewardship Planning Workshop*, *Wildfire Hazard Reduction*, *Forest Harvesting Practices / Advanced Silviculture* or *Wildfire Restoration*?
      - ☐ No
      - ☐ Yes

8) In the last two years, have any of your forest recreation activities been negatively affected by wildfire?
   - ☐ No
   - ☐ Yes

9) In Flathead County, what kinds of forestland recreation do you partake in? (Check all that apply)

☐ Camping	☐ Skiing/Snowboarding	☐ Cross-country skiing/Snowshoeing
☐ Picnicking	☐ Snowmobiling	☐ Rafting/Canoeing/Kayaking
☐ Hiking/Biking	☐ Off-road driving	☐ Motor boating
☐ Hunting	☐ Horseback riding	☐ Wildlife viewing/Bird watching
☐ Fishing	☐ Rock climbing	☐ Mushroom or berry picking

10) Do you think wildfire on the landscape will:
- ☐ Increase your income
- ☐ Decrease your income
- ☐ Not affect your income
- ☐ Not sure how wildfire affects your income

11) Please indicate by checking one box per line in the following table what you think about the current management objectives of state and federal forest lands in Flathead County?

Management objective	Too much emphasis on this objective	Too little emphasis on this objective	The emphasis on this objective is about right	Don't Know
a. Fire management and suppression	☐	☐	☐	☐
b. Timber harvesting and resource use	☐	☐	☐	☐
c. Environmental protection	☐	☐	☐	☐

12) The following are some opinions people have regarding wildfire in Flathead County. With which do you *most* agree?
- ☐ Current wildfire management is not aggressive enough and all wildfires should be suppressed.
- ☐ Current wildfire management, which allows some wildfires to burn under certain conditions, is about right.
- ☐ Current wildfire management is too aggressive and more wildfires should be allowed to burn.

13) Who do you believe is **primarily** responsible when homes burn due to wildfire?
- ☐ The individual home owner
- ☐ Fire management agencies such as the Forest Service, Montana Department of Natural Resources and Conservation, and the Flathead County Volunteer Fire Department

14) We would like to know your opinion about the importance of some possible uses of your tax dollars. Below is a list of some concerns that can be addressed with the taxes you pay. Please rank the three (3) issues of greatest importance to you by placing a 1 in the box beside the concern that is **most important** to you, a 2 beside your second-greatest concern, and a 3 beside your third most important concern. Leave all other boxes blank.

- ☐ Quality of the education system
- ☐ Fuel/gas/energy costs
- ☐ Public land management, including wildfire management
- ☐ Unemployment
- ☐ Climate change
- ☐ Economic development
- ☐ Preserving rural landscapes and lifestyles
- ☐ Quality of the healthcare system
- ☐ National defense

Thank you for answering Part 1 of this survey. The following pages discuss some key aspects of wildfire management and its impacts, and will help you evaluate the different wildfire management strategies in Part 2 of this survey. Please take a few minutes to carefully read this material before completing Part 2 of the survey.

HISTORIC AND CONTEMPORARY WILDFIRES IN FLATHEAD COUNTY

Historically, wildfires in Flathead County burned forests every 50 to 500 years. These fires were predominantly stand-replacing crown fires and mosaic fires. Stand-replacing fires are of high intensity and kill most or all of the vegetation, including large mature trees. Mosaic fires have patches of low intensity and high intensity fire, and kill a lower proportion of vegetation. These fire types are illustrated in Photos 1 and 2 respectively. We still experience both types of fire today; however, stand-replacing wildfires have become more common and a typical stand-replacing wildfire burns more acres today than it would have historically. Since 2003, 325,000 acres (10%) of Flathead County has been burned by wildfire, and 90% of the acres burned were in large fires greater than 5000 acres.

WHY ARE WE EXPERIENCING MORE LARGE WILDFIRES TODAY?

Scientific evidence suggests that the increasing size of wildfires in Flathead County is due in large part to successful wildfire suppression throughout much of the last century, which resulted in wildfire burning fewer acres per year than it would have naturally. With more woody fuel accumulating across wide areas of forest, large fires are likely to result if a fire starts under particular weather conditions. Longer, hotter, drier summers and increased beetle outbreaks are additional factors contributing to the increase in large wildfires, and are likely to continue.

WHAT ARE THE COSTS AND BENEFITS OF WILDFIRE MANAGEMENT?

Wildfires play an important natural role in maintaining healthy ecosystems in Flathead County. However, they can also impose considerable costs on society, including putting lives and structures at risk, reducing air quality, changing or restricting access to recreation areas, destroying or devaluing current timber resources, and requiring the expenditure of large sums of tax revenue to manage them. These important effects of wildfire on Flathead County residents are described below.

Forest and watershed health

Native plants and animals in the forested headwater areas of Flathead County are adapted to the small and moderate (less than 5000 acre) stand-replacing and mosaic wildfires that burned historically in this region. Small and moderate fires are likely to have mostly positive effects on forest and watershed health. For example, they prevent trees from establishing in natural grassland ecosystems, and maintain important winter range for deer, elk and other species. The short-term impact of wildfire on fish is negative, but wildfire is essential for long-term maintenance of habitat quality for salmon, trout and other aquatic life through recruitment of large woody material and coarse sediment into streams. By creating a mosaic of habitats, historic wildfire helped ensure the conservation of a wide variety of species, and made forests more resilient to epidemic infestations of insects and disease. Also, areas previously burned often act as natural barriers to the spread of future wildfires by consuming and modifying available forest fuels. Photo 2 illustrates the aftermath of a mosaic fire of low and high intensity.

Several scientific research studies suggest the large (greater than 5000 acre), high intensity stand-replacing wildfires we commonly experience today are more likely to be detrimental to the health of the forests and watersheds of Flathead County. Large fires create large stands of even-aged forest regrowth (not patches) that do benefit some wildlife, but are less beneficial for most species. Furthermore, they typically burn multiple watersheds at once, which can lead to greater chances of severe soil erosion, flooding and increased debris flow in rivers, reduced water quality, and degradation of fish habitat. Large fires also increase the probability of local loss of endangered animals and fish (like bull trout) that have experienced habitat loss, habitat fragmentation (by dams, roads and other infrastructure), or have been negatively affected by the expansion of non-native species. Photo 1 illustrates the aftermath of a large stand-replacing wildfire.

Photo 1. Large, high intensity, stand-replacing wildfire more typical of today's wildfires.

Photo 2. Mosaic fire of low and high intensity that is more typical of historic wildfires.

Lives, homes and infrastructure

Wildfires can threaten human lives, homes and public infrastructure such as power lines. Roads may be cut, restricting travel and isolating communities. Increased levels of suspended sediment and debris in waterways following wildfire is detrimental to water quality for drinking and other purposes shortly after the fire, and can damage or reduce the effective life of infrastructure, including bridges, dams, water distribution systems and hydroelectric power turbines.

Air quality

Smoke from wildfire reduces visibility and may cause health effects such as irritation of the eyes and nose, and increase the incidence of respiratory illnesses, including asthma. Particular groups of individuals, including people with respiratory or heart disease, the elderly and children, are especially sensitive to wildfire smoke and may have to remain indoors or even leave an affected area until the smoke has passed. Local fire management does not have the ability to entirely eliminate smoke, particularly because under certain weather conditions fires as far away as California and British Columbia can create smoky conditions in the Flathead. However, the severity and timing of smoke originating within Flathead County can be modified by management activities.

Recreation

Wildfire and post-fire management can have positive and negative effects on forest recreation opportunities. Most wildfire impacts on recreation are short-term and due to temporary forest trail and road closures, and smoke. However, safety concerns arising from standing dead trees and unstable slopes do occasionally lead to long-term closures of forest trails and roads. Amenities such as campsites may be destroyed, and the burned forest may be visually unattractive for years. On the other hand, wildfires may promote wildflowers, make wildlife viewing easier and reveal scenic views previously obstructed by tree cover. Fire-related habitat improvement in and adjacent to burned areas for game and fish typically translates into greater hunting success shortly after fire, and greater fishing success in the long-term.

Timber

The timber industry is an important part of the Flathead County economy. There are 30-35 wood products facilities active most years, generating products worth $400 million per year. Employment in forestry, logging and wood products manufacturing in the county is about 1600 (excluding federal and state employees) - approximately 5% of total county employment. Nearly half of the timber volume processed locally is harvested in the county.

Wildfire can have a substantial effect on the timber assets of Flathead County and the future of the local timber industry. Stand-replacing wildfires in the region typically kill much of the vegetation within the burned area, but a portion of mature forests can be salvage logged. Evidence from salvage logging operations following fires in Flathead County suggests that it costs the landowner (public or private) about $400/acre (40% of pre-fire timber value) in lost timber revenue when a wildfire burns a mature forest. The cost of wildfire burning immature timber stands (with little or no commercial value) is that the forest rotation must start over, and the forest will not reach harvestable age for another 60-80 years.

Wildfire Management Costs

Larger wildfires, and increasing residential development in forested areas has made wildfire management more challenging and led to rapidly increasing levels of wildfire suppression expenditure in Flathead County. Wildfire management in the county is primarily the responsibility of the Forest Service, the Montana Department of Natural Resources and Conservation (DNRC), and Flathead County – all taxpayer-funded. Since 2003, the state has spent an average of $36 million per year on fire preparedness and suppression, with $60 million being spent in 2007. Federal agencies do not report fire management expenditure by state, but in Forest Service Region 1 (Montana and North Idaho), the Forest Service has spent an average of $140 million per year managing wildfire since 2003, with $170 million being spent in 2007. Flathead County spent $0.36 million on structure protection in 2007.

PART 2: Wildfire Management Choice Sets

We would now like to know what you think about possible wildfire management strategies in Flathead County. You will be presented with 6 **choice sets**, each of which contains three alternative wildfire management strategies for Flathead County. For each choice set, carefully consider the implications of each fire management strategy by looking at the outcomes listed in the table. Each strategy will have both positive and negative outcomes in terms of evacuations, forest recreation, smoke, timber assets, forest and watershed health, and cost to you. These alternative strategies can be implemented by varying levels of prescribed fire, mechanical fuel treatments, wildfire suppression and other management activities.

Please complete ALL six choice sets. For each **choice set**, please select the one wildfire management strategy that you most prefer. **When deciding the strategy you would select, please remember to keep in mind your available income and all other things you have to spend your money on.**

What does **"Number of homes requiring evacuation because of the threat of wildfire"** mean?

This means 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.

Consider:

- Evacuated homes are considered to be in danger of being damaged or destroyed by wildfire.
- In 2007, 130 privately owned structures were evacuated in Flathead County.
- Wildfire has not destroyed a home in Flathead County since 1988.

What does **"Chance per year that your forest recreation opportunities will be substantially affected by wildfire"** mean?

This means the chance per year for the next 10 years your public use forestland recreation plans will be affected during the summer due to wildfire.

Consider:

- Approximately 15% of forest recreation plans in Flathead County have been substantially affected by wildfire each year in recent years.
- Substantial effects of wildfire on recreation opportunities include closure of access to roads, hiking trails, fishing and floating areas, prohibition of campfires due to wildfire risk, and levels of smoke that discourage outdoor recreation.
- Since some recreation areas will be closed, open recreation areas will become more crowded.

What does **"Number of smoky days per year"** mean?

This means the average number of days of *moderate* smoke and *unhealthy* smoke per fire season for the next 10 years.

Moderate smoke 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. Sensitive individuals should limit outdoor exposure. Visibility is between 5 and 13 miles.

Unhealthy smoke can affect the respiratory health of the general population, while health effects for sensitive individuals are significantly increased. The general public should limit outdoor exertion, and sensitive individuals should avoid *any* outdoor activity. Visibility is between 2 and 5 miles.

Consider:

- From 2005 to 2007, Flathead County averaged 25 days of moderate smoke per year and 6 days of unhealthy smoke per fire season.
- 14.5% of Montanans are asthmatic—the highest proportion in the nation.
- Some smoke originates from fires outside the county and cannot be controlled by local wildfire management strategies.

What does **"Acres of timber assets burned per year by wildfire"** mean?

This means the average number of acres of harvestable private, state and federal timber lands burned each year for the next 10 years.

Consider:

- Since 2003, an average of 12,600 acres of harvestable forest has burned each year in Flathead County.
- A portion of burned mature stands can be salvage logged, but on average yield 40% less timber value per acre than an unburned stand. Young stands cannot be salvaged logged and the rotation must restart.
- The timber industry is an important source of employment and income in Flathead County and the proceeds of harvests from state forest land funds public schools in Montana.

What does **"Forest and watershed health: percent of acres burned in large fires"** mean?

This means the proportion of acres burned annually by wildfires greater than 5000 acres in size.

Consider:

- Since 2003, 90% of acres burned were in large fires greater than 5000 acres.
- Research suggests large fires are detrimental to the health of forests and watersheds of Flathead County.
- Reduction in large fires will likely reduce the wildfire related losses of wildlife habitat and water quality.

What does **"Cost to me each year"** mean?

This means how much you will pay per year for the next 10 years in taxes to fund wildfire management in Flathead County.

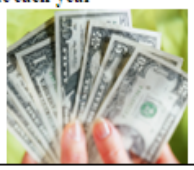
Consider:

- Please keep in mind your available income and all the other things you have to spend your money on.
- The average household in Flathead County already pays $125 per year in state income and property taxes, plus a small proportion of their federal taxes to fund management of wildfire.
- More proactive management of wildfire to reduce the potential for large fires will require increases in management funding over the next 10 to 15 years before the benefits of reduced suppression costs and wildfire size are realized.
- County, state and federal taxes are fully committed, so increases in wildfire management costs associated with alternative strategies in Flathead County would need to be funded by increases in your taxes.
- Even if you do not live near wildfire prone areas, wildfires can affect your air quality, recreation opportunities, family and friends, and income levels in your community.

