An Assessment of Wildland Fire Use in Areas of the Selway-Bitterroot and Frank Church-River of No Return Wilderness

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Executive Summary

The objective of this assessment is to measure in a qualitative manner the success of Wildland Fire Use (WFU) in a portion of two large wilderness areas in Idaho and Montana. This assessment was conducted using the following methods:

- A spatial analysis of fires was conducted to determine the number of acres burned and frequency of WFU fires.
- WFU and fire suppression costs were compared to understand the efficiencies of management for each type of fire.
- Smoke emissions were modeled to determine if there is a change in the amount of particulate matter (PM_{10}) produced as subsequent fires burn within the footprint of earlier fire events.
- Discussions were conducted with personnel from the Payette and Bitterroot National Forests involved in fire management to provide insight into leadership, decision making and their effects on program success.

The findings of this assessment include:

- The cost per event for WFU on both Forests show they are efficient in the use of funds to manage these events.
- The wilderness fire management objective of allowing lightning fire to play its natural role is being met.
- The amount of particulate matter produced by wildfire will decrease over time as a result of reduced fuel loadings.
- There is an increase in the number of WFU acres that have burned and those that have reburned for the 1998-2007 period.
- On the Payette National Forest, the number of large fires per decade has increased as well as the amount of acres burned by these fires.
- The management of the Payette and Bitterroot National Forests embraces the practice of WFU and is skilled in using different management strategies to concurrently manage large fires.

Introduction

The Selway-Bitterroot (SBW) and Frank Church – River of No Return (FC-RONR) Wilderness areas comprise 3.7 million acres in central Idaho and western Montana. For multiple decades these wilderness areas have had lightning ignitions managed for resource benefits. These fires are managed to accomplish specific pre-stated resource management objectives in predefined geographic areas. The goal of managing fires for resources benefits is to allow fire to resume its natural role in the ecosystem.

The SBW was created in 1964 and encompasses 1,304,502 acres on the Clearwater, Nez Perce and Bitterroot National Forests. It is the third largest wilderness area in the contiguous United States. The pursuit of a natural fire program began in the early 1970's in the White Cap Creek drainage on the West Fork Ranger District of the Bitterroot

National Forest (Aldrich and Mutch 1972). The program objectives recognized fire as an element of wilderness environments and the need for a more natural incidence of fire.

The FC-RONR was created in 1980 and encompasses 2,353,739 acres on the Bitterroot, Payette, Nez Perce and Salmon-Challis National Forests. It is the second largest wilderness area in the contiguous United States. This wilderness has had a natural fire program since 1988.

This assessment specifically looks at WFU programs of the Payette National Forest, Krassel and McCall Ranger Districts and the Bitterroot National Forest, West Fork Ranger District (Map 1). These units have a history of managing natural ignitions and are noted for their ability to respond and adapt to changes in fire management policy. Most importantly is their ability to develop programs that have resulted in meeting wilderness fire management objectives over multiple decades.

The objectives of fire management in wilderness (Forest Service Manual 2324.21) are to:

1. Permit lightning caused fires to play, as nearly as possible, their natural ecological role within wilderness.

2. Reduce, to an acceptable level, the risks and consequences of wildfire within wilderness or escaping from wilderness.

The FC-RONR Wilderness Fire Management Plan also includes these objectives:

1. Maintain cost-effective prescribed fire and fire suppression programs within wilderness.

2. Provide a smoke management program that reduces the impacts of residual smoke on air quality.

There has been considerable research specific to the SBW and the FC-RONR wilderness areas, the Northern Rocky Mountains, as well as on the subject of wilderness fire management in general. Topics include historical and current vegetation, fire return intervals, fuel consumption, smoke emissions, economics, and fire exclusion and its effects on fire size and vegetation.

Fire history studies in the Northern Rockies revealed fire maintained open stands of many-aged trees in some areas while in others fires were stand replacing (all trees were killed). However, fires burned at variable intensities, creating a mosaic of stands differing in composition and age (Arno 1980).

An investigation of fire ecology in the SBW suggests that prior to widespread fire suppression policies, the landscape supported a great diversity of life forms, ranging from recently–burned, early seral stages consisting of grasses, forbs and shrubs to older, late seral forests (Habeck 1972). Following implementation of fire control, the mosaic fire pattern was simplified, with a trend towards uniform communities of life forms favoring old-aged climax forests. In the absence of early successional stages, fuel accumulations increase, setting the stage for larger, higher intensity fires.

Research on wilderness fire economics in the FC-RONR analyzed various fire management strategies. Two strategies emphasized full suppression or suppression with the options of contain, confine or control. Two additional strategies focused on unscheduled ignitions and prescribed fire. The strategy that favored unscheduled ignitions showed a reduced probability of catastrophic wildfire over time (Saveland 1985). This strategy was anticipated to burn approximately 14,500 acres annually at an annual average cost of $52 per acre. Both suppression strategies had a higher cost per acre burned.

A case history of WFU in the Yosemite National Park Illilouette Creek Basin determined that the effects of a long-term WFU program creates a jigsaw puzzle of burned areas with fires filling in unburned areas in intervening years. Areas that reburn have greatly reduced fire intensity (van Wagtendonk 1995).

Methodology

- Spatially analyze fires to determine the number of acres burned and frequency of WFU fires.
- Compare WFU and fire suppression costs to understand efficiencies of each type of fire management.
- Model smoke emissions to determine if there is a change in the amount of particulate matter (PM_{10}) produced as subsequent fires burn within the footprint of earlier fire events.
- Determine through discussions with personnel from the Payette and Bitterroot National Forests how leadership and decision making affect program success.

