THESIS

FOREST FIRE HAZARD AND RISK IN COLORADO

Submitted by

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY KEVIN C. RYAN ENTITLED FOREST FIRE HAZARD AND RISK IN COLORADO BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

Committee on Graduate Work

Jack S. Barrows
Adviser

Head of Department

ABSTRACT OF THESIS

FOREST FIRE HAZARD AND RISK

IN COLORADO

The purpose of the study was to enhance understanding of forest fire hazard and risk factors which are important to resource management and public safety.

Annual forest fire records were used to determine general trends in forest fire occurrence from 1946 to 1973 for the State of Colorado and the ten National Forests in Colorado. Five year moving averages were used to determine trends in the number of fires and acres burned. The trend in man caused fires was compared to population trends to determine the effect of recent growth on fire occurrence.

Individual fire reports from the ten National Forests were used for detailed analysis of fire occurrence from 1960 to 1973. Analysis concentrated on the cause of fire, forest cover type at origin of fire, aspect and slope steepness. Seasonal patterns of fire occurrence were also determined. The number of fires, acres burned, average size per fire, number of class C and larger fires (over 10 acres), and percent of class C and larger fires were computed for all variables analyzed in the study.

A conceptual model of forest fire potential was used to combine hazard and risk in the forest cover types and elevation zones. The number of fires, acres burned, and number of class C and larger fires were calculated on a

per million acre basis and normalized on a scale from 0 to 100. The normalized numbers of fires, acres burned, and class C and larger fires were used respectively as ignition, magnitude, and spread potentials. Combined they provided the total fire potential for the cover types and elevation zones.

Results indicate a definite increasing trend in both lightning and man caused fires in Colorado. Man caused fires approximately tripled during the 28 year period while population only doubled. Lightning and man caused fires also increased in the National Forests but at a much slower pace than in the State.

Although fires were more common in the high risk months of July and August, hazard is generally lower than in the spring and fall months. The majority of large fires burned in June and October.

The forest cover type, elevation and aspect strongly affected patterns of fire occurrence. The ponderosa pine had the greatest number of fires and acres burned. The number of class C and larger fires was highest in the grass and sagebrush type. Man caused ignitions per acre were highest in the lower elevations while lightning ignitions were highest in the middle elevations. Both lightning and man caused ignitions per acre were low above 8,500 feet.

Aspect also had a strong effect on fire occurrence. Southerly exposures had more and larger fires than northerly ones.

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CHAPTER I. INTRODUCTION

Since World War II, the State of Colorado has been experiencing dramatic population growth. The U.S. Census Bureau estimates that the population of the State increased 79.0 percent between 1950 and 1972. The greatest growth has been in the Front Range Area including the immediately adjacent high plains counties. In Colorado Planning Regions 2, 3, 4, 7, 8, and 13 (Figure 1), which encompass the Front Range forests, population increased 99.0 percent between 1950 and 1972. During the same period population increased 113.9 percent in the greater Denver area (Region 2) and 235.3 percent in the Colorado Springs area (Region 4) (Table 1). In general, the western slope areas experienced slower growth rates than did the Front Range areas during the 1950 to 1972 period. Some rural regions lost population during the earlier years but all regions of the State have increased in population in the more recent years.

Accompanying this spectacular growth there has been a great increase in the development and use of the forest resources. Influxes of people, opening up of new communities, development of recreation facilities, construction of new transportation routes, and greatly increased demands on the overall forest resources influence the characteristics and importance of forest fire hazards and risks. The problem of increased demand on the forest resources is being further compounded by planned large scale development of energy resources in several sub-regions of Colorado.

The historic fire records of Colorado show that many large fires occurred during the last half of the 19th century and the early years of the 20th century. These fires burned during the pioneer era of resource exploitation and settlement in the mountain areas of the State. During these years there were few restrictions on resource use and organized forest fire control was unknown. In the past fifty years forest fires have had a relatively small impact on man and forest resources in most of the Colorado mountain area. This is due primarily to the successful methods of organized fire control. In recent years less than one percent of the fires in Colorado have reached sizes of more than 300 acres. However, this fire control record was achieved prior to the intensive development that is now underway in the forest areas. As development and use of forest areas increases, there will be an enlarged potential for ignition and a greater opportunity for fires to have serious consequences.