Instructions for Completing Choice Sets

This page provides an example **choice set** to help you understand the choices you will be asked to make on the following six pages. On each page, three different wildfire management strategies will be presented to you. Each of these strategies have different advantages and disadvantages associated with them, reflecting different asset protection priorities and alternative levels of emphasis on wildfire suppression, prescribed fire, and mechanical fuel treatments. **For all six choice sets on the following pages, please select the one management strategy that you most prefer.**

Example Only:

EXAMPLE CHOICE SET	Average annual outcomes of wildfire management strategies over the next 10 years		
Attribute	Status Quo	Strategy X	Strategy Y
Number of homes requiring evacuation because of the threat of wildfire 	130 homes	100 homes	170 homes
Chance per year that your forest recreation opportunities will be substantially affected by wildfire 	15%	15%	15%
Number of smoky days per year 	25 moderate / 6 unhealthy days	25 moderate / 6 unhealthy days	50 moderate / 6 unhealthy days
Acres of timber assets burned per year by wildfire 	12,600 acres	15,000 acres	12,600 acres
Forest and watershed health: percent of acres burned in large fires 	90%	90%	90%
Cost to me each year 	$125	$250	$70
I would choose (select one only)	☐	☐	☐

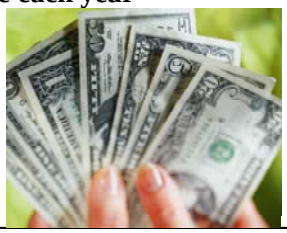
Status Quo: The status quo reflects the current wildfire management strategy in Flathead County. The outcomes in this column reflect how each of the attributes are affected in a typical year. For example, under the current management strategy, 130 homes are threatened each year and you pay $125 per year in taxes for fire management. You will always have the option to select the status quo in each choice set.

Strategy X: The Strategy X column represents a different management strategy than the Status Quo. As you can see, the outcomes are different from the status quo column. For example, only 100 homes are threatened each year in this strategy, but 15,000 acres of timber would be lost to fire each year and the yearly cost to you would be $250. Strategy X will be different in each choice set.

Strategy Y: The Strategy Y column represents another management strategy that is different from both the Status Quo and Strategy X. In this strategy, the cost to you is only $70 per year, but 170 homes are threatened by wildfire each year and there are 50 moderate and 6 unhealthy smoky days every year. Strategy Y will also be different in each choice set.

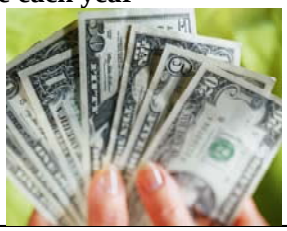
CHOICE SET 1	Average annual outcomes of wildfire management strategies over the next 10 years		
Attribute	Status Quo	Strategy A	Strategy B
Number of homes requiring evacuation because of the threat of wildfire 	130 homes	260 homes	130 homes
Chance per year that your forest recreation opportunities will be substantially affected by wildfire 	15%	40%	5%
Number of smoky days per year 	25 moderate / 6 unhealthy days	50 moderate / 6 unhealthy days	25 moderate / 6 unhealthy days
Acres of timber assets burned per year by wildfire 	12,600 acres	12,600 acres	10,000 acres
Forest and watershed health: percent of acres burned in large fires 	90%	80%	90%
Cost to me each year 	$125	$70	$180
I would choose (select one only)	☐	☐	☐

CHOICE SET 2	Average annual outcomes of wildfire management strategies over the next 10 years		
Attribute	Status Quo	Strategy C	Strategy D
Number of homes requiring evacuation because of the threat of wildfire 	130 homes	400 homes	100 homes
Chance per year that your forest recreation opportunities will be substantially affected by wildfire 	15%	5%	40%
Number of smoky days per year 	25 moderate / 6 unhealthy days	25 moderate / 6 unhealthy days	50 moderate / 6 unhealthy days
Acres of timber assets burned per year by wildfire 	12,600 acres	10,000 acres	12,600 acres
Forest and watershed health: percent of acres burned in large fires 	90%	95%	80%
Cost to me each year 	$125	$450	$180
I would choose (select one only)	☐	☐	☐

CHOICE SET 3	Average annual outcomes of wildfire management strategies over the next 10 years		
Attribute	Status Quo	Strategy E	Strategy F
Number of homes requiring evacuation because of the threat of wildfire 	130 homes	100 homes	170 homes
Chance per year that your forest recreation opportunities will be substantially affected by wildfire 	15%	25%	5%
Number of smoky days per year 	25 moderate / 6 unhealthy days	25 moderate / 6 unhealthy days	25 moderate / 1 unhealthy days
Acres of timber assets burned per year by wildfire 	12,600 acres	15,000 acres	7,500 acres
Forest and watershed health: percent of acres burned in large fires 	90%	70%	90%
Cost to me each year 	$125	$180	$70
I would choose (select one only)	☐	☐	☐

CHOICE SET 4	Average annual outcomes of wildfire management strategies over the next 10 years		
Attribute	Status Quo	Strategy G	Strategy H
Number of homes requiring evacuation because of the threat of wildfire 	130 homes	260 homes	170 homes
Chance per year that your forest recreation opportunities will be substantially affected by wildfire 	15%	25%	15%
Number of smoky days per year 	25 moderate / 6 unhealthy days	50 moderate / 1 unhealthy days	50 moderate / 6 unhealthy days
Acres of timber assets burned per year by wildfire 	12,600 acres	7,500 acres	10,000 acres
Forest and watershed health: percent of acres burned in large fires 	90%	95%	70%
Cost to me each year 	$125	$70	$125
I would choose (select one only)	☐	☐	☐

CHOICE SET 5	Average annual outcomes of wildfire management strategies over the next 10 years		
Attribute	Status Quo	Strategy I	Strategy J
Number of homes requiring evacuation because of the threat of wildfire 	130 homes	130 homes	100 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 / 1 unhealthy days	25 moderate / 6 unhealthy days
Acres of timber assets burned per year by wildfire 	12,600 acres	7,500 acres	10,000 acres
Forest and watershed health: percent of acres burned in large fires 	90%	90%	95%
Cost to me each year 	$125	$450	$250
I would choose (select one only)	☐	☐	☐

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	130 homes	400 homes
Chance per year that your forest recreation opportunities will be substantially affected by wildfire 	15%	15%	40%
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 lost per year 	12,600 acres	15,000 acres	7,500 acres
Forest and watershed health: percent of acres burned in large fires 	90%	80%	90%
Cost to me each year 	$125	$70	$125
I would choose (select one only)	☐	☐	☐

We would like to know your general feelings about this survey. Beside each statement below, please tick the box that most closely describes your point of view. Please give a response to every statement.

	Yes	No	Don't Know
I needed more information than was provided	☐	☐	☐
The survey was confusing	☐	☐	☐
The alternative wildfire management strategies were unrealistic	☐	☐	☐
There are other attributes at least as important as evacuations, recreation, smoke, timber, forest and watershed health and cost that were not included in the choice sets. If yes, please list _____	☐	☐	☐
The information was biased against traditional wildfire suppression strategies	☐	☐	☐
I oppose any additional taxation for government programs	☐	☐	☐
I distrust the government to manage my money properly	☐	☐	☐

Thank you for completing Part 2 of the survey. Finally, we would like to know a little about you. This will greatly assist our analysis of returned surveys, including allowing us to check if we have obtained a representative sample of Flathead County residents.

1. What is your sex?
   ☐ Male ☐ Female

2. What is your age?
   ☐ 18-24 ☐ 35-39 ☐ 50-54 ☐ 65-69 ☐ 80-84
   ☐ 25-29 ☐ 40-44 ☐ 55-59 ☐ 70-74 ☐ 85 and over
   ☐ 30-34 ☐ 45-49 ☐ 60-64 ☐ 75-79

3. What is your marital status?
   ☐ Single/Never married ☐ Divorced ☐ Widowed
   ☐ Now Married ☐ Separated

4. Do you have children? (Check all that apply)
   ☐ No children
   ☐ Children under 18 living with you
   ☐ Children over 18 living with you
   ☐ Children under 18 not living with you
   ☐ Children over 18 not living with you

5. What is your race/ethnicity?
   ☐ Native American ☐ Black/African American
   ☐ White/Caucasian ☐ Asian
   ☐ Hispanic/Latino ☐ Other _____

6. How long have you lived or owned a property in western Montana?
   - ☐ 0-5 years
   - ☐ 5-10 years
   - ☐ 10-20 years
   - ☐ More than 20 years

7. In your opinion, how has the health of forests and watersheds changed in the time you have lived in western Montana?
   - ☐ Forest and watershed health has declined
   - ☐ Forest and watershed health has improved
   - ☐ Forest and watershed health has stayed about the same
   - ☐ No opinion

8. What is the highest level of education you have earned?
   - ☐ Elementary school
   - ☐ High school diploma or GED
   - ☐ Associate's degree
   - ☐ Bachelor's degree
   - ☐ Master's Degree
   - ☐ Professional Degree (MD, DDS, DVM, LLB, JD, DD, etc)
   - ☐ Doctorate Degree (Ph.D. or Ed.D.)

9. Which of the following best describes your current work status?
   - ☐ Employed full or part time
   - ☐ Unemployed and looking for work
   - ☐ Unemployed and not looking for work
   - ☐ Other _____
   - ☐ Retired/Pensioner
   - ☐ Home-maker
   - ☐ Student

10. Which of the following most closely represents your total household income in 2007 before taxes?
    - ☐ Less than $10,000
    - ☐ $10,000 to $14,999
    - ☐ $15,000 to $24,999
    - ☐ $25,000 to $34,999
    - ☐ $35,000 to $49,999
    - ☐ $50,000 to $74,999
    - ☐ $75,000 to $99,999
    - ☐ $100,000 to $149,999
    - ☐ $150,000 to $199,000
    - ☐ $200,000 or more

11. Are you employed in any of the following industries?
    - ☐ Wood products, mining, farming or ranching
    - ☐ Fire fighting or fire management
    - ☐ Insurance or real estate
    - ☐ Recreation and tourism
    - ☐ Health Care
    - ☐ No, I am not employed in any of these industries

12. Do you belong to any of the following types of organizations? Check all that apply.

- ☐ Federal land management agency
- ☐ State land management agency
- ☐ Tribal land management agency
- ☐ Montanans for Multiple Use
- ☐ Other multiple use organizations
- ☐ Montana Logging Association
- ☐ Wildlife or Fisheries Group (Rocky Mountain Elk Foundation, Trout Unlimited, Ducks Unlimited, etc.)
- ☐ Environmental group (Natural Resources Defense Council, Defenders of Wildlife, Audubon Society, Sierra Club, Nature Conservancy, etc.)
- ☐ Local citizen land trust and local land management groups (Flathead Landtrust, Swan Ecosystem Center, etc.)
- ☐ No, I do not belong to any of these types of organizations

13. Are there any comments that you would like to make?

_____

_____

_____

_____

_____

_____

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_____

_____

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_____

_____

_____

THANK YOU VERY MUCH FOR COMPLETING OUR SURVEY,

YOUR TIME AND OPINIONS ARE VERY APPRECIATED!

College of Forestry and Conservation/
Montana Forest & Conservation Experiment Station
The University of Montana
Missoula, Montana 59812

Phone: (406-243-5521)
FAX: (406-243-4845)

October 15, 2008

Address of recipient
….
….

About two weeks ago, we sent a questionnaire to you that asked you about your opinions on wildfire management in Flathead County. To the best of our knowledge, it has not yet been returned.

We have already received responses from many individuals who have expressed a wide variety of different preferences for wildfire management in Flathead County. We think the results from this survey will be very useful to federal and state land management agencies for evaluating current and alternative wildfire management strategies in Flathead County.

We are writing again because of the importance that your questionnaire has for helping to obtain accurate results. Only by hearing from as many people as possible can we be sure that the results of this survey will be truly representative of Flathead County residents. Your response will help ensure that our results accurately reflect the fire management preferences of your local community.

We would like to remind you that this survey is completely confidential and anonymous. A questionnaire identification number is printed on the back cover of the questionnaire so that we can check your name off of the mailing list when it is returned. The list of names is then destroyed so that individual names can never be connected to the results in any way. Protecting the confidentiality of people's answers is very important to us at The University of Montana.

We hope that you will fill out and return the questionnaire soon, but if for any reason you prefer not to answer it, please let us know by returning a note or a blank questionnaire in the enclosed stamped envelope.

Sincerely,

Tyron Venn.
Assistant Professor of Natural Resource Economics

P.S. If you require any further information about the survey, please feel free to contact Janet Stevens at the toll-free phone number 1-877-700-2237.