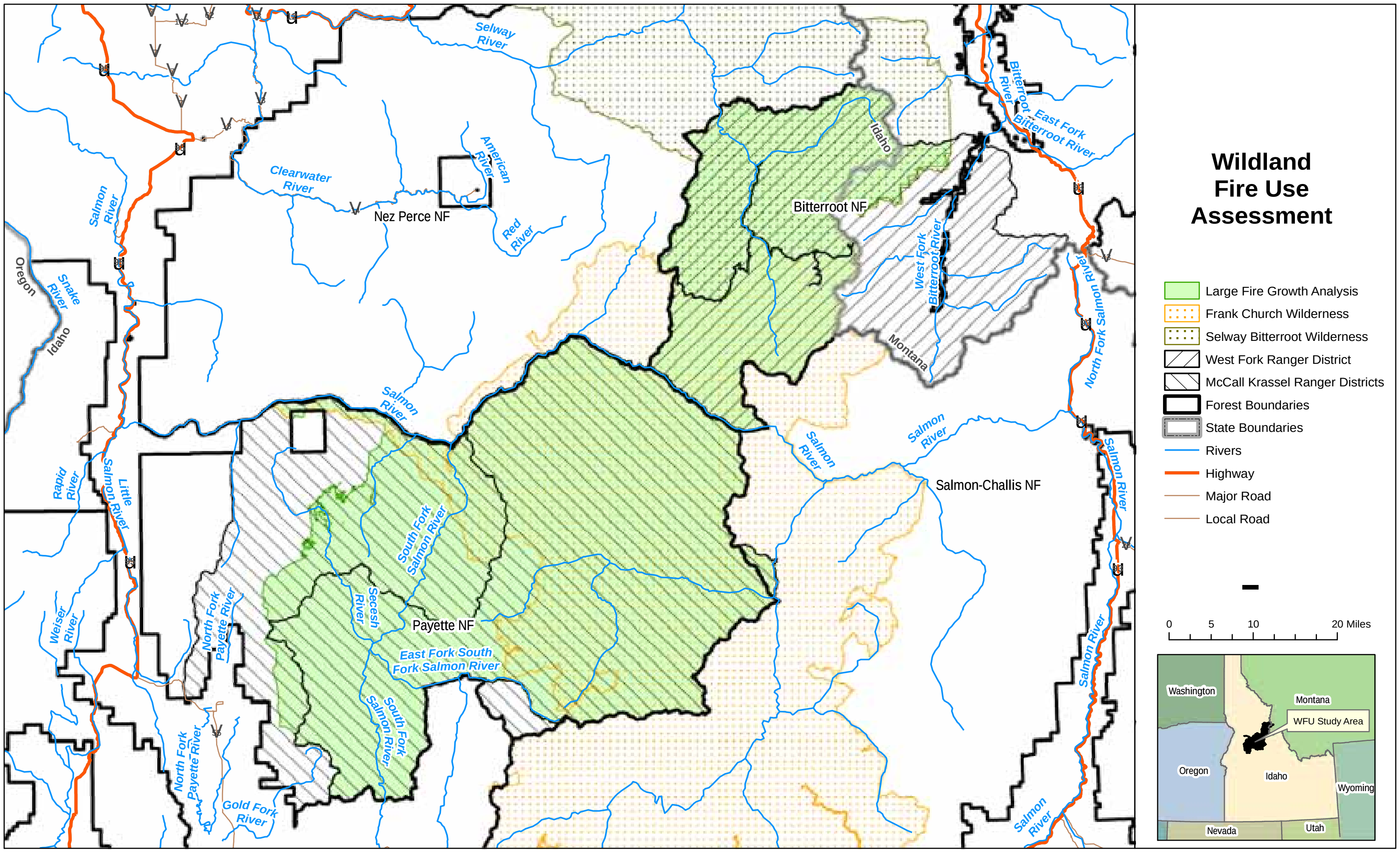
Data Collection

Fire perimeters and ignition points were obtained from the GIS fire atlases of the Bitterroot and Payette National Forests.

Individual Fire Reports specific to each analysis area were downloaded from the National Interagency Fire Management Integrated Database (NIFMID) using the Fire Statistics System (FIRESTAT) program. This information was used to determine fire costs and size.

For this assessment only lightning fires were reviewed as under current policy all human caused ignitions receive a management response of suppression.

During the management of the Krassel and West Fork Wildland Fire Use Complexes in the 2007 fire season, interaction occurred between personnel from the Payette and Bitterroot National Forests This group included Forest Supervisors, District Rangers, Forest and Regional Fire Staff, as well as local biologists, archeologists, fire, and wilderness managers. This provided the opportunity to discuss and observe how individuals perceived wildland fire use, and enhanced leadership decision-making during program implementation.


Wildland
Fire Use
Assessment
Large Fire Growth Analysis
Frank Church Wilderness
Selway Bitterroot Wilderness
West Fork Ranger District
McCall Krassel Ranger Districts
Forest Boundaries
State Boundaries
Rivers
Highway
Major Road
Local Road
0
5
10
20 Miles
Washington
Montana
WFU Study Area
Oregon
Idaho
Wyoming
Nevada
Utah
Nez Perce NF
Bitterroot NF
Salmon-Challis NF
Payette NF
Selway River
Clearwater River
American River
Red River
Salmon River
Snake River
Oregon
Idaho
Montana
Rapid River
Little Salmon River
Weiser River
North Fork Payette River
South Fork Salmon River
Secesh River
East Fork South Fork Salmon River
Gold Fork River
Bitterroot River
East Fork Bitterroot River
West Fork Bitterroot River
North Fork Salmon River

Map 1

Analysis

Several analyses were conducted on the available information as described below. Results are provided in the following section.

GIS Analysis

On the Payette National Forest, Krassel and McCall Ranger Districts, large fires that occurred within the WFU Zone of the FC-RONR Wilderness and those outside and adjacent to the WFU zone were analyzed (Map 1). The entire area includes 1,340,594 acres. The fires within the WFU Zone occurred between 1972 and 2007. The area outside of the WFU zone has a history of large fires in the last 15 years (1994, 2000 and 2007) which are of interest and benefited the analysis. These were classified as suppression fires but point protection and partial perimeter control were the primary tactics used. This left large portions of the fires free burning, similar to conditions which occurred on WFU incidents in the area.

On the Bitterroot National Forest, West Fork Ranger District, the analysis included large fires from 1972 to 2007 that burned within the boundaries of the pre-determined Maximum Manageable Area (MMA) of the WFU Zone (Map 1). This area comprises 495,325 acres and is all within the Selway-Bitterroot and FC-RONR Wildernesses.

Using ArcGIS, a spatial analysis of the overlapping burned area polygons within the areas described above was completed to determine how much acreage had burned and how many times it had burned for three time periods: 1988-1997, 1998-2007 and 1972-2007. The outputs were the sum of the acres burned and the percent of the acres burned within the analysis area for each time period.