The large scale growth necessitates the understanding of the relationship of hazard and risk to overall forest fire potential. It is necessary to understand the

Figure 1
Colorado Planning Regions

COLORADO

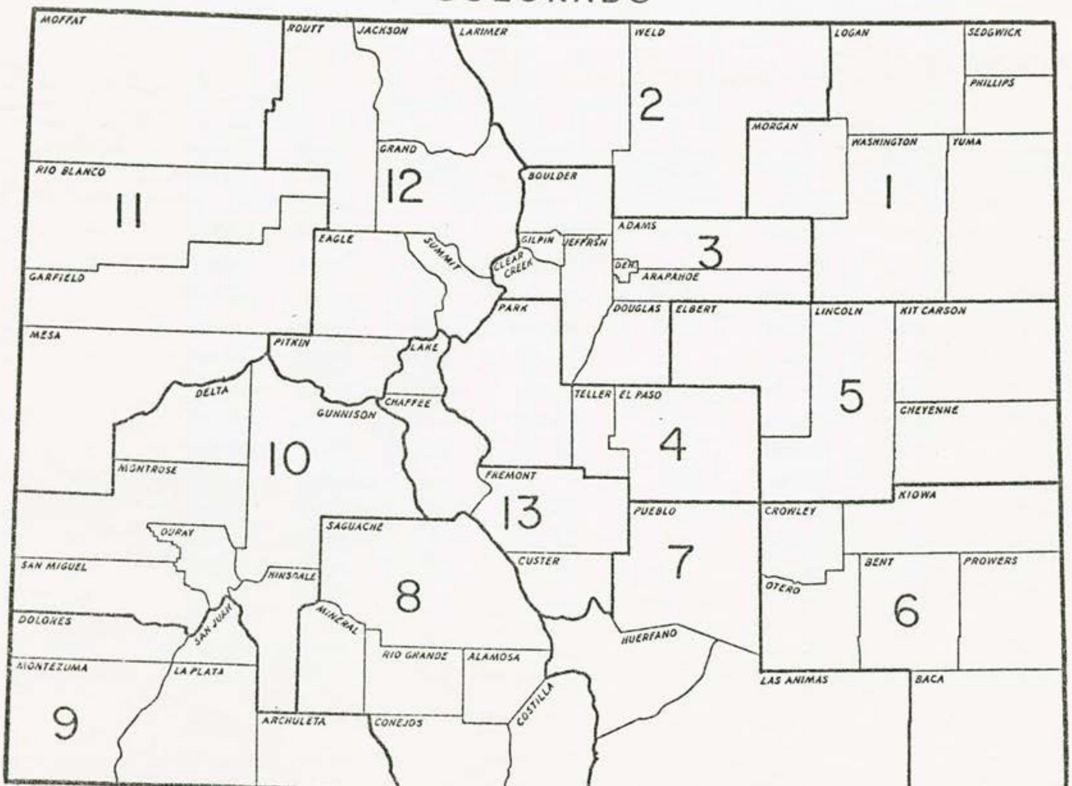

MOFFAT
ROUTT
JACKSON
LARIMER
WELD
LOGAN
SEDGWICK
PHILLIPS
2
MORGAN
WASHINGTON
YUMA
GRAND
RIO BLANCO
BOULDER
11
12
1
ADAMS
3
EAGLE
SUMMIT
GILPIN
JEFFRSN
CLEAR CREEK
DEN
ARAPAHOE
GARFIELD
PARK
DOUGLAS
ELBERT
LINCOLN
KIT CARSON
MESA
PITKIN
LAKE
DELTA
CHAFFEE
GUNNISON
TELLER
EL PASO
5
CHEYENNE
10
4
MONTROSE
FREMONT
KIOWA
13
PUEBLO
CROWLEY
SAGUACHE
OURAY
SAN MIGUEL
HINSDALE
CUSTER
7
BENT
PROWERS
OTERO
8
6
DOLORES
SAN JUAN
MINERAL
HUERFANO
RIO GRANDE
ALAMOSA
MONTEZUMA
LA PLATA
LAS ANIMAS
BACA
COSTILLA
9
ARCHULETA
CONEJOS