College of Forestry
and Conservation

APPENDIX E – MINI-MODELS

Live in WUI

	β	Z	Shadow Price
homes	-0.0021374	-4.41	$0.43
recreation	-0.008659	-2.27	$1.76
smokemod	-0.0179756	-4.59	$3.65
smokeunhea~h	-0.0619208	-3.09	$12.56
timber1000	-0.069665	-3.85	$14.13
forhealth	-0.0211773	-3.97	$4.30
cost	-0.0049297	-9.27	
Observations	4482		
McFadden's R^2	.585		

Live out of WUI

	β	Z	Shadow Price
homes	-0.0013903	-2.62	$0.22
recreation	-0.0116427	-2.62	$1.80
smokemod	-0.0170514	-3.72	$2.64
smokeunhea~h	-0.081481	-3.5	$12.62
timber1000	-0.0917971	-4.34	$14.21
forhealth	-0.0256138	-4.06	$3.97
cost	-0.006459	-9.67	
Observations	3342		
McFadden's R^2	.695		

Live in Intermixfor big

	β	Z	Shadow Price
homes	-0.0046971	-3.07	$0.83
recreation	-0.0064085	-0.59	$1.13
smokemod	-0.0197443	-1.76	$3.48
smokeunhea~h	-0.1046601	-1.8	$18.43
timber1000	-0.0402315	-0.81	$7.08
forhealth	-0.0471216	-3.01	$8.30
cost	-0.0056787	-4	
Observations	819		
McFadden's R^2	.942		

Live in Intermixsmall

	β	Z	Shadow Price
homes	-0.00028	-0.26	$0.14
recreation	-0.00721	-0.83	$3.62
smokemod	-0.02026	-2.24	$10.18
smokeunhea~h	-0.02173	-0.46	$10.93
timber1000	-0.08388	-1.94	$42.17
forhealth	-0.00278	-0.23	$1.40
cost	-0.00199	-1.84	
Observations	762		
McFadden's R^2	.924		

No Fire Insurance

	β	Z	Shadow Price
homes	-0.0017179	-1.96	$0.29
recreation	-0.0091566	-1.39	$1.52
smokemod	-0.0233174	-3.18	$3.88
smokeunhea~h	-0.1082886	-2.79	$18.00
timber1000	-0.05963	-1.81	$9.91
forhealth	-0.0329366	-3.29	$5.47
cost	-0.0060173	-6.17	
Observations	1125		
McFadden's R^2	.887		

Have Fire Insurance

	β	Z	Shadow Price
homes	-0.0016715	-2.92	$0.37
recreation	-0.0104874	-2.31	$2.33
smokemod	-0.0130511	-2.83	$2.89
smokeunhea~h	-0.0317684	-1.35	$7.04
timber1000	-0.0581275	-2.69	$12.89
forhealth	-0.0287264	-4.61	$6.37
cost	-0.0045101	-7.23	
Observations	3072		
McFadden's R^2	.708		

Wildland fire management not aggressive enough

	β	Z	Shadow Price
homes	-0.0014403	-2.43	$0.35
recreation	-0.0080204	-1.69	$1.96
smokemod	-0.0105585	-2.12	$2.57
smokeunhea~h	-0.0801255	-3.04	$19.54
timber1000	-0.0407872	-1.78	$9.95
forhealth	-0.0157836	-2.29	$3.85
cost	-0.0041009	-6.21	
Observations	2385		
McFadden's R^2	.759		

Wildland fire management too aggressive

	β	Z	Shadow Price
homes	-0.0004408	-0.51	$0.06
recreation	-0.0060394	-0.81	$0.76
smokemod	-0.0218627	-2.84	$2.74
smokeunhea~h	-0.0594902	-1.51	$7.44
timber1000	-0.0646997	-1.83	$8.10
forhealth	-0.0268155	-2.53	$3.36
cost	-0.0079911	-6.6	
Observations	1053		
McFadden's R^2	.899		

Too much emphasis on fire management

	β	Z	Shadow Price
homes	-0.000907	-0.95	$0.09
recreation	0.0009398	0.11	-$0.09
smokemod	-0.0198995	-2.37	$2.00
smokeunhea~h	-0.0035755	-0.08	$0.36
timber1000	-0.0555796	-1.4	$5.58
forhealth	-0.0321746	-2.69	$3.23
cost	-0.0099595	-6.62	
Observations	966		
McFadden's R^2	.913		

Too little emphasis on fire management

	β	Z	Shadow Price
homes	-0.0018184	-3.24	$0.47
recreation	-0.0052705	-1.2	$1.37
smokemod	-0.0134176	-2.92	$3.50
smokeunhea~h	-0.1004839	-4.18	$26.18
timber1000	-0.0886842	-4.14	$23.11
forhealth	-0.0273981	-4.36	$7.14
cost	-0.0038375	-6.39	
Observations	2841		
McFadden's R^2	.715		

Emphasis on fire management about right

	β	Z	Shadow Price
homes	-0.0017219	-3.68	$0.29
recreation	-0.0154126	-4.04	$2.63
smokemod	-0.016765	-4.26	$2.86
smokeunhea~h	-0.0605699	-3.01	$10.32
timber1000	-0.069446	-3.87	$11.83
forhealth	-0.0226411	-4.2	$3.86
cost	-0.0058696	-10.71	
Observations	4743		
McFadden's R^2	.580		

Too much emphasis on timber and resource extraction

	β	Z	Shadow Price
homes	-0.0015163	-1.41	$0.30
recreation	-0.0080189	-0.94	$1.59
smokemod	-0.0106099	-1.2	$2.10
smokeunhea~h	-0.0666078	-1.45	$13.18
timber1000	-0.0865282	-2.1	$17.12
forhealth	-0.0088385	-0.74	$1.75
cost	-0.0050534	-4.27	
Observations	855		
McFadden's R^2	.920		

Too little emphasis on timber and resource extraction

	β	Z	Shadow Price
homes	-0.0014639	-3.63	$0.29
recreation	-0.0093676	-2.85	$1.86
smokemod	-0.0183972	-5.37	$3.66
smokeunhea~h	-0.0703979	-4.02	$13.99
timber1000	-0.0879442	-5.58	$17.48
forhealth	-0.0262565	-5.63	$5.22
cost	-0.0050309	-10.67	
Observations	5757		
McFadden's R^2	.458		

Emphasis on timber and resource extraction about right

	β	Z	Shadow Price
homes	-0.0017259	-2.44	$0.29
recreation	-0.010684	-1.88	$1.79
smokemod	-0.0141771	-2.44	$2.38
smokeunhea~h	-0.0732134	-2.41	$12.30
timber1000	0.0115657	0.44	-$1.94
forhealth	-0.0316097	-3.92	$5.31
cost	-0.0059544	-7.31	
Observations	1974		
McFadden's R^2	.818		

Too much emphasis on environmental protection

	β	Z	Shadow Price
homes	-0.0017568	-3.51	$0.28
recreation	-0.0059206	-1.44	$0.93
smokemod	-0.0125163	-2.96	$1.96
smokeunhea~h	-0.0676785	-3.15	$10.63
timber1000	-0.089013	-4.52	$13.97
forhealth	-0.0244115	-4.18	$3.83
cost	-0.0063697	-10.35	
Observations	1325		
McFadden's R^2	.641		

Too little emphasis on environmental protection

	β	Z	Shadow Price
homes	-0.0008812	-1.26	$0.22
recreation	-0.0116649	-2.04	$2.89
smokemod	-0.0231598	-3.9	$5.73
smokeunhea~h	-0.0917094	-2.96	$22.69
timber1000	-0.0306132	-1.13	$7.57
forhealth	-0.0289537	-3.62	$7.16
cost	-0.0040417	-5.26	
Observations	1767		
McFadden's R^2	.826		

Emphasis on environmental protection about right

	β	Z	Shadow Price
homes	-0.0017672	-3.09	$0.38
recreation	-0.0135741	-2.97	$2.91
smokemod	-0.0155078	-3.22	$3.33
smokeunhea~h	-0.0664472	-2.67	$14.26
timber1000	-0.0646254	-2.99	$13.87
forhealth	-0.0292185	-4.49	$6.27
cost	-0.0046608	-7.38	
Observations	2808		
McFadden's R^2	.730		

Home protection
owner responsibility

	β	Z	Shadow Price
homes	-0.0013326	-3.66	$0.23
recreation	-0.0077029	-2.59	$1.35
smokemod	-0.0199089	-6.48	$3.49
smokeunhea~h	-0.0621243	-3.94	$10.90
timber1000	-0.0637221	-4.52	$11.18
forhealth	-0.0268934	-6.39	$4.72
cost	-0.0057017	-13.15	
Observations	7254		
McFadden's R^2	.329		

Home protection
government responsibility

	β	Z	Shadow Price
homes	-0.0013288	-2.05	$0.44
recreation	-0.012916	-2.45	$4.23
smokemod	-0.0061207	-1.11	$2.00
smokeunhea~h	-0.0850572	-2.98	$27.85
timber1000	-0.0816238	-3.21	$26.73
forhealth	-0.0146814	-1.96	$4.81
cost	-0.0030539	-4.38	
Observations	1992		
McFadden's R^2	.780		

Do not oppose taxation

	β	Z	Shadow Price
homes	-0.0017048	-3.5	$0.37
recreation	-0.0120055	-3.15	$2.58
smokemod	-0.0264744	-6.49	$5.69
smokeunhea~h	-0.1023653	-4.82	$21.99
timber1000	-0.0765966	-4.18	$16.45
forhealth	-0.0369397	-6.75	$7.94
cost	-0.004655	-8.82	
Observations	3783		
McFadden's R^2	.628		

Oppose Taxation

	β	Z	Shadow Price
homes	-0.0012736	-2.74	$0.19
recreation	-0.0070551	-1.8	$1.06
smokemod	-0.0056305	-1.41	$0.84
smokeunhea~h	-0.0249709	-1.25	$3.74
timber1000	-0.0746914	-3.99	$11.20
forhealth	-0.0149454	-2.72	$2.24
cost	-0.0066702	-11.2	
Observations	4518		
McFadden's R^2	.597		

Do not distrust government to manage money properly

	β	Z	Shadow Price
homes	-0.0013766	-2.37	$0.31
recreation	-0.0064862	-1.44	$1.45
smokemod	-0.01899	-3.91	$4.26
smokeunhea~h	-0.1015175	-3.95	$22.76
timber1000	-0.0796701	-3.6	$17.86
forhealth	-0.0343445	-5.16	$7.70
cost	-0.0044598	-7.11	
Observations	2718		
McFadden's R^2	.737		

Distrust the government to manage money properly

	β	Z	Shadow Price
homes	-0.0015612	-3.81	$0.26
recreation	-0.0127248	-3.71	$2.08
smokemod	-0.0167364	-4.82	$2.73
smokeunhea~h	-0.0642972	-3.66	$10.50
timber1000	-0.0597952	-3.72	$9.77
forhealth	-0.0209283	-4.39	$3.42
cost	-0.0061222	-12.26	
Observations	5763		
McFadden's R^2	.472		

Age >50

	β	Z	Shadow Price
homes	-0.0018432	-4.76	$0.41
recreation	-0.0091698	-2.98	$2.04
smokemod	-0.0171411	-5.36	$3.81
smokeunhea~h	-0.0470209	-2.87	$10.44
timber1000	-0.068263	-4.64	$15.16
forhealth	-0.0158387	-3.64	$3.52
cost	-0.0045042	-10.55	
Observations	6759		
McFadden's R^2	.373		

Age <50

	β	Z	Shadow Price
homes	-0.0009044	-1.8	$0.14
recreation	-0.0105976	-2.49	$1.59
smokemod	-0.0150403	-3.47	$2.26
smokeunhea~h	-0.1145869	-5.09	$17.23
timber1000	-0.0747938	-3.69	$11.25
forhealth	-0.0377337	-6.29	$5.67
cost	-0.0066511	-10.41	
Observations	3390		
McFadden's R^2	.676		

Children

	β	Z	Shadow Price
homes	-0.0013205	-4.02	$0.27
recreation	-0.0091147	-3.39	$1.88
smokemod	-0.0161586	-5.83	$3.33
smokeunhea~h	-0.0615219	-4.33	$12.69
timber1000	-0.0728742	-5.68	$15.03
forhealth	-0.0209219	-5.54	$4.32
cost	-0.0048477	-12.78	
Observations	8634		
McFadden's R^2	.184		

No Children

	β	Z	Shadow Price
homes	-0.0019841	-2.33	$0.28
recreation	-0.0135953	-2	$1.90
smokemod	-0.0195407	-2.76	$2.73
smokeunhea~h	-0.1200666	-3.19	$16.78
timber1000	-0.0575544	-1.81	$8.04
forhealth	-0.0447148	-4.57	$6.25
cost	-0.0071574	-7.08	
Observations	1341		
McFadden's R^2	.876		

Female

	β	Z	Shadow Price
homes	-0.0004042	-0.69	$0.08
recreation	-0.0092973	-1.86	$1.82
smokemod	-0.0211106	-4.1	$4.13
smokeunhea~h	-0.0915134	-3.45	$17.92
timber1000	-0.0648479	-2.73	$12.70
forhealth	-0.0284785	-4.02	$5.58
cost	-0.0051065	-7.29	
Observations	2469		
McFadden's R^2	.766		

Male

	β	Z	Shadow Price
homes	-0.0018208	-5.11	$0.35
recreation	-0.0101754	-3.56	$1.96
smokemod	-0.0153073	-5.18	$2.94
smokeunhea~h	-0.0616761	-4.07	$11.86
timber1000	-0.0712042	-5.23	$13.70
forhealth	-0.021729	-5.4	$4.18
cost	-0.0051988	-12.75	
Observations	7680		
McFadden's R^2	.279		

No High School Degree

	β	Z	Shadow Price
homes	-0.0111077	-3.08	$1.39
recreation	-0.0149792	-0.69	$1.87
smokemod	-0.0727031	-2.83	$9.07
smokeunhea~h	-0.0626161	-0.61	$7.81
timber1000	-0.1268053	-1.31	$15.82
forhealth	-0.0469974	-1.63	$5.86
cost	-0.0080142	-2.47	
Observations	192		
McFadden's R^2	.984		

High School Grad

	β	Z	Shadow Price
homes	-0.0016558	-3.33	$0.29
recreation	-0.014745	-3.55	$2.58
smokemod	-0.015158	-3.58	$2.65
smokeunhea~h	-0.0775509	-3.6	$13.58
timber1000	-0.0696521	-3.58	$12.19
forhealth	-0.018291	-3.14	$3.20
cost	-0.005712	-9.62	
Observations	3642		
McFadden's R^2	.663		

Bachelors/Associates Degree

	β	Z	Shadow Price
homes	-0.0008073	-1.79	$0.16
recreation	-0.0090967	-2.48	$1.85
smokemod	-0.0199853	-5.18	$4.06
smokeunhea~h	-0.0735911	-3.68	$14.96
timber1000	-0.0906208	-5.09	$18.42
forhealth	-0.0332431	-6.34	$6.76
cost	-0.0049201	-9.53	
Observations	4422		
McFadden's R^2	.580		