A second GIS analysis was completed to determine if the number of acres burned per year was decreasing. The outputs were sorted by year (1973-2007) and included the number of fires, total and average acres burned, and standard deviation.

Fire Reports

Policy and practicality do not allow for WFU in all locations. Suppression of unwanted fire is the appropriate response where the potential damage to values at risk overrides the ecological benefits of fire. Public safety, private property, public infrastructure, and natural resources are a few of the values that are protected by suppressing unwanted wildfires. The objective of this portion of the assessment is to make a general comparison of the cost efficiencies of each management strategy.

Using the information from Individual Fire Reports, the number of fires, fire size, and cost for two management strategies, WFU and suppression, were analyzed. Lightning fires for the years 2002 and 2004 through 2007 within the boundaries of the Krassel and McCall Ranger Districts were analyzed. Additional years were not analyzed as costs were missing from the data available through NIFMID. Lightning fires from 1998 to 2007 within the boundaries of the West Fork Ranger District were also analyzed.

Fires were separated by management strategy and then sorted into the seven standard fire size classes (Table 1). The median, average, and standard deviation was determined for fire size, cost per event, and cost per acre within each size class. The sum of the total acres burned and the total cost for the time period was also determined.

Table 1: Fire Size Class Definition

Fire Size Classes	
Class	Definition
A	$\geq$ .25 acres
B	.26 to 9.9 acres
C	10 acres to 99 acres
D	100 acres to 299 acres
E	300 acres to 999 acres
F	1,000 acres to 4,999 acres
G	5,000 or more acres

Smoke Emissions

The objective of this analysis was to compare emissions from the different vegetation types and fuel loadings and to evaluate the potential reduction in emissions in a previously-burned fuel bed due to lower fuel loading.

The tree and shrub species contained in the Ecological Land Units (ELU) from Ecological Interpretations of the White Cap Drainage (Aldrich and Mutch 1972) and the Fire Groups from the FC-RONR Wildland Fire Use Management Guidebook allowed a cover type to be determined for use in the First Order Fire Effects Model (FOFEM). This data is provided in Appendix A. This model contains a module that calculates potential smoke emissions from fires.

Photo Guides for Appraising Downed Woody Fuels in Montana Forests (Fischer 1981) were used to identify fuel loading for each cover type. The Fire Potential Rating for the selected fuel bed was used to determine the percent of crown that would be burned in the FOFEM model.

FireFamily Plus software was used to analyze historic weather data for the assessment area. A Special Interest Group (SIG) (Appendix B) was developed in the summer of 2007 by Long Term Analysts (LTAN) working on the Krassel and West Fork Wildland Fire Use Complexes. This information was used to determine fuel moisture values during August, the driest month of the fire season.

The cover type, fuel loading and fuel moistures were entered into the Smoke Module of FOFEM to calculate smoke emissions. Model components are described in Appendix C.

Results

Acres Burned

The first spatial analysis evaluated the number of acres burned, the time since an acre had previously burned, and the number of times it had burned.

Payette National Forest, Krassel and McCall Ranger Districts

From 1972 to 2007, within the area analyzed, 977,889 acres (73%) of the 1,340,594 acres had burned at least once. Approximately 77% of the area was unburned in the first period, from 1987-1997, and only 39% was unburned in the second period, from 1998 to 2007. In the first period, 1987 to 1997, only 932 acres (<1%) burned more then once. In the second period, from 1998 to 2007, approximately 33,569 acres, or 3.4% of all the acres burned between 1972 and 2007, burned for the second time. For the time period 1972 to 2007, very few acres have burned three and four times. The average time between fires in previously burned areas was 7 years, the minimum time 1 year, and the maximum 34 years.

Bitterroot National Forest, West Fork Ranger District

From 1972 to 2007, within the pre-determined MMA, 198,192 acres (40%) of the 495,325 acre analysis area had burned. Approximately 87% of the area was unburned in the first period, from 1987-1997, and 71% was unburned for the second period, from 1998 to 2007. In the first period, 1987 to 1997, only 143 acres burned more then once. In the second period, from 1998 to 2007, approximately 4,283 acres, or 2% of all the acres burned from 1972 to 2007, burned for the second time. For the time period 1972 to 2007 very few acres have burned three and four times. The average time between fires in previously burned areas was 9 years, the minimum time 1 year and the maximum 26 years.

These results show an increase in acres burned from WFU as well as an increase in reburned acres during the period 1998 to 2007 for both National Forests. These first and second entry burns are moving the landscape towards the desired condition, achieving the wilderness fire management objective of allowing lightning fire to play its natural role. This is also true for those fires outside of the WFU Zone on the Payette even though WFU is not a management objective.

The second GIS analysis evaluated the number of fires and acres burned from 1973 to 2007 to determine if fire size was smaller over time due to a mosaic of fire scars limiting fire spread. Due to problems in the data set that was available from the Bitterroot National Forest, the second analysis was not performed for this Forest.

On the Payette National Forest, the theory that fires would be smaller did not hold true for the specific area assessed. Not only has the average number of acres burned increased (Figure 1) but the number of large fires (Size Class G) has increased from one for the period 1973-1982, to five for the periods 1983-1992 and 1993 to 2002, and to ten in the period from 2003-2007.

Also, in the last 20 years, the number of acres burned in large fires has increased in those years when large fire activity is above average (Figure 2). For example, the number of acres burned in 2007 was 3.8 times the acreage burned in the 1998 fire season.