Table 1

Colorado Population Growth 1950-1972

Planning Region	Total Pop. 1950	Total Pop. 1960	% Pop. Change 1950-1960	Total Pop. 1970	% Pop. Change 1960-1970	Total Pop. Est. 1972	% Pop. Change 1970-1972	Total % Change 1950-1972
1	63,627	65,713	3.3	60,587	-7.8	62,300	2.8	-2.1
2	111,058	125,687	13.2	179,197	42.6	204,543	14.1	84.2
3	612,774	937,677	53.0	1,242,027	32.5	1,325,400	6.7	113.9
4	79,184	148,049	87.0	241,441	63.1	265,500	10.0	235.3
5	22,439	18,665	-16.8	18,764	.5	18,900	.7	-15.8
6	65,102	57,556	-11.6	54,063	-6.1	55,000	1.7	-15.5
7	126,639	146,557	15.7	140,572	-4.1	143,000	1.7	12.9
8	45,963	38,704	-15.8	37,466	-3.2	38,563	2.9	-16.1
9	31,338	38,923	24.2	37,356	-4.0	38,624	3.4	23.2
10	43,360	44,118	1.7	44,927	1.8	45,686	1.7	5.4
11	61,264	74,943	22.3	80,362	7.2	81,998	2.0	33.8
12	22,148	20,346	-8.1	28,858	41.8	35,000	21.3	58.0
13	33,257	36,900	11.0	41,506	12.5	44,600	7.5	34.1
Total All Regions	1,318,153	1,753,838	33.1	2,207,126	25.8	2,359,114	6.9	79.0

characteristics of both hazards and risks that have impact on the protection and management of forest resources and on the safety of the public utilizing these resources. Dealing with these problems requires a program of forest fire management that is fully integrated with overall land use planning and resource management.

Purpose and Objectives

The purpose of this study was to enhance understanding of forest fire hazard and risk factors which are important to resource management and public safety. To accomplish this is a conceptual model of forest fire potential was developed through an analysis of fire hazards and risks.

The specific objectives of this study were to:

(1) Analyze trends and consequences of wildfires that have burned in various fuels and under various conditions common to the forests of Colorado.

(2) Identify fuel and topographic situations that provide serious potential for ignition and initial fire growth.

(3) Compare fire hazard and risk factors in eastern and western slope forests of Colorado.

CHAPTER II. METHODS

The Data Base

The broad scope of this study required maximum use of readily available data and limited acquisition of new data. Forest fire data published annually in the Clarke-McNary Wildfire Statistics (U.S.D.A. Forest Service 1946-1973 a) and National Forests Fire Report (U.S.D.A. Forest Service 1946-1973 b) were used along with the U.S. Forest Service Region II Individual Fire Reports (5100-29). The annual Clarke-McNary Wildfire Statistics and National Forest Fire Reports provided data on the number of lightning and man caused fires and on the number of acres burned. The individual fire reports provided data on fire date, location, cause, forest cover type, rate of spread fuel type, elevation, aspect and slope steepness. The Forest Service also provided additional data on the acreages in the major forest cover types and on recreational use.

Research Approach

The research approach involved the following principal areas of study summarized below:

(1) Review of historic fire occurrence for the State of Colorado and for Colorado's National Forests from 1946 to 1973.

(2) Review of seasonal fire occurrence patterns in Colorado's National Forests from 1960 to 1973.

(3) Analysis of forest fire hazard in Colorado's National Forests from 1960 to 1973.

(4) Analysis of forest fire risk in Colorado's National Forests from 1960 to 1973.

(5) Integrated analysis of hazard and risk in Colorado's National Forests from 1960 to 1973.

Fire History

A general review of fire history was completed primarily through examination of fire reports of various state and federal forest fire control agencies. The period reviewed was 1946 to 1973. Annual Clarke-McNary Wildfire Statistics published by the U.S. Forest Service provided the history of the number of fires and area burned on private, state, and federal lands (U.S.D.A. Forest Service 1946-1973 a). These reports were supplemented by examination of annual National Forest Fire Reports (U.S.D.A. Forest Service 1946-1973 b) for the ten National Forests in Colorado.