Graduate Degree

	β	Z	Shadow Price
homes	-0.0036804	-3.37	$0.80
recreation	-0.0088533	-1.12	$1.93
smokemod	-0.0244952	-2.99	$5.35
smokeunhea~h	-0.0823072	-2	$17.97
timber1000	-0.0461216	-1.26	$10.07
forhealth	-0.0329529	-2.99	$7.19
cost	-0.00458	-4.33	
Observations	1140		
McFadden's R^2	.900		

Timber Industry

	β	Z	Shadow Price
homes	-0.0010074	-1.05	$0.18
recreation	-0.0176773	-2.22	$3.19
smokemod	-0.0191272	-2.26	$3.45
smokeunhea~h	-0.0730654	-1.69	$13.16
timber1000	-0.1229188	-3.14	$22.15
forhealth	-0.0350831	-3.07	$6.32
cost	-0.00555	-4.76	
Observations	771		
McFadden's R^2	.919		

Fire Industry

	β	Z	Shadow Price
homes	-0.0440984	-1.36	$0.28
recreation	0.0726981	0.66	-$0.46
smokemod	-0.3156263	-1.15	$1.98
smokeunhea~h	-0.388523	-0.98	$2.44
timber1000	-0.7749641	-1.18	$4.86
forhealth	-0.9452572	-1.34	$5.93
cost	-0.1593372	-1.36	
Observations	72		
McFadden's R^2	.997		

Recreation Industry

	β	Z	Shadow Price
homes	0.0012791	0.78	-$0.15
recreation	-0.0319956	-1.89	$3.84
smokemod	-0.0183321	-1.16	$2.20
smokeunhea~h	-0.0851659	-1.01	$10.23
timber1000	-0.0095989	-0.13	$1.15
forhealth	-0.0359397	-1.49	$4.32
cost	-0.0083236	-3.24	
Observations	342		
McFadden's R^2	.973		

Health Care Industry

option	β	Z	Shadow Price
homes	-0.0023586	-1.66	$0.59
recreation	-0.0134993	-1.15	$3.38
smokemod	-0.0227607	-2.02	$5.70
smokeunhea~h	-0.0981099	-1.72	$24.55
timber1000	0.0273414	0.52	-$6.84
forhealth	-0.0398403	-2.71	$9.97
cost	-0.0039965	-2.59	
Observations	489		
McFadden's R^2	.952		

Insurance Industry

	β	Z	Shadow Price
homes	-0.0008719	-0.49	$0.21
recreation	-0.022074	-1.55	$5.33
smokemod	-0.023121	-1.51	$5.58
smokeunhea~h	-0.0830874	-1.08	$20.05
timber1000	-0.1811698	-2.56	$43.71
forhealth	-0.0701019	-3.4	$16.91
cost	-0.004145	-2.26	
Observations	306		
McFadden's R^2	.972		

Gov. Management Group

	β	Z	Shadow Price
homes	-0.0096206	-2.03	$0.70
recreation	-0.0030361	-0.12	$0.22
smokemod	-0.0354871	-1.03	$2.57
smokeunhea~h	-0.1537741	-0.8	$11.14
timber1000	-0.2466684	-1.58	$17.87
forhealth	-0.1415223	-2.35	$10.25
cost	-0.0138028	-2.52	
Observations	90		
McFadden's R^2	.992		

Multiple Use Group

	β	Z	Shadow Price
homes	-0.0021601	-1.54	$0.48
recreation	-0.0154451	-1.35	$3.43
smokemod	-0.0031624	-0.27	$0.70
smokeunhea~h	0.0414192	0.7	-$9.19
timber1000	-0.1339985	-2.45	$29.74
forhealth	-0.0326045	-2.06	$7.24
cost	-0.0045063	-2.79	
Observations	429		
McFadden's R^2	.955		

Environmental Group

	β	Z	Shadow Price
homes	-0.0024924	-2.15	$0.67
recreation	-0.0200287	-2.3	$5.38
smokemod	-0.0242828	-2.62	$6.52
smokeunhea~h	-0.0964101	-2.04	$25.88
timber1000	-0.0821221	-1.97	$22.04
forhealth	-0.0538509	-4.39	$14.45
cost	-0.0037257	-3.27	
Observations	693		
McFadden's R^2	.930		

Wildlife & Fisheries Group

	β	Z	Shadow Price
homes	-0.0018418	-2.02	$0.34
recreation	-0.015255	-2.19	$2.82
smokemod	-0.0109562	-1.51	$2.03
smokeunhea~h	-0.0222014	-0.57	$4.11
timber1000	-0.1102527	-3.19	$20.40
forhealth	-0.0467544	-4.73	$8.65
cost	-0.005405	-5.36	
Observations	1146		
McFadden's R^2	.887		

Attribute Comments

Wildlife habitat

medical costs differences for different health exp

Jobs created or lost, Wages created or lost

Uncontrollable weather and climate

What happened to better forestry mgmt and thinning

Lost time before fighting fire and amount of resources on initial attack

Timber harvesting to help suppress wildfires - Environmentalist at their finest

Improved fire camp monies used a lot of waste

Most important are types of treatment to restore forest health

$ Lost in tourist and recreational income in our local economy

Immediate suppression within 2 hours of fire sitting

Effectiveness of fire suppression, Risk of weed invasion due to suppression

More logging

More logging to reduce fuels, pests, cost to loggers

controlled burn harvest

Tax incentives for landowner to fireproof property

forest fire costing management

Safety issues to firefighters, equipment to fight fire and animals or maybe I dk

more logging cleanup the forest

Dollar loss of timber value

Jobs created by wildfire …Crews and Firefighters

Reclamation

loggers - uses 0f the forest

logging

Total economic effect to the county/loss of jobs/tourist dollars/business dollars

Possible politics or Manpower/budget @ time

the future of all and everything

scenery, sustainability, ecosystem health

firefighter safety

Individual homeowner in fare area pays more of the cost for being stupid re: exposure to fire.

Personal costs, if you had to evacuate or lost your home

I think we are doing a good job but I think the cost will be more

Fuel reduction Logging Future Firebreak Grids

what about prescribed burning and logging selective areas

More logging, Cut beetle killed trees and underbrush to prevent fires

Lost or gains in timber revenue were not mentioned! Could of it!

Forest management, thinning Sell forest products to pay for fire management

letting trees burn instead of logging income from logging

timber management I.E. old growth, Insect Damage, etc.

safety, economy, policy, li8ves, infrastructure, strategy procedures

Homeowners to clear his property to protect area against fire

future population density in forested areas

All harvestable timber after fire

Job losses: slow legal process

Future outlook

Focused dwelling protection strategy

timber harvesting/cutting

What's best for the forest

Value of the land involved

Proper care and maintenance forests including thinning

Allow limited burning create mosaics

Forest Roads Should Not Be Closed!

saving wildlife

More forest lands open of recreation

the loss of our forestry industry

Homeowners should choose safe locations be responsible for fire prevention/safety

Allow more logging

Did not consider age of current forests Loads of Management on National Forests Forest plan suitable

timber acres

Global Warming

Methods of fighting wildfire Wasteful Spending

affect on global warming

Restoration

Firefighter safety

consider logging

biodiversity

wildlife amenities

Increase harvest

Get rid of the excess fuels before there is a fire.

I would like to see all agencies work together not alone as in the past.

Proper logging that would create jobs and less fuel on the ground to burn

Legal timber sales not in litigation

Non-burned timber harvest

Employees & Employment Part time and full time. People paid for doing nothing!

Education Smokey Bear type

community tourist value, intrinsic economical expenses, national lumber yield rates/ $

Money generated through harvesting timber

Logging see comments

More discussions or options on methods of suppression 0

What about selectively logging some areas before wildfires

Resource management (thinning & prevention)

What happened to logging mining and real forest care?

Fire must be controlled when small

Costs of above are not taken into account - unrealized income

Allow more timber harvesting

Long term effects of logging

Wildlife Fish Public Health

Impact on future generations

I've heard of instances where some fires could have been extinguished sooner?

Higher cost doesn't mean results necessarily

More logging should be allowed

More homeowner responsibility on property and where building site is

Jobs

General Comments

Had about three years in US Artillery school and about another 3 in (unreadable) ASTU etc. life member of MENSA. Have lived in Panama & Germany and seen their forests. My family and I first came here from Panama to be advisor to National Guard artillery units. Thought this place was heaven. Now with housing developments being created in what used to be forest land I believe it will all be trashed soon. Sort of like the wall to wall orange groves in California when I lived there in (1927 or 1977 not sure). Good Luck with your survey.

I HAD A PROBLEM UNDERSTANDING PART 2 BUT MAYBE THAT IS JUST ME!

houses BUILT IN FOREST SHOULD BURN TOO OR HAVE ADEQUATE protection at owners expense not mine.

Health of forests are horrendous. Need to be managed by more logging. Keep out of state environmentalist out of our forests and court systems

Logging so that forests don't burn of pose less of a wildfire threat seems the best choice. More revenue is gained for the state: Jobs result: forests are managed and safe: and fewer fires will result in better air quality and fewer evacuations. It just seems like prevention is the smartest choice and a "Win - win" for Montana.

Forests are renewable. Too many roads are locked up for hunting. Some should be opened every other year. Oil should be opened up more instead of killing our kids in other countries for oil.

As I have grown up and lived in the valley most of my life, I have witnessed a massive change in how wildfire has changed. It is obvious to me that the lack of forest management, mostly on federal land, has greatly contributed to the amount of catastrophic wildfire in our surrounding areas. The states mandate to suppress all wildfire is the proper attitude and should be the blueprint for forestland as well. The state forests as a whole are far better managed with less fuel on the ground than the surrounding federal lands. Using the proper strategies such as selective logging, controlled fire and insect control, are several ways to achieve positive and a healthy renewable resource for all Montanans to enjoy. The barren landscapes of today's wildfires are evidence of the lack of proper forest management, mostly due to governmental bureaucracy, and should be proof enough that a change is needed.

Wildfire suppression and management is truly a complex issue. With competing groups, with conflicting economic agendas and confusing political positions the answers are at odds with the true victim here and that is "common sense". If private owners near forests fire proofed their property, if environmental groups allowed "true science" in their defensive positions, if the timber industry allowed sustainable harvesting and if government agencies truly managed instead of policing by closing gates then maybe something would work. But true intellectual honesty is ignored by all of the above. Deception is not a viable educational tool. Deception has become institutional epidemic.

I have a degree in chemical engineering. I spent 27 years (1969-1996) on environmental control for one of the largest air polluters in Idaho. There are estimates of the health costs relating to varying levels of air pollutants. This information should be provided to survey participants. Furthermore, chemical analysis of wood smoke will show it is more hazardous than "average" air particles because of: 1.) chemical composition, 2.) smaller size.

My Father Richard S. Greig died years ago - His widow Kathrane died 2 years ago. I am the current owner of the remaining property in Kalispell. My dad was a property owner and a dairyman for many years and an avid booster of this wonderful area. I have answered the questions as I think he might have. He was independent and very suspicious of government intrusion and a firm believer in letting nature take its course. Thanks for this opportunity to state my opinions and thanks for the 2 dollar bill.

If we build a home in the woods that is our decision. It's not the job of the Fire Dept. or the American taxpayer to save our home during a forest fire. The job of fire control is to manage the fire and keep it from overtaking towns but a fire burning in the wild should be allowed to burn as nature intended. If I lose my home in that fire its up to me to either have quality fire insurance of the foresight to build my home out of something like brick or masonry. Either way fire is more natural than the home in its way.

The closure of forest roads within our national forests primarily pushed by obstructionists groups that call themselves environmentalists, have vastly altered the ability to have effective initial fire suppression on small starts. These fires could many times be controlled if fire crews could reach them. Also the obstructionist have stopped harvesting activities and on or cultural practices that would slow down the massive pine beetle infestation the inland empire is now enduring. These groups that have stopped the professional agencies from doing their work should be made to pay for their ignorance.

Individuals need to be more responsible for their choices. Good logging practices need to be utilized and timber needs to be harvested to help work in a healthy forest.

Are we saving the National Forests from logging and roads just to have them burn down?

Interesting preliminary info on subject matter - - I would be interested enough to learn some more about these issues in the future. Lots of variables to consider here, kind of a balancing act - - All aspects should be considered and weighed carefully.

I would like to see seniors get full usage of state parks. As I am a senior the fees we have to pay for camping is hard on some of us who live on low income.

Found it difficult to choose given the comparing aspects on some of the stuff. (Might be a good psychological test as well)

More controlled burns would be good if they were kept small enough to control.

Burning at the wrong time (windy etc.) or allowing fires to get so large that they are hard to control are not acceptable.

When people decide to live in rural areas that are prone to forest or wildfires they should assume some of the risks. The cost for rural firefighting is expensive due to equipment distance and water resources. The lack of good management of forests has also contributed to excessive fuel loads with the dead and diseased forests.

The Gov. closed our roads and reduced harvesting Quotas and even made it more difficult for indivi9duals to gather firewood: How they can't figure out why we have a greater fire problem your scientific research doesn't even consider the course of the action: not to mention the devastating effect its had on the local economy.

Proper forestry Mgmt has declined due to environmentalist groups. A forest harvested with the environment in mind (thinning) will reduce fires and or help fight them. Forests are too thick and overgrown and infested with pine beetles. It all started with the spotted owl scare which swung the pendulum too far to the environmentalists' side. I hope a more even balance can be accomplished.

Trees in general seem to have no intrinsic value but monetary in this part of the state, where I have lived. They are considered (forests) as for animal habitat especially as it relates to hunting or logging, which I am told, is on its way out. I believe we are all a part of the whole. The circle of life. True, successful stewardship considers the effects on the parts in making decisions for the whole. The $ cost seems the last consideration in order of importance to me, or should be.