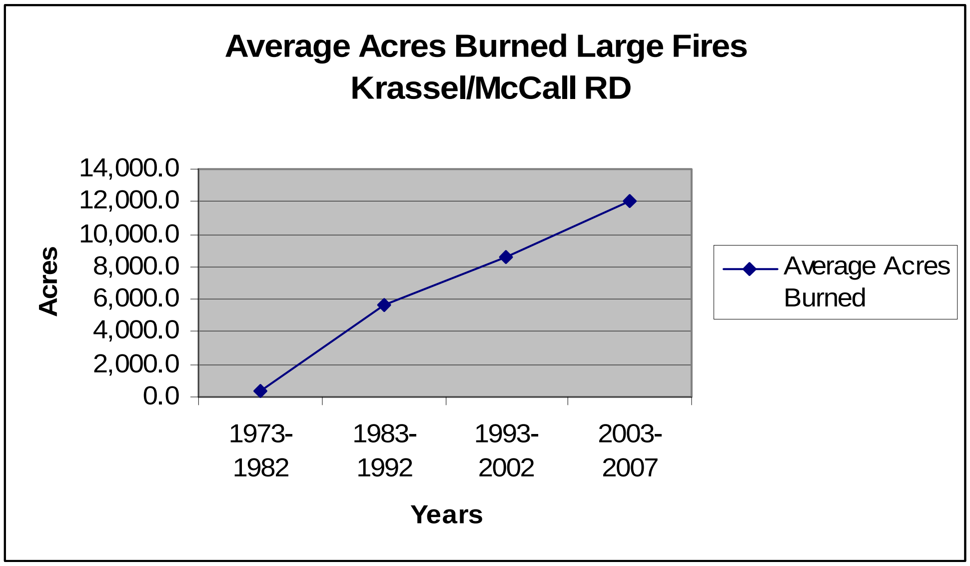


Figure 1: Average Acres Burned by Large Fires (WFU & Suppression)

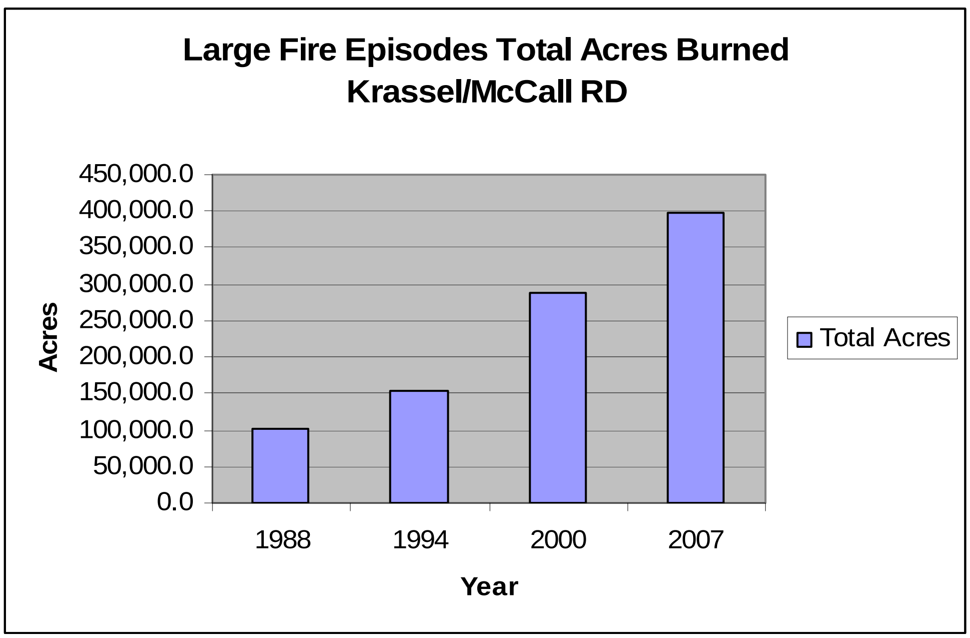


Figure 2: Large Fire Episodes Total Acres Burned (WFU & Suppression)

Based on data in Individual Fire Reports, more than half of the WFU fires in the analysis areas were small. The final fire size was less than 10 acres for 57% of WFU fires on the West Fork and 54% of WFU fires on the Krassel/McCall Ranger Districts.

All size classes are represented in the acres burned by WFU fire on the West Fork Ranger District (Table 2). This distribution suggests that fires may be self limiting in this area of the SBW. When comparing West Fork WFU acres burned by size class to those burned in suppression fires (Table 2), 85% of suppression acres occur in the largest size class, Size Class G, while only 37% of the WFU acres are in this size class.

The differences in fuels, weather and topography would account for some of the differences in fire size. However, there is a noticeable difference in the distribution of acres burned by size class between the WFU fires and suppression fires on the West Fork.

Empirical evidence based on personal observation of fire managers in the SBW support the idea that fires are self limiting. In general, in the mid and higher elevations, there is a period of approximately 10 years before fire will spread in a previously burned area. In the lower elevations of the Salmon and Selway Rivers, the period is much shorter due to the abundance of annual grasses. These findings are not definitive but suggest that a mosaic of different age fires may be limiting fire spread and further investigation may be worthwhile.

When the number of acres burned by size class was analyzed in the Payette National Forest, the findings support the results of the GIS analysis. Currently, Size Class G WFU and suppression fires account for the largest portion of acres burned (88% WFU, 96% suppression). Any evidence of a mosaic of fire scars that is limiting fire spread is not readily apparent. Although the amount of data available for analysis of WFU fires (5 years) is limited and reduces the confidence in the outcome it still allows a look at trends from which broad conclusions can be drawn.

Table 2: Acres Burned By Size Class, West Fork Ranger District 1998-2007

Acres Burned By Size Class West Fork Ranger District 1998-2007		
WFU		
Size Class	Acres Burned	Percent of Total Acres Burned
A <.25 acres	7	<1
B .26-9.9 acres	113	<1
C 10-99 acres	957	1
D 100-299 acres	3341	4
E 300-999 acres	11714	16
F 1000-4999 acres	27969	40
G 5000 acres +	25899	37
Suppression		
A <.25 acres	24	<1
B .26-9.9 acres	151	<1
C 10-99 acres	682	<1
D 100-299 acres	520	<1
E 300-999 acres	4348	3
F 1000-4999 acres	15082	11
G 5000 acres +	117228	85

Fire Costs

The economics of wilderness fire management are difficult to quantify for various reasons (Agee 2000, Saveland 1985). One of these is the least-cost-plus-loss approach common in fire economics which assumes that all resource change is a loss. Systems which measure the economic benefit of wilderness or the value of functioning ecosystems are still elusive.

The Individual Fire Reports used in this analysis only account for the costs directly associated with the management of the individual event. The costs of pre-suppression for both WFU and suppression are not accounted for. Damage to natural resources and infrastructure which occurs from fire suppression activities such as fireline construction and the cost of repair and rehabilitation of this damage is also not included.