A separate analysis of the number of fires and acres burned was also completed for the five east slope and five west slope National Forests. The division of National Forests into east and west slope was necessary because of differences in weather patterns and population densities. The National Forests represented in each group are:

East Slope

Arapaho National Forest

Pike National Forest

Rio Grande National Forest

Roosevelt National Forest

San Isabel National Forest

West Slope

Grand Mesa-Uncompahgre National Forest

Gunnison National Forest

Routt National Forest

San Juan National Forest

White River National Forest

Due to the great variability in the annual number of fires and acres burned, regression could not be used to determine trends in the number of fires and acres burned. Instead, five year moving averages were calculated. The moving averages provided data for graphs of the trends in fires and acres burned from 1946 to 1973.

Fire Season

The U.S. Forest Service Individual Fire Reports (5100-29) were analyzed by using two computer programs to determine seasonal trends in ignitions, acres burned, and number of class C and larger fires. The period 1960 to 1973 was used for this analysis. The FIRLOAD program provided a daily summary of the number of fires and acres burned. This program also summarized the number of fire days and the number of multiple fire days. The SPSS CROSSTABS program produced a table of the monthly occurrence of lightning and man caused fires.

Fire Hazards and Risks

Fire hazard refers to the fuel complex in which fires burn. Risk refers to the source and potential numbers of fire brands that will ignite forest fuels. The best available data for a study of forest fire hazards and ignition sources are the U.S. Forest Service Individual Fire Reports (5100-29). For each fire the specific hazard and risk factors of cause, forest cover type, fuel type, and topography are recorded in a standard manner (U.S.D.A. Forest Service 1960-1973). The variables and values used in this study corresponded directly to the coded data on the fire reports.

Fire performance in terms of ignitions, size class of fire, and area burned was used to evaluate hazard and risk factors. The average size per fire and percent of class C and larger fires were also calculated for comparison between hazard and risk factors. In some cases, the average size per fire was increased several times by a single large fire. To make the average size per fire more comparable to what can be expected by the majority of fires, an average size per fire was also calculated excluding the large fire.

The hazard and risk factors examined in this study were cause, forest cover type at point of origin, fuel type, elevation, aspect, and slope steepness.

Fire performance was evaluated for lightning and man caused fires. Man caused fires were not broken down by causal agent. The cause of fire was also crosstabulated by nine forest cover types, five elevation zones, ten aspects, and ten slope classes. The crosstabulated variables formed a matrix. The number of ignitions, size class of fire and area burned were then evaluated for each cell in the matrix.

The forest cover types coded on the fire reports are indicators of hazard. Each type covers a broad range of stand conditions and fuel complexes. Statistics were not available on the actual number of acres in each forest cover type on the National Forests. As a result, the number of commercial timber acreages for the major timber species was used as an estimate of the true acreages. The noncommercial National Forest acreages were assumed to include only noncommercial species. Commercial and noncommercial acreages were divided into east and west slope National Forests (Table 2). Fire performance was evaluated by the following forest cover types:

- ponderosa pine
- lodgepole pine
- spruce-fir
- Douglas-fir
- fir/subalpine/white pine group
- pinyon-juniper
- deciduous
- heavy brush
- grass and sagebrush

Table 2

Commercial Timber Acreage for the Major Forest Cover Types by East Slope and West Slope National Forests[a]

Forest Cover Type	Thousand Acres		
	East Slope National Forests	West Slope National Forests	Total All National Forests
Ponderosa Pine	503.0	460.9	963.9
Lodgepole Pine	918.4	677.5	1,595.9
Spruce-fir	1,217.7	2,047.6	3,265.3
Douglas-fir	497.2	383.9	881.1
Deciduous (Primarily Aspen)	475.0	1,410.6	1,884.6
Noncommercial Acreage	2,202.7	2,902.5	5,105.2

[a]Source: Region II U.S. Forest Service 1956 to 1961 Timber Inventory data on file in regional office Denver, Colorado.

The nine forest cover types were also crosstabulated by the five elevation zones forming a 45 cell matrix.

For many years the U.S. Forest Service fuel classification and mapping system has been used to evaluate fuel complexes according to fire control efforts. The classification system delineates fuel complexes by the rate of spread and resistance to control (Hornby 1933). Rates of spread and resistance to control are divided into four relative classes known as low, medium, high, and extreme. Because rate of spread is a more important factor to fire behavior, analysis of fuel types was limited to the four rate of spread classes. The four fuel types and average spread levels are as follows (U.S. Forest Service Region II 1964).