Put more emphasis on more harvesting of wood products for lumber and bio-fuel before it burns naturally

I work at an equipment rental store and have seen first hand the amount of wasted dollars fire camps because of the "shift tickets" and poor utilization of resources - Costs are extremely high and communication from one shift to the next is terrible. One crew might have one piece of equipment, but the next crew uses something else so money is spent moving the machines several times. Communication from fire camp to requisitions to rental is lousy. Wrong info provided means wasted trips and higher cost. Camps should run as if they had to pay for it.

I think in general Flathead county residents have a fairly refined level of knowledge of resource management and the role of fire. More information regarding the strategies would reveal people's opinions more accurately For example would people be more or less supportive of harvest strategies that generate less merchantable fiber but help restore pre-settlement forest health condition. Would people be more or less supportive of more prescribed and natural fire tied to modified harvest? The choice-sets are too indirect for people to make informed choices.

Reduce fuels in populated areas by means of select topping on state and federal lands. Let people go in burned areas and clean it up by getting the firewood out. I used to work in the timber industry up until the early 90's but the environmental bullshit forced me to work elsewhere. Now this is what the environmental shut down has caused. We need to use our natural resources not help destroy them.

We have not lived in Flathead County very long and I do not have any experience or employment which give me the knowledge in providing the best approach utilizing wildfire management.

We have 3 months or 90 days of summer that bring in a lot of tourist $'s that are lost when huge fires burn in our area. We are losing our timber industry and it is being replaced by the service industry. Lower wages - more traffic _ more people. In the next ten years we must find a happy medium to this problem. Forest management should not just be fire suppression. Controlled logging, fuels reduction usage i.e.. Clearing undergrowth, better management by forest service is greatly needed. When the forest service was centralized to Albuquerque N.M. We in Montana Lost!

I feel fire fighting should start immediately at time of first report. Most fires could be extinguished before they grow to unmanageable size if they were attacked within 48 hours of ignition. Costs of fighting fires when they are allowed to grow beyond that point are outrageous. Fire fighting has become a "cottage industry" and too many fire fighter services are required (i.e. Laundry, mess hall, shower facilities Etc). Throw everything you've got at a fire the first two days of its existence and put the damn thing out. Don't organize an army with Type 1, Type 2, and Type 3 "commanding officers". There is only one type of fire----Type 'D' for dangerous. Firefighters don't put forest fires out---The weather usually does and the armies of people you assign to fight fire are "fire watchers" most of the time.

Believe selective harvesting thinning is positive for forests. Okay to let fires burn to naturally thin forests hopefully in time will prevent widespread high intensity burning. Mosaic type of burning is preferred - Fire will happen whether naturally or man started. To acknowledge and fight responsibly is much preferred than automatically suppressing all fires.

Management of National forest needs to be localized. Cannot fathom the idea of bureaucrats in Washington D.C. knowing what to do in a timely fashion.

Regarding the Survey: The choice sets were confusing, unrealistic, and didn't make much logical sense. Example: Why does burning the same or less timber double the amount of smoky days? (choice sets 2 & 6). This part of the survey was like trying to a puzzle, and seemed designed to make you choose "status quo". Regarding fire management: I am in favor of fire prevention, careful fuels reduction, and containment of small wildfires. I am not in favor of the threats to human life, wasteful spending, an d ecological damage we cause when trying to fight large wildfires that are rarely affected by our efforts until a major meteorological event occurs. We send armies of people and equipment out at enormous expense, and any auditor would cringe at the lack of control from finances to environmental damage. Most large fires finish with miles of useless dozer lines that take forever to stabilize, weed problems that cost millions to contain after machinery brings them in, and fire camps with enormous amounts of surplus food and gear that goes to personal use or dumpsters at taxpayers expense.

There was no mention of the Bio-fuel from the forest. Why can't we use forest for renewable fuel to generate electricity?

I live in the west valley of the flathead. I spend a fair amount of time in the hills west of here. There has been very little management of timber here in the years I've lived here. Why can't these forests be thinned through selective (not clear cutting) logging? The timber in my area is of high value and the price would be high in a good market. Why can't these areas be thinned to reduce fire prospects with lower cost environmental assessments? It should be reasonable for a logging co. to do much of the work as part of the cost of the timber.

If old logging roads are cleared, natural firebreaks will be there, plus access for firefighters. Also citizens can access dead and dying trees from bug kill for firewood. Too many roads are closed & trees are dying by the thousands & are creating a huge fire hazard.

Survey was too vague to make informed feedback

No option for "other" with some of the questions.

It is very apparent that there is already a "plan" and regardless of the input received at least the decision - makers can say "They received public comment"

why don't the experts in forestry with degrees manage forests the way they have been taught in stead of wasting time and money gathering information from people who know little or nothing about the subjects. What good is a degree in forestry if you have to ask a baker or a housewife how to do your job?

If I were to join any of the above it would be to save wildlife. I don't understand your job any more than you could have done ours. You can see by my choices that I value homes, education, and financial resources. I hate to see anything wasted.

Cut timber as it is renewable. Don't protect so many houses because they choose to live in a forest and don't thin the forest at all.

Leave Mother Earth Alone!

don't let forests burn when jobs and income can be produced by harvesting our natural resources. There must be a logistical balance between natural burning and selective harvesting. It just can't be that hard.

The set of choices were tedious. Is there any other way to present your info?

I was not able to understand management strategies based on the projected outcomes in Part II of your survey.

I don't feel qualified or informed well enough to understand all of the influence and differences presented in part 2.

Part II was very confusing to me and I was really unable to answer. I am 86 years old and the 2003 fire made me very ill even though I stayed inside.

Bureaucracy has hampered timberland management & fire suppression when suppression is appropriate. Incident commanders from Florida or other S.E. areas can't fight fires in the mountains. We have USFS Hotshots leave fires for locals to fight. We've had incident teams show up to fight lightening strike and leave because it was the wrong category for them. Come on red tape is killing us all - This type of Federal mismanagement has created distrust and teamwork is non-existent. Please Contact the local timber bosses, county firefighters, etc. The USFS Fire Suppression efforts sound like the "Fleecing of America" on NBC. "Smokey the Bear" attitude has hurt the mgt of the timber of MT.

Our forests could be better served by allowing more logging, thinning and deadwood reduction. We are always going to have some large fires regardless of our suppression tactics, but we should "always" attempt to put all fires out. We should spend less on saving structures and more on actual suppression. With the cost of resources (cost of fuel etc.) we should go back to some of our earlier detection methods: Lookouts, make a better effort to keep roads open to make quicker fire suppression and more people in the woods (workers etc) make for earlier detection and suppression.

This seems a little bias toward environmentalist. Please exclude me from any more surveys.

I have MS so difficult to write please forgive spelling. I live in Montana and I don't mind paying to live here. I don't give a fig of care to people who don't insure/or can't insure because of location of their home or business. We need to use common sense and I want no firefighters to loose a life or other at expense of fools. I'm concerned the survey will take away from true need of what it takes to keep our forestland healthy. For I do not have the education to know what's best so I leave my opinions to those who have years of education and specialty in forestlands to make that decision. I want a Teddy Roosevelt attitude to take care of what God gave us and I know at this venture nothing runs cheap but what do we choose for our children's children a paved paradise No so I side with those who love Montana its beauty and if we get our towns not perfect little smoky well we got the beauty/wildlife of MT to pass down. So I believe and pray you will put our interest first No special interests or la nd sales It costs to be beautiful Nothing is Free! So keep Montana as President Teddy would have …Free from Greed - Free for all to Enjoy and to be well managed Forever!

I know this is a very complex issue and I'm not certain my "opinions" are the best for preserving our beautiful environment. Cost is certainly a consideration for me. I was greatly distressed by the fires and air quality of 2007 and it is still sad to see the remnants of the fires along GNP's Lake MacDonald from 2004. I do believe that people who choose to live or have houses/cabins in the densely forested areas have more responsibility to protect their homes and not depend on the government and taxpayers to take care if them in case of wildfire. Thank you for including me in your survey.

the forest land needs to be cleaned up by logging. There is much fuel going to rot. The new high school has a fuel boiler fed by chipped wood pellets this needs to be gotten out of the forest. I was on a month long trip.

I would like to know the % of total state revenues collected which is represented by the "status quo" of $125 per/household. Thank you!

Frequently local people are hired to bring equipment (backhoes, cats, water trucks etc.) to a fire site and are WAY OVERPAID" for their efforts. Most of the time they are they are not even utilized and simply "Sit Around" while the fire is "managed". If we are not actively attempting to put a fire out, save the taxpayer's money, don't waste it by bringing people & equipment in and letting it sit idle. Effective removal of down timber will reduce the effects of the large, high intensity fires we now experience and will allow employment opportunities as well as fire severity reduction.

I would like a tax credit for reduction of fuels on my property that I pay to have done or do myself. I would like to have building moratoriums in fire - prone areas, or additional fees assessed on homes or structures built in forest interfaces.

More naturally occurring wildfires should be allowed to burn. Too much suppression the last 30 years. I think the DNRC is out of control and should remember their role is to manage land and wildlife not make policy.

Yes years ago when I sawed in the timber. We used to take all our logging equipment, cats, skidders, chainsaws and men when called upon and go put out fires. I was never out more than 10 or 12 days on any one fire. Now you numb skulls won't let a cat driver, skidder driver, chainsaw operator go out unless they get "Certified" to operate any of these. Every one of them have probably forgot more on how to operate any of them than you people ever figured you knew. They know what their machines will and can do and being people that make their living in timber "Like I used to do" Don't want to see the trees wasted like you people seem to want. For Heaven's Sake wake up and use these things we have to put out fires. I know for a fact that some of the young girls you put in charge DON'T KNOW HOW TO PUT OUT FIRES. Yes I have always been interested in our country, timber, water and all else. In fact I spent 38 months fighting for our country in W.W. II. Stop by sometime I'll show you actual photos taken from the air of the bombing I helped do over Germany

Decrease property taxes. Low income housing - Median prices just too high for most wage earners. National Park access for low income people. More public access to Flathead Lake/East - West Shore. Politics Now>Non-American at all levels Both sides Federal and State Just throw monies at it I think not! For example Educational system over 1 Billion, that’s over a thousand million dollars. It's time to put the Kibosh on all Governmental spending Period.

I think logging should be allowed more in a selective fashion with requirements on cleaning up all dead slash fuels in the areas selectively logged. I think the bureaucracy clogs the process and has lots of excuses why. If more areas were selectively logged and cleaned good after logging I believe it would help considerably.

Fire management is not the root cause of this problem. The overall change in management practice and on adjoining forests to a "Lock it Up" standard is the true problem. By reducing the timber harvest and locking up roads so that vegetation can overgrow them, the current management practice has created the problem that you are trying to fix. In my opinion the answer is very simple: 1. Increase timber harvest using best management practice. 2. Open Gated roads to motorized traffic. People will keep the roads open that they use the most and reduce fuels levels by removing trees for firewood. It will also increase the speed fires are detected by having more "spotters" in the woods. 3. Change USFS, DNRC, MTFWP budget from tax base to profit base from timber sale, mining & special use. This way agency decisions and size will be based off of the best management and forest consumer profits not the ability to ask for a larger budget from the taxpayers. Any other questions feel free to contact me personally.

While I understood the intent, my feelings might not have been quantified. Basically I feel that less suppression in the long run will make for healthy forests and watersheds. I do not object to directing more tax dollars to forest and public land management if it is wisely spent. I do have skepticism about Big Governments management of money _ witness the current economics …..I am an urban resident and feel that if I owned land close to public domain that it would be my responsibility to reduce fire risk just as I would in my urban home.

Consider logging more beetle kill or diseased tree areas prior to burn.

This is an excellent educational tool. I have trust that our country and state government will make an honest attempt to fairly and judiciously use our tax money, but I absolutely distrust our federal government to do the same.

Being a family of loggers, hunters, camping, friends of wildlife, berry picking (non-commercial) so many of the "secret" places have become inaccessible, sad, but times change did experience 4 wheelers up a road where it was gated.

GO GRIZ

Thanks for the $2 bill.

I did not choose the higher evacuation of homes # because the cost of insurance is high enough now let alone when 270 more homes burn.

Destroying anything that is living is wrong!

If we have more timber sales and logging going on we would not have as many or as bad of forest fires. Logging is an excellent tool for maintaining a healthy forest and in my opinion it is the least used. I am a native Montanan for 3 generations and have seen the effects of both sides and I will take logging any day of the week. I feel half of the time environmentalists and forest service are working hand in hand. When we do have fires the loggers should be called in first at least they know what is going on and have the equipment to do the job.

Thank you for the opportunity to give my opinion. I believe fire suppression has become a way for people to depend on an income. People that come into my place of employment brag about the money they make without working. I see first hand people's glutton for free money. I believe fires should be controlled at all expense when families and houses are at risk, but all other circumstances need be: let burn! I have lived in Northwest Montana my whole life and my whole life revolves around the outdoors but we need to become a do it yourselfer or at your own risk society. Some of my favorite areas have been effected by fires but let mother nature do her job. Thank you for your efforts. Your everyday American.

I think that forest service policies are determined too much by environmental groups.

I believe in managing our forests. I believe that timber is a renewable resource and should be harvested not only to produce jobs and building materials but also to reduce the danger of wildfires. Select cutting reduces the impact on the forest while reducing fire risk and maintaining vegetation for erosion control. There are some areas of the forest with so much fuel on the ground that a fire would be beneficial to clean it up and bring back the underbrush.

I have lived 30 years now in Europe. For them fire is not a discussion. It will be put out. Here it is only a money making business. This does not make me proud at all.

I think we need more logging thinning, and fuel reduction projects to promote forest health and reduce wildfires. These things can be done without adversely affecting the environment and may in fact help the overall environmental quality of our area. Also after a fire we need to be more aggressive in recovering the burned timber and biomass fuels before they lose their economic value. These practices would not only help to prevent large scale wildfires but would provide natural resources and jobs to the Flathead economy!!