Some observations can be made from an analysis of the information in the Individual Fire Reports for the Bitterroot and Payette National Forests.

As shown in Table 3, the cost per event of WFU fires in contrast to those of suppression fires is considerably lower for both the Bitterroot and Payette National Forests. This is to be expected as fewer resources are utilized on WFU incidents and the costs and complexities associated with WFU fires are considerably less than for suppression fires. The cost per event for WFU does show that both Forests are efficient in their use of funds in managing these events.

Looking at individual events, there are higher costs associated with some WFU fires. Factors which account for these higher costs are the proximity of fire to the MMA boundary, the amount of infrastructure that needs protection, and the use of fixed and rotor wing aircraft for checking actions, reconnaissance, or logistical support.

One finding that stood out in the review of fire reports was that, in 2000, fires inside the WFU Zones of both the Payette and Bitterroot National Forests were managed under a suppression strategy. This was due in part to air quality concerns as well as other issues. Operational tactics on these fires included point protection and partial perimeter control; these tactics would have also been applied under a WFU strategy. Three G Class Fires in the FC-RONR (Flossie, Three Bears and Diamond Point) burned a combined total of 239,090 acres at a cost of $319,980. The average cost per event was $106,660 and the average cost per acre was $1.34. This is far less than the costs associated with most fires and demonstrates the potential cost savings of applying non-traditional tactics to large suppression fires.

Table 3: Fire Size and Costs, Bitterroot and Payette National Forests.

Size Class	Number of Fires	Average Size	Cost/Event	Cost/acre	Acres Burned	Total Cost
Bitterroot National Forest				**West Fork RD WFU Fires 1998-2007**		
Size Class	**Number of Fires**	**Average Size**	**Cost/Event**	**Cost/acre**	**Acres Burned**	**Total Cost**
A	64	0.12	$496.00	$4,683.00	7.45	$31,745.00
B	35	3.21	$1,683.00	$842.00	112.50	$58,917.00
C	23	42	$14,883.00	$385.00	957	$342,326.00
D	17	197	$11,007.00	$69.00	3341	$187,124.00
E	20	586	$12,294.00	$18.00	11714	$245,884.00
F	11	2543	$56,877.00	$19.00	27969	$625,653.00
G	4	6475	$174,892.00	$25.00	25899	$699,568.00
	174			**Totals for period**	**70,000**	**$2,191,217.00**
West Fork RD				**Suppression Fires 1998-2007**		
Size Class	**Number of Fires**	**Average Size**	**Cost/Event**	**Cost/acre**	**Acres Burned**	**Total Cost**
A	198	0.12	$1,842.00	$15,004.00	24.32	$364,814.00
B	95	1.59	$5,829.00	$6,675.00	151.45	$553,765.00
C	22	31	$11,457.00	$749.00	682	$252,056.00
D	4	130	$221,197.00	$1,813.00	520	$884,788.00
E	7	621	$792,468.00	$1,548.00	4348	$5,547,277.00
F	8	1885	$586,383.00	$302.00	15082	$4,691,070.00
G	8	14654	$1,231,558.00	$116.00	117228	$9,852,467.00
	342			**Totals for period**	**138,036**	**$22,146,237.00**
Payette National Forest				**Krassel/McCall RD WFU Fires 2002, 2004-2007**		
Size Class	**Number of Fires**	**Average Size**	**Cost/Event**	**Cost/acre**	**Total Acres Burned**	**Total Cost**
A	19	0.12	$930.00	$8,515.00	2.35	$17,679.00
B	7	3.1	$867.00	$673.00	21.5	$6,075.00
C	6	50	$1,724.00	$55.00	297	$10,345.00
D	6	164	$1,933.00	$12.00	981	$11,600.00
E	1	400	$14,000.00	$35.00	400	$14,000.00
F	7	2290	$366,134.00	$232.00	16027	$2,562,941.00
G	8	15982	$776,713.00	$61.00	131939	$6,307,275.00
	54			**Totals for period**	**149,668**	**$8,929,915.00**
Krassel/McCall RD				**Suppression Fires 2002, 2004-2007**		
Size Class	**Number of Fires**	**Average Size**	**Cost/Event**	**Cost/acre**	**Acres Burned**	**Total Cost**
A	122	0.14	$2,118.00	$17,114.00	16.80	$258,419.00
B	69	1.67	$22,677.00	$8,201.00	106.85	$892,738.00
C	11	38	$287,554.00	$7,011.00	413	$3,163,103.00
D	2	255	$112,500.00	$432.00	510	$225,000.00
E	1	475	$15,500.00	$32.00	475	$15,500.00
F	6	2320	$460,187.00	$145.00	13922	$2,761,125.00
G	7	48355	$4,414,913.00	$237.00	338487	$30,904,397.00
	218			**Totals for period**	**353,931**	**$38,220,282.00**

Smoke Emissions

As a decomposition process, wildland fire produces combustion byproducts that are harmful to human health and welfare (Hardy et al. 2001). Air quality for the FC-RONR and SBW is regulated by the states of Montana and Idaho. Particulate matter produced from wildfires and other sources is monitored to determine effects on public health and visibility, which are two major concerns of air quality regulators.

PM_{10} is a measure of particles less than 10 micrometers in diameter in the atmosphere. This includes both fine and coarse dust particles. These particles are one of the many byproducts of wildland fire. PM_{10} particles easily penetrate into the airways and lungs where they may produce harmful health effects, such as the worsening of heart and lung diseases. Exposure to elevated concentrations of particulate matter is associated with increased hospital and doctor visits and increased numbers of premature deaths. Fine particles are the major cause of reduced visibility (haze) in parts of the United States (Environmental Protection Agency 1995).

Adverse impacts to air quality from WFU fires can affect areas that are far from the source of emissions (Miller 2003). Practitioners of WFU have determined that the public has a level of tolerance for these impacts and once this level is exceeded, support for the program declines. Planning and public education prior to events, close coordination with air quality regulators and the public during WFU incidents, and program review with air quality regulators and the public are all key to program success (Wildland Fire Lessons Learned Center 2006, Chambers & Duncan 1995).

Higher fuel loading generally equates to more fuel combustion and emissions. Emissions from the smoldering phase are greater then from the flaming phase of combustion. Smoldering is more prevalent in certain fuels such as duff due to the lack of oxygen to support combustion (Hardy et al. 2001).