Fuel ROS Type	Perimeter Increase per Hour
Low	1-10 chains
Medium	11-20 chains
High	21-40 chains
Extreme	41 plus chains

Fuel complexes are dynamic and unfortunately the fuel type maps were not kept current. Most maps were discarded when the National Fire Planning was completed in the early 1970's. For this reason only data from the 1960-1969 period were used in this analysis. Data are not available on the acreage available in each rate of spread type but it is estimated that the majority of the fuels are in the low and medium spread types.

Fire performance was evaluated for five elevation zones. Because the National Forest lands are not evenly distributed throughout the range of elevations, it was necessary to calculate the approximate number of acres in each zone. A 1:500,000 U.S. Geological Survey topographic map of Colorado was used to compute acreages. Elevation zones were delineated by colored pencils and National Forest acreages were computed by using a dot grid. The five elevation zones are: (1) 4,501 to 5,500 feet; (2) 5,501 to 6,500 feet; (3) 6,501 to 7,500 feet; (4) 7,501 to 8,500 feet; and (5) above 8,500 feet. The number of acres available in each elevation zone was divided into east and west slope National Forests (Table 3).

The number of fires, size class of fire and area burned were evaluated by the following aspects:

north	southwest
northeast	west
east	northwest
southeast	ridgetop
south	flat

Because acreage figures were not available for the amount of land at each aspect, it was necessary to make comparisons among the different aspects by using the percent of fires, percent of class C and larger fires, and percent of acres burned at each aspect. The average of the three percents was then used as a relative indicator of forest fire potential by aspect.

Table 3

Approximate Acreage by Elevation Zones

for Colorado National Forests

Elevation	East Slope		West Slope		Total	
	#	%	#	%	#	%
4,501-5,500	4,359	.07	...	...	4,359	.03
5,501-6,500	68,501	1.03	28,023	.32	96,524	.63
6,501-7,500	282,103	4.24	387,347	4.52	669,450	4.40
7,501-8,500	803,962	12.07	1,568,069	18.31	2,372,031	15.82
Above 8,500	5,499,519	82.59	6,580,733	76.84	12,080,252	79.36
Total	6,658,444	100.00	8,564,172	100.00	15,222,616	100.00

Fire performance was evaluated for slopes of varying steepness. The following percent slope classes were used on the fire reports:

0 to 9%	50 to 59%
10 to 19%	60 to 69%
20 to 29%	70 to 79%
30 to 39%	80 to 100%
40 to 49%	Over 100%

Acreage figures were not available for the amount of land in each slope class but it is estimated that the amount of land decreases rapidly with increasing slope steepness.

The Statistical Programs for the Social Sciences (SPSS) CODEBOOK program provided tables of the absolute, relative, and cumulative frequency of observations of the variables. The SPSS CROSSTABS generated 2 and 3 dimensional matricies of designated variables. Program ELSORT was used to tabulate fire cause by cover type, elevation zone, and size class. Program ASPLP was used to tabulate fire cause by aspect, slope, and size class. Program VOCAPL provided summary tables of the number of fires, acres burned, and average size per fire for observations of designated variables.

Integrated Hazard and Risk

Hazard and risk were integrated by using a conceptual model of forest fire potential developed by Ryan and Barrows (1975). They defined forest fire potential as: "The interrelationship of hazard and risk factors which combine to cause specified levels of fire ignition, spread, and magnitude." They further defined fire ignition, spread, and magnitude for application to the model as follows:

<u>Fire ignition</u>: The number of lightning, man caused, and total fires per million acres.

<u>Fire spread</u>: The number of class C and larger lightning, man caused, and total fires per million acres.

<u>Fire magnitude</u>: The area burned by lightning, man caused, and total fires per million acres.

The number of fires, number of class C and larger fires, and acres burned were calculated on a per million acre basis for the major forest cover types and elevation zones. The peak number of fires, number of class C and larger fires, and acres burned were then used to calculate normalized ignition, spread, and magnitude potential on a scale from 0-100. The normalized values then provided a relative fire potential rating for lightning and man caused fires in the forest cover types and elevation zones.