Would really like to receive more info on this topic. Thanks

The cost of hands on suppression seems excessive & I base that opinion on discussions w/ people that actually were on fires, I.E. hiring a person w/ a pickup, what a caterer might make, all the costs seem so inflated.

Landowners, local Gov't zoning, & insurance companies need to play a more active role in managing the urban interface problem.

I believe we need to open more logging in both state and federal lands to remove underbrush and reduce fuel on the ground. Do more selective logging to get bug killed trees out of the forest health system. Opening up more logging will also put more funding into the school systems and may be take a little pressure off the tax payers for school funding.

Believe the "Choice Set" items are pretty unrealistic situations. Not as though "we" have an actual vote in the decisions.

Step up the fuel reduction programs. Log the big blocks of timber into a grid system so wildfires cannot reach the destructive size. The proceeds from the reduction sales can fund schools and fire fighting programs. It's a no - brainer, log it, for 40% after millions in fire fighting costs or log it for 100% with no fire fighting costs and improve our schools, our economy and increase the state funds.

Being a former logger I've worked and played in the forest well into my 40s. I had to leave because of the lack of timber sales to work on. If we would have better timber management and more fire suppression related jobs such as thinning timber brush fuel removal etc. I would be still out there doing what I really loved and took pride in. Now its too late, but I sure would be happy to see others getting more work to save our forests from burning up. Thank you for sending this survey to me and good luck. Looking forward to more to come.

1. Increase use of small to medium fires - Prescribed burns. 2. Increase timber harvest on forest lands to compliment use of prescribed burns. (State is already doing this)

I never know for sure what surveys hope to get from our replies. Probably better to ask specific groups who are better informed of the topic. I appreciate our firefighters and think they do a great job of fighting our forest fires here in Western Montana

It would seem to me that a portion of the money used to fight fires could be better used to clean up our forests. Eliminating much of the debris cluttering up our forests which furnishes kindling for forest fires.

My question to you is why do we need 500 to 600 people on the pay roll at these fires just to watch our natural resources go up in smoke? Put the fires out and before we let it burn - - harvest.

This survey is quite complicated because most of it depends on whether it going to be a hot dry year or rain with lots of snow. We have had some fires start - have been spotted and by the time that the powers that be get started the fire will be many times larger. We have more houses in danger because more people are building in isolated places. Maybe the forest service should open a few more gates so people could get downfall for firewood getting rid of fuel that help wild fires. As far as the monetary part it seems like the property owners get to pay the bill.

I currently live just 1/4 mile from a DNRC Base operation at Bittrant Lake. This season I witnessed multiple 1 ton trucks going by my house with only one person. Many days it was raining and obvious there was no fire danger. I went to their location and asked why they were wasting so much fuel in a time of fuel shortage. I was not given any answer, other than training. This is not acceptable. We need to be more efficient.

It was difficult to understand various strategies - i.e. as a former planning board member I think we do a terrible job of managing venerable forest interface areas & allow development where it should be prevented or allowed only more stronger restrictions. I couldn't figure out which best supported my philosophy.

It seems as though current policy dictates that we "manage" fires to death, instead of putting them out! Rumors abound about heavy equipment not being fully utilized to contain/suppress fires. Current forest conditions are not the effect of aggressive fire management/suppression for the last 10 years, but rather the result of a lack of any kind of active management! Forest revenue could be generated from timber sales on public land, and fuel reduction projects would greatly reduce the risk of catastrophic fire! Modern forestry practices have been in use in other countries for a long time (See Carceta & Sweten).

I believe the forest service needs to do more thinning of forest lands to prevent forest fires. They proceeds from thinning could pay for fire management.

Sorry I didn't return this - Been very busy remodeling our home.

Overall I am satisfied with the direction we are going. I think suppression at all costs was a bad deal and think we are moving in the right direction. My other main issue is taxes. Please no More! I know we have to pay for this but is it is very difficult in this climate to be taxed for any additional issues.

I hope I helped you.

The choice set portion was confusing - Do you pick just one of each set or just one out of all six sets? I called the 877# and there was no one who could answer my question. Sorry for the writing I am right handed and have a cast on the right hand. Thank you.

The forests need to be thinned and cleared of dead under brush.

Environmental protections have increased fuels that burn. 2003(?) fire in Glacier Park federal employee could have put fire out but "Let burn" largest fire in Glacier Park could have been stopped. Response too slow. Survey somewhat overwhelming procrastinated rather than completed. Awesome photos with choice sets helped with comprehension.

Forestry first, no more taxes wasted, too many studies that are biased, Turn federal lands that belong to the people back to the states for management

I believe our forests should be managed as a renewable resource. I would like to see the timber harvested with as small a footprint as possible. I also believe the forests should be thinned out to benefit the forests and wildlife. I also think manmade global warming is a hoax and am against spending large sums of money to fix something that has not been proved. (Consensus is not science.)

Sorry I am late I was out of the state for most of October.

Require proper fire management by individuals living in forested areas

Put the fire out immediately. Pay the firefighter 200% more than pay scale in 2007-2008.

Would be interested in how the sales from the 12 different strategies were arrived at Dartboard? Scientific Formula? What and How are values assigned? Feel that the USFS only sets in the way of good forestry management. I think the state does a much better job.

Our forests are difficult to lump together and place a "grade: upon them. Some have improved and some have declined. Growing up here I routinely avoided recreating in the North Fork of the Flathead in August. The fires helped rid the area of dead beetle kill trees. I believe strongly in sustainable yields that promote forest health. I don't believe in shipping raw timber out of our country we have craftsmen here! Also when complaining about job loss people rarely mention automation of the logging process as well as the production of lumber. Sorry (I know the last few had nothing to do with fires!) But getting back to fires I watched the burns from West Glacier a few years back it was interesting to watch how fast the fir moved thoroughly previously burned or logged areas I am assuming producing a much lower temperature fire.

I think citizens should not be allowed to build homes in forests because of the dangers of wildfires. When their homes burn the rest of us pay more in increased insurance rates. Thank you for the $2 bill.

Environmentalists ruining our country by stopping logging and all the stuff being declared endangered and restricting use of our wild lands and ruining our economy. Need to replace Judge Malloy as he sides with environmentalists and stopped everything and declaring so much endangered when they are not endangered.

I was a forestry student at UM in the early 60's & I now do some volunteer work with USFS in the "Bob". I believe in healthy forests which means using them logging & replanting (no clear cutting because that's what got all the environmental groups involved). Old growth & Insect kills cause hotter fires and more damage in every aspect. Use the trees don't let them burn, Easier said than done I know.

I did not like being asked to pick some unknown strategy. I think the details of a particular strategy may be as important as the attributes that were selected as criteria

We need more logging on State and Federal ground. It's a waste that is going on in the forest now.

There is enough waste of funds within Government if recovered to fund any type of fire fighting that's needed. I returned after 43 of federal service and witnessed these waste. The whole federal system needs to be re-vamped to get better use of our funds.

The $2 bill was a nice touch and greatly affected my desire to fill out the survey. I think the instructions and background information were unusually well done.

After a fire the Forest Service should not allow environmental groups to block immediate logging to clean up timber which is salvageable for logs and pulp.

I really feel you are not being fair to the elderly and handicapped people. By making "Kelly Humps" with 6-10 feet deep its impossible to walk or ride a bike or horse down the gated or closed roads. Having lived in the Flathead all my life I am literally shut out of the forest. Roads that are closed soon become nothing but a barricade of elder brush and weeds. I also think its sneaky the way the closed gates are always placed so that they can't be seen from the main road.

Take good care of the fires and put more care on human causes and stricter penalties

Fire protection priority should be given to houses/homes that are : A. Are primary residence B. Less than 2,000 square feet And even they should be prepared to watch their house go up in smoke. Building/Living in the forest is not unlike building in a flood plain People mainly attribute floods or wildfire to tragedy or divineism when it's the collective stupidity of the humans in not being aware of nature and or history. My wife took the two bucks, story of my life.

Allow logging before wildfire to reduce fuel and make forests more healthy. Log completely after fire all timber affected for economic and safety reasons.

Legal challenges need to be streamlined and expedited, particularly for time sensitive recovery timber harvest of burned areas Fed level in particular and for the "permitting" of areas for timber harvest in general. Forest harvesting can mimic nature and can be given more sway than currently practiced Multiple use is important for areas now not designated as wilderness or park I.E. grazing responsible recreation. Thank you for asking!

Pulled the choice sets out

I'm happy to see that these problems are being considered and addresses. I question why small fires aren't addresses immediately when cost would be minimal instead of letting them grow to catastrophes then needing millions to fight them. I think that money should be used to thin and clean upnderbrush. This would provide employment and at least partially pay for itself in timber sales. I'm glad to see salvage of burned areas. I think that more attention is needed to address beetle kill and that these areas should be open to firewood cutting. I know that some species need fire to propagate and if forests were thinned (not clear-cut) occasional fires would accomplish this without catastrophe because they would be more manageable prescribed burns wouldn't be needed as much (clouding up our beautiful fall days) with more manicured forests and if dead areas (beetle kill) were opened to firewood taking. I'm glad to be part of this survey and have a chance to state my opinion.

I believe all and any strategies should be brought forth n public meetings and voted on as to the individual counties in this state based on needs available monies also discuss possible volunteer to help maintain the health of our beautiful country. Trained Volunteers. I have concerns on how a fire is handled as told to me by people who have fought on fires, that some fires have not been managed well, not been put out or stopped when they could have been, thus feeding the pockets of those being paid to have trucks equipment sitting big Dollars rather than hiring out on equipment maybe consider each county having own equipment set for that. Don't Know but when I hear some truckers, equipment owners cutting each others throats so to speak to have their equipment sitting on a site makes Big Dollars even if not used on the fire site not caring really how much land etc. is burnt just that they make big Dollars off it really upsets me. I know I would volunteer and train in any way possible to support our community, our land and wildlife and homes.

More aggressive firefighting tactics used in future wildlife areas. Montana should make better use of aerial tankers, smoke jumpers and heavy w=equipment than was the case of the 2001 fires though out the state.

If no one lived here fires would occur as a natural course of nature. This should be the primary consideration secondarily, residences and infrastructure need to be protected. Each fire should be viewed as a natural occurrence, with the control strategy evaluated on threat to residences and property. When fires are detected the initial action taken should be to minimize destruction to structures, (houses, businesses and power services). People also need to realize fires are natural threat and take ind ividual action to protect themselves (metal roofs, fireproof siding, fire gap thinning around structures, self - contained personal fire suppression system (water or foam system store). Residences in timbered areas could shoulder a tax relative to fire threat. Businesses who rely on timber could share a tax targeted at protecting (Specific) mature stands areas. Other immature areas would be predetermined to allow wild burn. This would require predetermination of high yield stands which come under the same classification as structures. Then when fire is discovered the initial strategy would be structures here, here, and here and non-burn stands here and here need to be protected allowing fi9re control assets to be deployed strategically rather than "Lets just put the whole fire Out."

It seems to me that special interest groups regardless of their interest usually drive and shape management policy. It would be nice to think that what is best for our natural resources take point and that special interest fall in behind that.

The survey does not take into account the effect of increased logging and its influence on the statistics!

In my opinion federal and state forest lands have different purposes and should have separate practices. The primary purpose of federal forest lands is to maintain a diverse and mostly natural environment as a trust for posterity. The primary purpose of state forest lands is to maximize public access and sustained use of renewable resources. Wildfires are important to the sustained health of both systems. However it is much more important to limit the size of wildfires on state lands so as to maximize public access and preserve timber and other renewable resources.

I believe all fires should be extinguished as soon as possible at first sight.

We need actual stewardship of our forest lands managed by trained foresters. Logging should be selective to thin and maintain healthy forests except in wilderness where natural thinning by burning can occur. This means that we would be putting money into forests to subsidize selective logging which is not profitable in short run. (Might raise increase housing costs incrementally.)

I am opposed to having roads put to sleep. I am for gates on them but keep them for access if necessary. Money was spent to build these roads we don't have to pay more to have them put to sleep. I would favor more access for cleaning forest fuel (firewood where possible to help prevent the large forest fires.

To me the one thing that would have the biggest positive impact would be to increase harvest levels as part of the management strategies to reduce fuels plus the revenue could be used to fund some of the costs of the alternative management strategies. I understand that additional watershed quality concerns can be impacted. But if done right those can be mitigated.

I feel fuel reduction education of landowners of forested areas should be a mandatory pre-requisite to ownership

Survey pages 11 - 16 are confusing the average person would have no concept of the numbers stated.

I would like to see more preventative maintenance being done in our forest such as prescribed burns. There is a reason Glacier Park burns as much as it does not saying they should log national parks, but treat public land differently by allowing selective logging to thin the troubled areas.

It is easy to read a bias toward logging in this questionnaire. For that reason it loses its effectiveness.

For the most part The National forest in Flathead are poorly managed. With fire suppression and lack of logging the forest is unhealthy. The forest needs to be managed just the same as a farm field. Trees need to be thinned so sunlight can hit the ground and when fires start they do not crown. When fires do happen get in and get the timber off immediately before it loses any more quality. Make the forest wildfire friendly with open parks where grasses can grow and have feed for winter. Landowners/homeowners need to manage their properties for fire. It should not be the taxpayer paying their bill for mismanagement.

Picking strategies was very confusing for me. I don't know what I was doing with it.

Extreme care when dry with potential fire starters. Quickly as possible on fires no Delay. SEND NO MORE!

I think almost all gates in national forests and private lands should be opened backup so the dead standing wood can be removed and used and so we the people can use the forests! There should not be any Kelly Humps on roads not being used so we can get up to the fires to fight them and clean out dead woods that can add to fuels in the woods.

We should be using the products from the forest - it is renewable! Replant with good genetics as well. Also the griz will adapt (it already has). The footprint will not even be seen in 50 to 100 years! I do think fire is good to control the pine beetle/but is the last resort!

I can't see how this "style" (i.e. 6 choice sets) will lead to any meaningful conclusions to form future policy. Seems to be a very expensive undertaking (the survey form) that might not have very useful results.