A range of possible fuel loadings for the vegetation types found within the FC-RONR and SBW were modeled to predict potential outputs of PM_{10} (Table 4). As expected as fuel loading decreases due to the effects of multiple fires on the landscape, the production of PM_{10} also decreases.

Table 4: Modeled Smoke Emissions

Ecological Land Unit	Species	Photo Series	Fuel Loading (tons/acre)	PM_{10} (lbs/acre)	Fire Potential Rating
Shrubfield	Serviceberry	N/A	26	562	High
	Ceanothus	N/A	36.3	595	High
Ponderosa Pine Savanna	Ponderosa	INT-97-23	3.8	292	Low
	Ponderosa	INT-97-17	10.4	475	Low
	Ponderosa (burn)	INT-97-29A	11.4	518	Low
Pine/Douglas Fir	Pine/Douglas Fir	INT-97-76	2.5	298	Low
	Pine/Douglas Fir	INT-97-77	12.3	394	Low
	Pine/Douglas Fir	INT-97-74	20.2	657	High
North Slope Communities	Grand Fir	INT-96-65	24	1828	High
	Douglas Fir	INT-97-86	16.2	855	High
	Douglas Fir	INT-97-43A	17.3	1037	High
	Douglas Fir (burn)	INT-97-34	19.8	862	Moderate
	Douglas Fir	INT-97-95	52.9	2212	High
Subalpine	Engelmann Spruce	INT-98-45	1.3	1220	Moderate
	Subalpine Fir/Spruce	INT-98-24A	12.8	1647	Moderate
	Subalpine Fir/Spruce	INT-98-22	48	2998	High
	Lodgepole Pine	INT-98-1	7.1	990	Moderate
	Lodgepole Pine	INT-98-35A	12	1059	Moderate
	Lodgepole Pine	INT-98-6	28.3	1346	High

The fire return intervals for these Ecological Land Units give some insight into the potential long term effects of fuel loading on air quality in relation to meeting the program objectives. Allowing fire to play out its natural role in the ecosystem may reduce the impacts of residual smoke on air quality.

Prior to fire exclusion policies, Ponderosa Pine Savanna had a short fire return interval with the primary fire type being surface fire (Arno 1980). The average return interval was 5 to 20 years, with a maximum of 21 to 30 years. As fire is reintroduced, initial events will consume the fuel that has collected during previous fire exclusion and a higher amount of particulate matter will be produced. Subsequent fires will occur more frequently in lower fuel loadings with reduced particulate matter outputs (Figure 3).

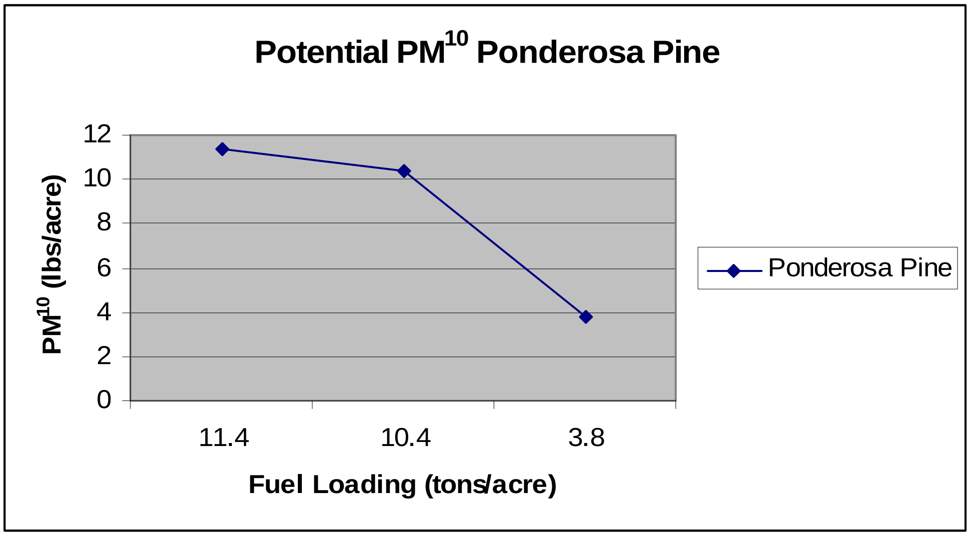


Figure 3: Potential PM_{10} Ponderosa Pine

The North Slope Douglas fir community historically had a mean fire free interval of 15 to 30 years with a maximum of 35 to 60 years. The predominant fire type was low to moderate severity surface fire. The longer the fire free interval, the denser the stands, which made them more susceptible to stand replacement fires (Arno 1980). Again, as fire is reintroduced, there are initially high outputs of particulate matter which decrease as succeeding fires occur (Figure 4).

Modeling results support the theory that reducing the amount of fuel consumed in the smoldering stage will reduce overall particulate matter output. The fuel bed Douglas fir INT-97-34 has a higher fuel loading (19.8 tons) then Douglas fir INT-97-43A (17.3 tons). INT-97-34 produces 862 lbs/acre of PM_{10} which is 175 lbs/acre less then the 1037 lbs/acre of PM_{10} produced by INT-97-43A (Table 4). The difference can be attributed to the decreased loading of duff in the previously burned 19.8 ton fuelbed which has an average duff depth of .3 inches in comparison to 2.7 inches of duff in the 17.3 ton fuelbed.

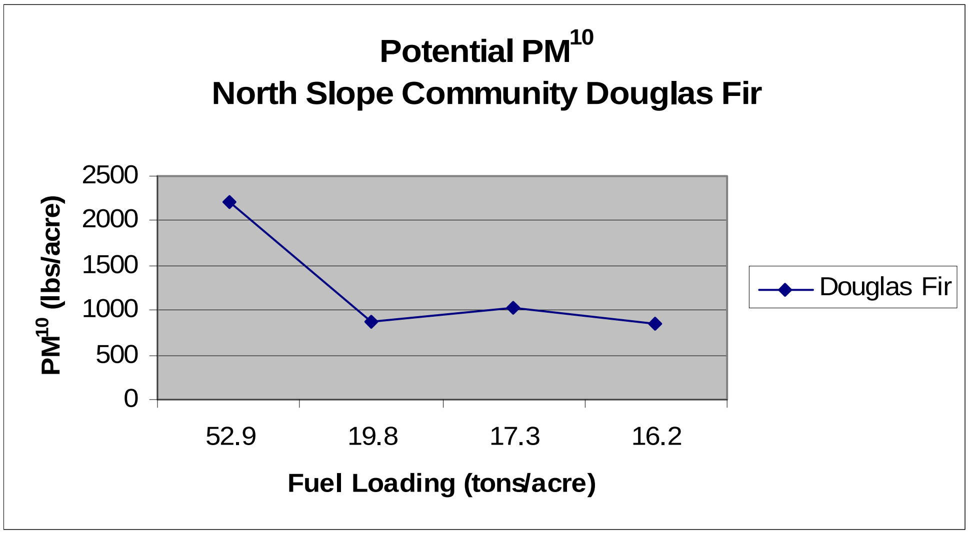


Figure 4: Potential PM_{10} North Slope Community Douglas fir

The spatial analysis of the number of acres burned and burn frequency for WFU fires further supports this theory. This analysis determined that there is an increase in acres that have burned as well as the number of times acres have reburned. The acres that burned for a second, third, and fourth time had reduced fuel loads which produced lower emissions. The vegetation types with frequent, low intensity surface fires (Pine Savanna and Pine/Douglas Fir) will maintain low fuel loads if fires continue to occur in these areas. The vegetation types with infrequent, high intensity fires (North Slope Communities and Subalpine Fir) are less likely to burn for a longer time. This allows the vegetation community to progress to a later seral stage before burning again. As the diversity of seral stages increases from the reintroduction of fire, a range of emissions will be produced based on fuel loading and the time since the last fire. Younger, healthier stands will produce lower emissions and older, decadent stands will produce higher emissions.

<u>Discussions with Forest Personnel</u>

A key element in measuring the success of the Payette and Bitterroot National Forests WFU programs is the consideration of human factors. The willingness of Forest staff to take risks, make decisions, accept the outcomes, and communicate to all levels in the organization are important to understanding program success. Research on decision making, success, and barriers in WFU programs, point out that organizational culture, institutional support, public perception, and organizational capacity, among other factors, contribute to the successful implementation of WFU (Williamson 2007, Doane et al 2006, Knotek 2006,).

Observations of and interaction with personnel on the Payette and Bitterroot National Forests developed the following conclusions.

It is apparent that personnel on both Forests, from the Forest Supervisor to the seasonal firefighters, are accustomed to managing multiple large fires with different management objectives. The objective to allow natural processes play their role in wilderness areas with minimal interference by humans is clearly understood and highly valued by Forests personnel. The use of the minimum tools needed to protect wilderness values is emphasized by all involved.

The District Ranger on the West Fork Ranger District expressed that he considered that it was his responsibility to consider how his decisions to manage risk today would reduce the risk of future decisions for himself and others that might take his place.

The decision to suppress potential WFU incidents, even though based on sound reasoning, is not an easy one to make for local fire managers. They saw these as missed opportunities to meet wilderness fire objectives. The reasons for suppressing WFU candidates included current and projected fire work load, resource availability, proximity to the WFU boundary and/or major travel corridors, and smoke management concerns.

A study of how District Rangers made decisions to implement WFU found that the need for Agency support surfaced as a key requirement for managing non-suppression fires to meet objectives (Williamson 2007). It is clear that the Forest Supervisors of the Payette and Bitterroot National Forests provide this support and the District Rangers in turn support their staff on WFU management decisions.

Key Findings

- The cost per event for WFU on both Forests shows that they are efficient in their use of funds in managing these events.
- The wilderness fire management objective of allowing lightning fire to plays its natural role is being met.
- The amount of particulate matter produced by wildfires will decrease over time. This is a result of reduced fuel loadings. Fires burning in these fuels will produce lower emissions and be of shorter duration. The investment in the initial WFU fires will reduce the likelihood of large smoke events during future fires.
- There is an increase in WFU acres that have burned as well as in the number of acres reburned in the period from 1998-2007 on the Payette and Bitterroot National Forests. These second entry burns move the landscape closer to the desired condition of allowing fire as a natural process to occur.
- The average number of acres burned has steadily increased on the Payette National Forest with no evidence that fires are self limiting.
- Within the area analyzed on the Payette National Forest, the number of large fires per decade has increased from one for the period 1973-1982, to five for the periods 1983-1992 and 1993 to 2002. In the last 5 years, 2003 to 2007, there have been ten large fires.
- In the last 20 years, within the area analyzed on the Payette National Forest, the number of acres burned in years with above-average fire activity has increased for each episode. The number of acres burned in the 2007 event was 3.8 times the acreage burned in the 1998 fire season.
- On average, 57% (West Fork Ranger District) and 54% (Krassel/McCall Ranger Districts) of WFU fires in the areas studied have a final fire size of less then 10 acres.

- Managing several large fires with different management objectives is a common and accepted practice on the Payette and Bitterroot National Forests.
- Forest and District Line Officers embrace the implementation of WFU and this is reflected in the actions of their personnel.
- The investment in risk taken by fire managers in making the decision to implement WFU has paid off in the form of meeting wilderness objectives as well as providing greater decision space in managing future fires.

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Cover photo courtesy of John Thornton, Boise National Forest.

Citations

Agee, J.K. 2000. Wilderness fire science: A state of knowledge review. In: Cole, D.N.; McCool, S.F.; Borrie, W.T.; O'Loughlin, J. 2000. Wilderness Science in a Time of Change. Conference Proceedings: RMRS-P-15-VOL-5. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Aldrich, D.F and Mutch R.W. 1972. Biological interpretations of the White Cap drainage: A basis for wilderness fire management, US Department of Agriculture, Forest Service. 109 pg.

Arno, S. F. 1980. Forest Fire History in the Northern Rockies, Journal of Forestry 78: 460-465.

Chambers, M.A. and Duncan, E.A 1995. Prescribed natural fire and air quality: Identifying the real problem. Proceedings: Symposium on fire in wilderness and park management, Missoula, MT, 1993 General Technical Report INT-GTR-320. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Research Station. 77-79.