Why not log as much timber close to the highway, county roads as possible to reduce fires in these areas more food for wildlife? Why not log instead of let this resource burn? Why gate off roads and let them grow shut when we paid to build them? Why Kelly hump and gate roads to these areas? We should try to maximize profits with our forest and not let them burn and spend dollars to avoid this.

I do not believe you need to spend more money in fighting fires. It has been my experience that prevention is always less cost then the reactive action it takes to fix/repair the problem. Education in fire prevention should be everyone's concern that lives in wooded areas. Their homes are their responsibility to protect. As mine I have fire breaks completely around my house! When a building is being designed it is expected that all design flaws are discovered on paper (preventive) not in the construction phase (reactive) and costs much less to redraw lines than to find out a problem exists when the building collapses or fails to perform when the intention was built for. Those of us who have chosen to live in wooded areas also need to choose to educate ourselves in prevention or we with our choices/decisions not to and thereby loose our homes and belongings. If our fire fighting dollars were spent in removing, cleaning areas prone/prime for ignition especially in areas that have growth in homes and not be so worried about the eco system we may or not be destroying we would be better off. Requiring home owners/builders/developers to be or build more responsibly is not unreasonable if done in a reasonable manner. Our problem is that we always swing too far one way & over correct when it is recognized! Our political structure has failed us and special interest groups are usually unreasonable in their demands, people who sit in chairs (elected positions) very often have little or no knowledge and yet they are the ones who vote in or out good laws or protective measures for the people. Frustration begins where knowledge ends! We need fair and balanced people in the forestry department who refuse to be surveyed one way or the other and will spend our dollars as much in the prevention areas (removing fuels) as they do in being reactive (fighting fires and saving homes!)

In general any lands not managed for timber production should be allowed to burn from natural fire starts . The most expensive fires that we fought are on inaccessible acres that often have limitations on equipment and methods that can be used.

Get it together so we can log more USFS land and state land so we don't have all the wild fires that we do! And it would put people back to work and help the economy. You know it runs down hill. God told us to be good stewards of what he has gave us.

As on page 17??? Having lived for over 35 years in or adjacent to the heavily timbered area inc a number of years as officer of homeowners association during past 20 years I've never once been involved or had presented a program by forestry services of area & land assessment for need of preventative maintenance of forest for any organized effort to contact rural home owners or ssociations regarding assessment of their area for need of thinning and prevention to decrease chance of forest fires, Maybe! Is not effective?? But in 70's and 80's that is what was said about injury prevention in the logging industry until hospitals and logging associations started an aggressive program which resulted in a dramatic decline of injuries/logging day and decline in expense and # of injuries per amount harvested and relative decline in work comp. (taking into consideration overall decline in the industry volume 2% to both "green peacers" eastern do-gooders and market conditions. Presumably there will be extra Federal $ in the "Bailout" bill for rural areas affected economically. Perhaps it is time to consider more prevention and consulting visitations by forest service to areas with recommendations and resources.

I firmly believe for our state DNRC to create more $ for the school trust fund they should revert back to the original way the feds. Operated. The forest services picked up saws and harvested the timber. Use common sense from experience and not spend volumes of paper and time on EIS's don't put the units to be harvested up for bid _Let the Gov't use their own employees to cut the timber. Get out of the office and away from the water cooler!

I'd like to see more smaller (50 acres of less) prescribed burns to make up for past practice of aggressive wildfire management. Additionally naturally caused fires should be allowed to burn up to 50 acres and then suppressed unless structures are threatened. With the goal to promote mosaic burns. The problem of global warming will make fire management more complex in the future.

Environmental groups have tied the hands of the forest Managers with frivolous lawsuits not based on good science. These lawsuits have caused Forest Managers to spend tax dollars on lawyers instead of enhancing public lands. When fire has occurred on private or tribal lands, timber has been harvested while the log value is greater and rehabilitation begins sooner. This helps the watershed health and fisheries. If the Forest Service would be allowed to do its job, some of the additional (money you put forth is this questionnaire would come from harvesting and rehabilitation work after wildfires. I believe that to restore forest health more thinning and ladder fuel reduction projects are urgently needed. Environmental groups would do more good if they spent their money working with the Forest Managers to purchase seed trees, reduction projects, and reseeding of the burnt forests.

Gated roads should be open prior to hunting season for wood cutters. They might help reduce the dead wood and fuel that contribute to forest fires. Some dead snags might be eliminated from being struck by lightening.

I feel strongly that we should let nature run its course. Changing fire management strategies to allow for that may indeed make up for a rough 10 year period but beyond that should be healthy. We are in this position now due to the century of fire suppression. I also feel strongly that it is solely the homeowners responsibility to protect his home in the event of a wildfire. Just as someone chooses to live on the beaches of the Carolinas must deal with hurricanes a house built in the forest of Montana must be prepared to deal with wildfires. Damage occurs is between him and his insurance company. Thank You

I understand the urban- forest interface problem but feel land owners should assume most of the risks associated. This should never be stated as a gov't problem and more tax dollars should not be thrown forward as suppression costs w/o landowner participation. I also feel strongly that if we could rewind the forest management tape to around 1980 and then stay on a course of more systematic and sustained forest management. We wouldn't be sending out surveys to the public asking them (us) how to solve wildfire issues - let forest managers manage the forests. The conservation/preservation mindset we're currently stuck in plays a large roll in the situation you're trying to understand. Seems to me this approach in the survey is attacking the symptoms when gov't agencies should be attacking the root cause - return the forest health by more aggressive forest management.

My wife and I own 11 wooded acres in Lake county just south of Swan Lake. The property is surrounded by Federal Forest Lad on three sides and the Swan River on the fourth side. The forest is healthy and the river is clear. Forest fire is always a concern.

As a graduate of the University of Montana with a BS in Forestry: I feel this survey is a valid use of your time and resources. I appreciate the opportunity to participate.

1. Survey not recognizing the following a. Age of our forests and need for management b. Acres that forest mgt can occur on - Only 27% of Flathead National Forest can ever have TBR harvest occur as a MAXIMUM. c. TBR harvest has occur since harvesting on less than 10% of the forest. 2. You did not recognize fire protection taxes currently being paid by forest owners and rural residents. 3. The only way you will ever get a handle on acres burned is through ACTIVE forest manage.

I believe forest management should include a lot more logging. Also we should do salvage logging on all burned forest lands. I own 134 acres of forest land and have selectively logged it twice since 1984. Once because of fire not started on my property. I have loggers and state foresters tell me I have the most healthy forest around. I also have abundant wildlife. I think my land is proof that logging keeps a healthy forest. Oregon logs and replants. That is called management.

I saw very little about timber harvest management. Environmental groups have too much input and power.

My main concern with wildfire management is the lack of harvesting of dead trees. The over abundance of these seem to be a raging forest fire waiting to happen.

This is the most poorly designed survey I have ever seen. You should ask participants their views of what is wrong with current procedures. The waste of money is appalling. Most contractors are paid to sit and do nothing for days or weeks at a time when there is a fire. If you would provide a description of each strategy I would gladly make a choice. But providing only your determination/speculation of the outcomes of each strategy is unacceptable to me. I do not believe that fire is the only means of managing our forests.

I hope I was helpful but I wish I were more knowledgeable about these facts. Forests etc are important but I feel there are also more important issues at hand Thanks

Did not answer some of your questions because I did not see how they were pertinent to the subject: income, marital status, # of children, Race and age are not pertinent facts you need to know in a wildfire management survey. If you can not stick to the facts Take my name off your mailing list & do not include me in any future survey.

I chuck Dougard, filled out this survey for my 91 yr old mother. I don't and never could understand burning a forest for management. Logging is a much more equitable management program. You take out the bad or diseased trees send them to the mill where the revenue would help pay for other programs: schools etc. This creates a healthy forest able to sustain beauty and wildlife. Don't forget jobs created. Machines as they work cultivate the soil and make way for new trees to grow. In all due respect I think wildfire is a totally Bad Idea!!! No matter what the scientific community might think. P.S. And Mom agrees

I think that doing a survey is a good thing, but I was unable to tell what you meant by forest and watershed health: Percentage of acres burned in large fires! Percent of what acres? By large fires rather than small fires? Percent of total acres? It just didn't make sense

Page 5 Why are we experiencing more large wildfires today? I believe its because they wont let anyone log or take the firewood: No, Pleasant valley, Valley, 90's: Apgar… What are the costs and benefits of wildfire management? There are lots of people who would take down the dead stuff, for free but cant get to it.

We have too many black forests now put out all fires. More logging and Mechanical treatment. Logged area is a lot better than burnt area. Fight fires 24/7 not 9 to 5. Open closed roads. Clean up all burnt areas, Not just a few logs.

It seems to me that costs for fighting fires has gone up for two main reasons: 1. Houses being built in timber. Answer: Allow home owners to count the cost of building in such areas. 2. Reduction in timber harvest resulting in heavy growth of timber and brush. Answer: Harvest more.

I do not believe any public agency should have any fire protection obligation to those who elect to live in fire prone areas. Notification to evacuate should be their only obligation.

Stop catering to the environmentalists

Sorry about the lateness of this. I was out of town. I was born 80+ years ago in Missoula and have lived all over the state. I have spent a great deal of time outdoors camping, riding horses etc. I can see a great deal of change in the forests not only due to Management but to increased use, housing and population and the weather. From one year to the next the trees grow undergrowth gets thicker guess nature takes its course. Fires love it! I love this State. Take care of it. Thanks

I feel that way too much resources are used in an attempt to suppress wildfires. In my opinion it is useless to try to fight the fires the resources should be used to protect structures i.e. bridges, homes etc. if smaller controlled burns were done it could help to limit the larger fires. Also if logging with an emphasis on fuel reduction was done more it too would limit the size and intensity of the wild fires and create jobs. With good management practices we could get the forest healthy and back to a state like before the emphasis was to put out fires mosaic fires could be the norm again.

I have lived here my whole life 51 years. The changes I have seen are many and some drastic. The regulations put on loggers is fair yet they are still handcuffed as to where they can work. The fuel on the ground is the main fuel for fires as are insect infested areas. Logging could help. Times continue to change. To think that we can keep the recreation areas as they are is unrealistic. Change will happen and people will continue to move here which means more land is needed for dwellings. I just believe that all options are not looked at and peoples ideas of the future are wishes at best. I f things were like I wanted them then this part of MT would be the same as it was in the 1960s. Small and scarcely populated. Just not that way and the future will bring more of the same. We should prepare for that.

Restrictions of timber harvesting is not only devastating the NW. economy, but it is devastating the forests.

A forest is like a garden. Needs to be " tended". More selective logging should be allowed for forest health and fire prevention.

People choose to live in Montana should be aware of the environment. If they choose to live in the mountains surrounded by forest they should take steps to protect their homes in case of fires. It is no one else's responsibility. Fire fighters are to help with what they can.

the smoke in the air during summer 07 was enough to make us want to move if it happens every summer. That being said Smokey Bear is partly to blame for the devastating fire problems. I know enough to be dangerous but I am not informed enough to vote on it.

why don't we have more controlled burns at times when forests are not as susceptible to wildfires? Just thinking in lieu of thinning.

Environmental groups have filed suit against almost every timber sale and created a situation where proper maintenance of the forest is almost impossible. The "Don't touch the Forest" is a very poor condition. Fire conditions and health of the forest demands action of clean up and maintenance.

Item 12: Former Affiliation: Forester BS from U of M – 1957 US Forest Service - Retired - 25 yrs Montana DNRC - Retired - 14 yrs Owens & Hurst Lumber Co. - 3yrs

Don't Hump Roads! Don't Destroy Roads!

I feel that the government and forest services need to put their foot down with the judges and tell those radical environmentalists where they can put their protest. We need to start logging more of the land like we used to. Put the lumber money back to the schools to run the schools and clean up the forest. The lack of logging and cleaning the forest are what I think are leading to the bigger fires we are seeing. There's more timber (unreadable) Blow down then there has ever been. How can an animal live in there? Thin out and clean blow down will limit fires.

Part 2 was somewhat confusing. It would of helped to know what is being proposed in each alternative strategy. Are we talking about prescribed burns, thinning, quicker response attacks on fires or what? Big differences between how forest land is now tre ated between Federal State and Private (Plum Creek and Stoltz) Why no mention of how frivolous lawsuits by environmental groups stop timber harvest, thinning and even burned timber harvest? Timber harvest used to be a big part of the National Forest Revenue and now we just watch it all burn.

I have seen too many wasted dollars on fire. People who are nor directly involved with fire fighting making lots of money doing nothing at ALL!!!! Letting fires get out of control when they could have been managed much better. I believe in a let burn policy, but still closely monitor and contained fire. Too much waste!!! Food, supplies, Clothing, time. Wasted Time! Cost money!

I believe that the burned forested areas should be cleaned and the burnt logs and trees should be removed to prevent future fires in that area. This would also make it easier to replant new trees to the area

When we do have a fire allow the affected timber to be allowed.

Get right on the fires! Fires seem to get out of control before anyone starts to do anything about it. There is nothing pretty about a burned forest.

Thanks for the survey . Good luck with compiling the results.

Retired to Kalispell 2 years ago from Detroit Michigan area

1 I believe if the Forest Service (Federal) was allowed to go into all the timber stands and constantly thin and salvage dead & dying thin timber these fires would not burn so hot. 2 When forest fires occur, that forest service (federal) go in and cut all burned timber and utilize it even for firewood. Possibly looking into wood burning to generate electricity. Plum creek and State lands get in after fires and remove much of the merchantable wood. I wish USFS would do the same. 3 Quit taking out of use forest service roads that give access to timber harvest, hiking, fire suppression, wood cutting. 4 Having had some experience on forest fires I have seen huge waste of money on how fires are fought. The best time to fight fires are at night. The logging industry is equipped with machines with lights and well guarded they could do a major part of fire suppression. Then during day time hours the hand crews could mop up.