Doane, D.; O'Laughlin, J.; Morgan, P.; and Miller, C. 2006. Barriers to wildland fire use: A preliminary problem analysis. International Journal of Wilderness Volume 12, Number 1. 36-38.

Environmental Protection Agency. (1995). Environmental Protection Agency. Retrieved March 31, 2008 from the World Wide Web: http://www.epa.gov/air/airtrends/aqtrnd95/pm10.html

Fischer, W.C. 1981. Photo guide for appraising downed woody fuels in Montana forests: General Technical Report GTR-INT-96. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Research Station. 53 pg.

Fischer, W.C. 1981. Photo guide for appraising downed woody fuels in Montana forests: General Technical Report GTR-INT-97. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Research Station.

Fischer, W.C. 1981. Photo guide for appraising downed woody fuels in Montana forests: General Technical Report GTR-INT-98. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Research Station. 143 pg.

Forest Service Manual 2320.00 Wilderness Management 2007. US Department of Agriculture, Forest Service. 55 pg.

Frank Church – River Of No Return Wilderness Wildland Fire Use Management Guidebook 2001. US Department of Agriculture, Forest Service.

Habeck, J.R. 1972. Fire ecology investigations in the Selway-Bitterroot Wilderness: Historical considerations and observations. Publication No. R1-72-001, University of Montana, US Department of Agriculture, Forest Service. 119 pg.

Hardy, C. C., R.D. Ottmar, J.L. Peterson, J.E. Core, and P. Seamon. 2001. Smoke management guide for prescribed and wildland fire: 2001 edition. PMS 420-2. National Wildfire Coordination Group, Boise, ID, 226 p.

Knotek, K. 2006. International Journal of Wilderness Volume 12, Number 1.22-25

Miller, C., 2003. Wildland Fire Use: a wilderness perspective on fuel management. In: Omi, P.N., Joyce, L.A. (Eds.), Fire, Fuel Treatments, and Ecological Restoration. Conference Proceedings RMRS-P-29. US Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO, pp. 379–386.,

Saveland, J.H. 1985. Wilderness fire economics: The Frank Church-River of No Return Wilderness, Proceedings: National Wilderness Research Conference, Fort Collins, CO. 39-48.

Selway Bitterroot Wildland Fire Use Guide Book July 2004. US Department of Agriculture, Forest Service

van Wagtendonk, J.W. 1995. Large fires in wilderness areas, Proceedings: Symposium on fire in wilderness and park management, Missoula, MT, 1993 General Technical Report INT-GTR-320. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Research Station. 113-116.

Williamson, M.A. 2007. Factors in United States Forest Service district rangers' decision to manage a fire for resource benefit. International Journal of Wildland Fire 16: 755-762

Appendices

Appendix A: Ecological Land Units and Fire Types

Ecological Land Unit[1]	Fire Group[2]	Species	Cover Type	Photo Series	Tons/Acre	Fuel Model	Fire Potential Rating
Shrubfield	N/A	Serviceberry	SRM 421	N/A	26	5	High
		Ceanothus velutinus	NVCS	N/A	36.3	5	High
Ponderosa Pine Savanna	2	Ponderosa Pine	SAF 237	INT-97-17	10.4	9	Low
		Ponderosa Pine	SAF 237	INT-97-23	3.8	9	Low
		Ponderosa Pine	SAF 237	INT-97-29A (burn)	11.4	2	Low
Ponderosa/Douglas Fir	3	Ponderosa/Douglas Fir	SAF 237*	INT-97-74	20.2	10	High
		Ponderosa/Douglas Fir	SAF 237*	INT-97-76	2.5	2/9	Low
		Ponderosa/Douglas Fir	SAF 237*	INT-97-77	12.3	8	Low
North Slope Communities	6	Grand Fir	SAF 213	INT-96-65	24	10	High
	5	Douglas Fir	SAF 210	INT-97-34 (burn)	19.8	10	Moderate
	5	Douglas Fir	SAF 210	INT-97-86	16.2	10	High
	8	Douglas Fir	SAF 210	INT-97-95	52.9	10	High
	4	Douglas Fir	SAF 210	INT-97-43A	17.3	10	High
Subalpine	9	Engelmann Spruce	SAF 206	INT-98-45	1.3	8	Moderate
	7	Subalpine Fir/Spruce	SAF 206	INT-98-22	48	10	High
	10	Subalpine Fir/Spruce	SAF 206	INT-98-24A	12.8	8	Moderate
	7	Lodgepole	SAF 218	INT-98-1	7.1	8	Moderate
	7	Lodgepole	SAF 218	INT-98-35A	12	8/10	Moderate
	7	Lodgepole	SAF 218	INT-98-6	28.3	10	High

[1]Aldrich, D.F. and Mutch, R.W. 1972 Ecological Interpretations of the White Cap Drainage: A Basis for Wilderness Fire Management. U.S. Department of Agriculture, Forest Service

[2] Frank Church-River of No Return Wilderness: Wildland Fire Use Management Guidebook

* This cover type is listed as SAF 214 in INT-97 but is not available in FOFEM, used SAF 237 in its place.

Appendix B: Weather Analysis

Mean Values 1986-2006 WFU SIG[3]					
Outputs/Indices	June	July	August	September	October
1000 hour	18	15	14	14	15
10 hour	12	10	9	11	13
Woody	132	115	95	104	98
Herbaceous	118	97	68	60	40
ERC	24	36	44	39	31
Spread Component	7	10	12	11	10

[3]Significant Interest Group, Remote Automated Weather Stations, Firefamilyplus
Hell's ½ Acre and West Fork, Bitterroot National Forest
Lodgepole, Payette National Forest
Indianola and Skull Gulch, Salmon National Forest
Round Top, Clearwater National Forest

Seasonal Adjustment of Crown Percentage Burned[4]		
Fire Potential Rating[5]	**Month**	**Crown Burned**
Low	July	10%
	August	20%
Moderate	July	20%
	August	30%
High	July	60%
	August	80%

[4]July values are the default in First Order Fire Effects Model (FOFEM) August values are adjusted based on the approximate percent change in 1000 hour fuel moisture.
[5]Fire Potential Rating is from Fischer, W.C. 1981. Photo guides for appraising downed woody fuels in Montana forests.

Appendix C: Smoke Emissions Modeling Process