I am politically neutral & never had a disagreement or problem w/how fires are managed. I always thought overall most people involved are trying to help us stay safe & we appreciate that. Thanks also for protecting our environment's air cleaners trees.

I have driven by fire camps located near the Doris Complex Fires & Little Salmon Complex fires in 2003 and wondered if there were any fire fighters fighting fires or if they were in fact just camping. Hundreds of Gov't issued tents with firefighters sitting on lawn chairs next to their tents. 4 - 5 helicopters on stand by at each location. Seemed like a waste of money to me. Either put the fire out and send the people home or go home and let the fire burn. Mother nature is the best fire fighter in history. No need to "Manage" a fire if the decision is to let it burn. People like myself who choose to live near forested lands shouldn't be surprised by wildfire risks. It comes with where we have chosen to live. Less money spent on fire management . More money spent on fire suppression. Thank you for taking time to put together the survey.

The unhealthy smoke days were my priority in the choice sets. After that I tried to use a cost/benefit to the status quo. But high smoke days choices were immediately eliminated. Hope that helps, keep up the good work!

My wife works at West Glacier for the gov't. The organization listed all do some good environmental work not sure about sierra club? Enough of that. Education is just one key that can be explored above Elementary and High School.

Noxious weeds are increasing dramatically in our forest especially after forest thinning and harvesting. Montana should expand slash reduction program to include noxious weeds.

I appreciate the fact that this is a very important and complex subject. It also can bring emotional response on both sides of the debate. The information that you provided was good and informative, but your choice sets were not helpful in making decision to change from the status quo. No detail was provided about how you came to your analytical conclusions for the cost/benefit of the alternative strategies illustrated. What are the potential unintended consequences of change?

Thanks for being concerned about the management of our forests.

I answered as best I could. But I worry about survey results being put to use more than professional honest management knowledge. When we're talking costs to me am I answering what is best management of wildfires? I tried not to let that bias my answers. What I hoped my answers portrayed is that I am for healthy removal of timber by the logging industry in a manner that cleans up forests not clear cutting(and thereby causes less chance of forest fires.

I believe in having prescribed burns & forest thinning to reduce wildfire fuel and creating a healthy forest is necessary even if it were to cost us more money provided that money was "wisely" managed to the actual cost to do so!

I have recently heard reports from several hunting guides that they are seeing small herds (6 - 10 head of elk) where before there were only (2 - 3 head) in the Bob Marshal. These men say it is because it is because they have let fires burn naturally where it is feasible.

I know it is extreme difficult to extinguish a forest fire until the fall rains come. But one variable that could help the fire fighting problem would be a moratorium on home building in forested areas. I also know this is impossible because of personal freedoms. But home owners in forests must have extensive and fire fighting provisions and equipment ready and available.

Don't have money to belong to above organizations

Thank you for soliciting input from "the folks"!

There are large amounts of beetle kill or disease impacted forest areas that are not being harvested at this time. Timber harvests could reduce forest fuels, provide some employment and or tax revenues. Environmental impacts need to be considered but my perception is that too much weight or influence is realized in the area.

We are 3 generations of a woods industry family. I do not agree with the current forestry practices. Trees are a renewable resource. They should be used dead or alive. Open the forests to the public access.

Thank you for the opportunity to participate in this survey.

I own 40 acres of forested land in Washington state. 15 years ago I had it selectively logged and brush cleaned up and burned. I was fortunate in finding a logger (graduate of the U of M school of forestry) who was both honest and knew what the local laws were concerning this type of job. Why can't we do things like this on a larger scale and not only cut down on wildfires burning uncontrolled but produce enough timber to keep the industry going & yet open up areas for more pastures and wildlife. It is a renewable resource and if managed intelligently would help our economy, improve air quality and less destruction of personal and government properties. Also people who build in the woods need to clear the areas around buildings.

Rotting and overgrown timber needs to be thinned. Leaving the forests in an overgrown and unmanaged state we are asking for the forest fires we are getting. Leaving woodlands in this condition serves no useful purpose.

thanks for letting me partake in this survey.

Wild lands access has been reduced extensively since my relocation to the Flathead valley in 1978. Forest health has improved but our ability to enjoy it has been curtailed. State and Federal land management agencies personnel posses the land and have forgotten they work for the tax payers. I would like to see a map of all roads open to public access in 1978 versus now. I would like to see a comparison of man hours and dollars expended in 1978 versus now!

I believe that people who choose to build homes in remote areas, should know the risks and be willing to pay Higher shares of fire fighting costs relevant to their property. Firefighting policies should be determined by what is best for the forests and wildlife. Policies should not change to fit the timber industry any more than they should change to prevent logging. A house in a remote area should not change the wisest course of action. If it is best to let a back country fire burn, then a house shouldn't change that. Home owners who choose to build in remote areas should know the risks as well as the benefits. Their choice to build remotely should not put firefighters lives at risk or spend extra tax money. They should take the steps to protect t heir home and weigh the risks accordingly.

I believe that successful management of Montana forests is impossible so long as untrained and unbonded persons, spectators or agenda driven organizations are allowed to block or delay professional designed management projects. The costs to taxpayers is too high to have millions of dollars spent on professional planning wasted on chancy courts or unbonded and uninformed individuals.

The Federal forest needs to open up their forest for logging to utilize the natural resources that is getting wasted instead of environmental groups determining the forests outcome. Burning can still be utilized with logging. (Brush reduction) as needed for land management to lessen stand-replacing crown fires and the health from smoke would much less than the current situation. If forest land was taken care of around residential areas the loss of homes would be minimal!

Harvest or burn is the choice. Management of the forest to include responsible logging with protection of the environment is the best solution. Montana has been driven to the do nothing and hope a fire does not destroy the forest by out-of-state people that do not understand that fire is a natural occurring state. We can used logging as a fire substitute or even bio-fuel. Current policy influenced by emotion and nor science is and has been stupid!! Thank you for doing this survey.

If a person builds their home in a forested area, as I have, that person should: 1. Use fir resistant construction materials. 2. Maintain their property in a way that reduces their risk as well as their neighbors' risk of damage caused by fires. 3. Not complain when they do suffer damages. 4. Expect others/the government to save their property from fires. We should allow more harvesting of the timber on our State and Federal lands. I believe that our public lands in Montana can be better managed locally (county/state) than from Washington DC.

Log more public lands _ Use Independent loggers. Selective logging/No clear cutting bigger than 40 acres. Stop "trying" to put out large fires - You're wasting your time until it rains. LOG ALL BURNED AREAS Quit Wasting Resources. IF FOLKS CAN"T clear land around their homes in rural areas - Let them burn. I have cleared a 200 ft perimeter around my home and added a sprinkler system. More money will not solve the problem, quit wasting my tax dollars! Open roads, Let the private sector fix the problem, pay yourselves more for your hard work, but we do not need a bigger bureaucracy! My degree was in Natural Resources U of Wisconsin.

Forests fuels to generation facilities. Clean the forests and generate our power = win win

I believe that wildfire management is managed with a government mentality with no regard to tax payer costs. I personally deal with establishing emergency fire camps and have seen/experienced a cost is no object attitude with all parties in charge. If the local tax payer was aware of the costs associated with some of the camps in regards to the end result there would be a congressional investigation.

I believe that if managed correctly, our forest land should pay it's own way without the help of the tax payers. I believe that if we are not going to harvest timber we should not waste the money putting fires out. If we want to save our forests and prevent catastrophic fires, we need to cut a lot of trees. I don't think we need a bunch of clear cuts, but I do believe that we need to keep the forest clean!

Forest fires are a naturally occurring event. My tax dollars should not be used to protect other peoples property from a naturally occurring event. Nor should your tax dollars be used to protect mine.

I realize we must change the wild fire management practices to allow some fires to burn. Maybe this can be phased in.

They need to clean up all the dead trees and branches in the forest.

What does my level of education have to do with your survey. Other than give you reason to question my answers. All the education in this country and look how screwed up it is. Good try.

I feel that the more firewood removed from forests and burned areas will decrease the chances of hot damaging future fires. Even if the wood, down and dead trees were pulled to areas that people could cut and remove, if you don't want them in the areas in person. They can pay a lot cheaper cost for the cords they cut take. Or it will help low income to wood.

Thank you for the $2 bill

Page 7 Underlined the last sentence This is outrageous!!! Why do we have to protect someone else's building? That is their responsibility!! Too much money is spent fighting wildfires and the fires keep on burning until mother nature puts the fires out.

I would like to see more harvesting and thinning of our forests. This can be done in a manner which profits can be realized from the forest products, therefore taxes do not need to rise to support fuels reduction. The forests should be managed on a rotation to provide greater diversity for the wildlife. A cut over area can become an area of "early succession" vegetation similar to a burned area. Clear cuts for high intensity burns seed-tree or shelterwood cuts for lower intensity burns, smaller parcels cut to simulate mosaic burns etc. etc. It would be economically and ecologically feasible to manage the forests to provide wood products at a profit, reduce fuel and therefore fires, and support and enhance biodiversity. Managing the forests politically only hurts the forests and its natural residents.

Your average annual outcomes is more shuffled than needs to be. It is understandable there will be inconvenience to get back to natural (a more toward natural) management but I would rather see it controlled that way and ultimately it appears to be economically more productive.

My only comment would be that overtime paid for employees that work some of these fires seems too high. I understand that managing staff at all levels is important and emergencies warrant such extra funds paid. But in my opinion there seems to be some " milking of government clock". Better management of staff during non-emergency time is crucial to keep the cost more in control so the money can be spent for other fire issues. Thanks

Of course many factors play a part in the health of our forests and watersheds, many of which do not have anything to do with fire management and suppression, things beyond human control which makes status quo difficult.

I am "sick and tired' of hearing "The firefighters are observing the fire". Seems to me that local fire suppression units observe to let the fire grow in size so that at least a State or even a Federal agency will chip in and cover the costs of the fire. There is absolutely NO excuse for the five acre fire growing into a five thousand acre fire

The creation of jobs via funding thru tax would be something I would support. Thinning projects on private properties might in the long run be cheaper than suppression. Those who choose to build within heavily forested areas ought to be made to cover any costs related to saving such structures. But if they agree (unreadable) or to suggested harvesting then that would certainly be a sign of trying to work within all reasonable thought, Thanks for your time and effort.

Part 2 was confusing to me.

I think wildfires should be fought more aggressively. The forests should be harvested to reduce fuels. When I was younger, loggers were in the wood to prevent the spread of fires with a quick response. They were saving their jobs. Thanks for the $2!!

Since recent fire acreages have increased is it feasible to allow mosaic burns but to control them if they threaten to exceed that degree? Then eventually the thrust could be to let burn go - excepting threat to structures and /or life. The relatively recent increase in beetle kill changes things more areas/larger areas now are susceptible to fire - I know research into beetle control is ongoing but that is an important aspect of forest management.

Question 7 I think forest health has both improved and declined. I deplore clear cut logging and the loss of so much old growth forest. Forest Service policy has helped improve that However fires today are just a natural form of clear cut loss without the gain of harvested timber. I would recommend the creation of mosaic watersheds through selective logging of unburned forest. Thanks for including me in your survey.

This was sent to my son who lives with me. He didn't want to fill it out. Because the multiple choice questions do not give a true survey I did not fill them out. My husband was a logger with a brain and knew the way the timber was being managed was wrong. The clear cuts were stupid, the buggy timber allowed to get such a hold before it was taken out was also not too smart. Stopping logging (selective logging) was stupid and stopping timber sales even worse. Who better to manage the forests than people working in them. Someone behind a desk somewhere or some environmentalist hasn't a clue. There's no common sense any more and the old loggers are dying off.

I think all fires should be put out as soon as possible. No matter where it is and clean up after the fires that is forest management. PLANT TREES NOT HOUSES!

1. Well Designed survey 2. Item 14 of part 1 should be differentiate between Federal State and Local taxes e.g.. Priorities for each.

Would like to see more forests opened to logging to remove the mature trees and reduce the fire hazards of the "large" fires. Too much is lost: 1. Can not salvage 100% of the mature trees. 2. Lose the new growth trees. Upside more jobs and income for the county and state citizens.

I do not think Big Mountain should be allowed to expand beyond its present size. The reason I think this is because of dry years in which Big Mountain catches on fire home values will decline. I also think Heli skiing is very poor use of our forests as it is detrimental to all game and is just for the well to do and wealthy. Big Mountain should not be allowed to develop any more than it has.

Be curious to see how the survey turned out especially in am election year and given our current financial debacle.

When possible nip fires in the bud. I lived in a subdivision close to town centrally located in the valley _ less susceptible to wildfire. Tax money spent wisely is ok, money spent on equipment standby can be absurd . . . Kinda like bank bailouts. Who bails me out if I get myself in trouble? Me Hopefully that won't happen but who knows with the way things are going.

VERY CONFUSING! We are in big trouble if this is what comes out of U of M.

I hope that everyone filling out this survey took time to read and understand it and did not answer from preformed ideas.

Either log it or let it burn is the question - selective logging can be done why waste it?

This was the most confusing set of choices I have ever encountered but thank for the information and attempt to obtain opinions. It's very difficult here to get unbiased information. The Interlake does not help.

I have been involved in several small fires, helping w/ fire line and suppression. Set them when they are small and allow any logger or woodsman to attack the fire! Also I do not believe you can tell me the next 10 years will be as dry or hot as the last. Fire suppression should also be adj. by conditions/time of the year. Our gov'ts should be allowed to bank $ for years that aren't very bad for the years that are. Thanks

They need to let loggers go into the woods and thin out thick areas and burn areas in which they need to be burned for the habit and would not have the catastrophic fires which destroy wildlife habit and fish habit. And the smoke would occur by this practice it would be better for the health of the humans than the current situation. We should be able to go into the forest and enjoy the forest. We put all this money into roads that nobody can go enjoy.