CHAPTER III. RESULTS AND ANALYSIS

Long Term Trends in Fire Occurrence

During the period 1946 to 1973 over 20,000 wildfires consumed nearly 330,000 acres of Colorado's forest and range lands. Annually there has been an average of 730 fires and 11,746 acres burned (U.S.D.A. Forest Service 1946-1973 a). Variability is a salient feature of the annual fire load. The number of fires has varied from a low of 186 in 1957 to a high of 1,662 in 1971. Acreage burned in the State has varied from a low of 342 acres in 1957 to a high of 56,249 acres in 1958. The variation in the annual number of fires and acres burned was so great that it was necessary to calculate a fire year moving average to determine a trend. This analysis revealed a rather strong increase in the number of fires (Figure 2). Both lightning and man caused fires have been increasing since 1946, but man caused fires have been increasing at a faster rate than lightning fires. Man caused fires have accounted for 64.6 percent of all fires in Colorado since 1946. Acreage burned figures were not available for lightning and man caused fires but figures on the total acres burned were available. There was not a significant trend (Figure 3).

Figure 2

Five Year Moving Average Number of Lightning, Man Caused, and Total Fires in Colorado 1946-1973

TOTAL FIRES IN COLORADO

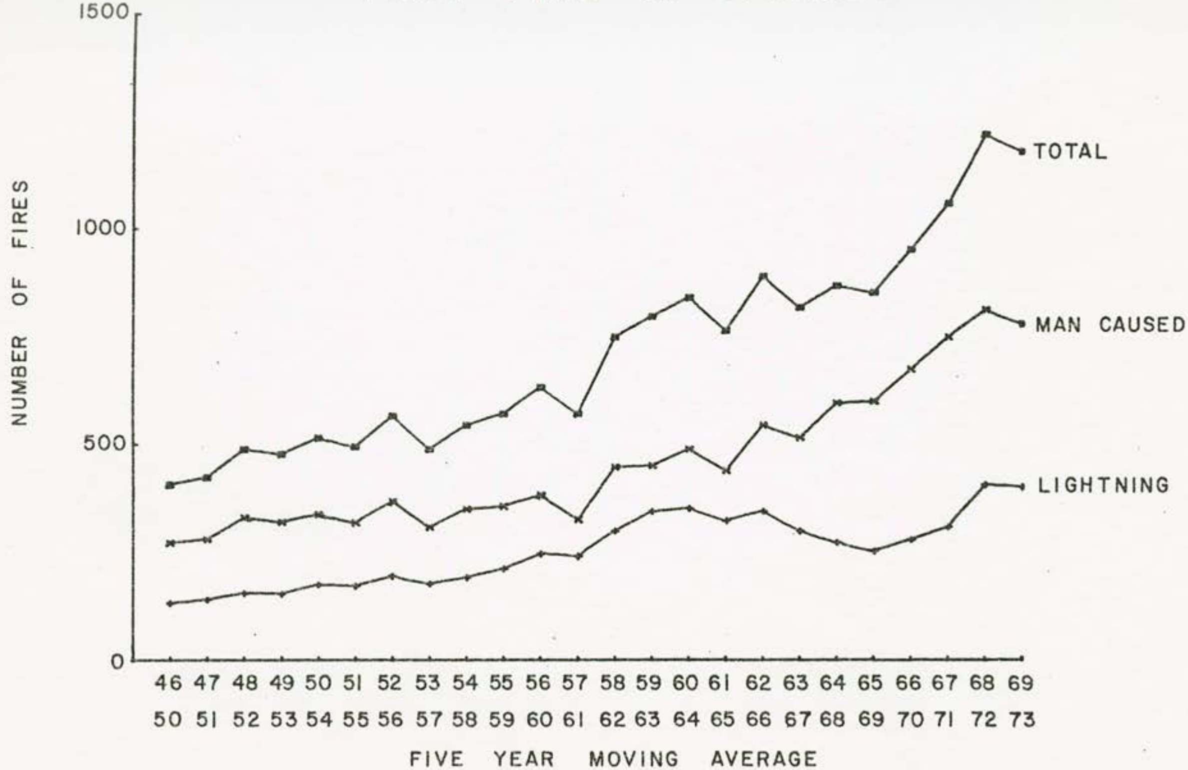


Figure 2

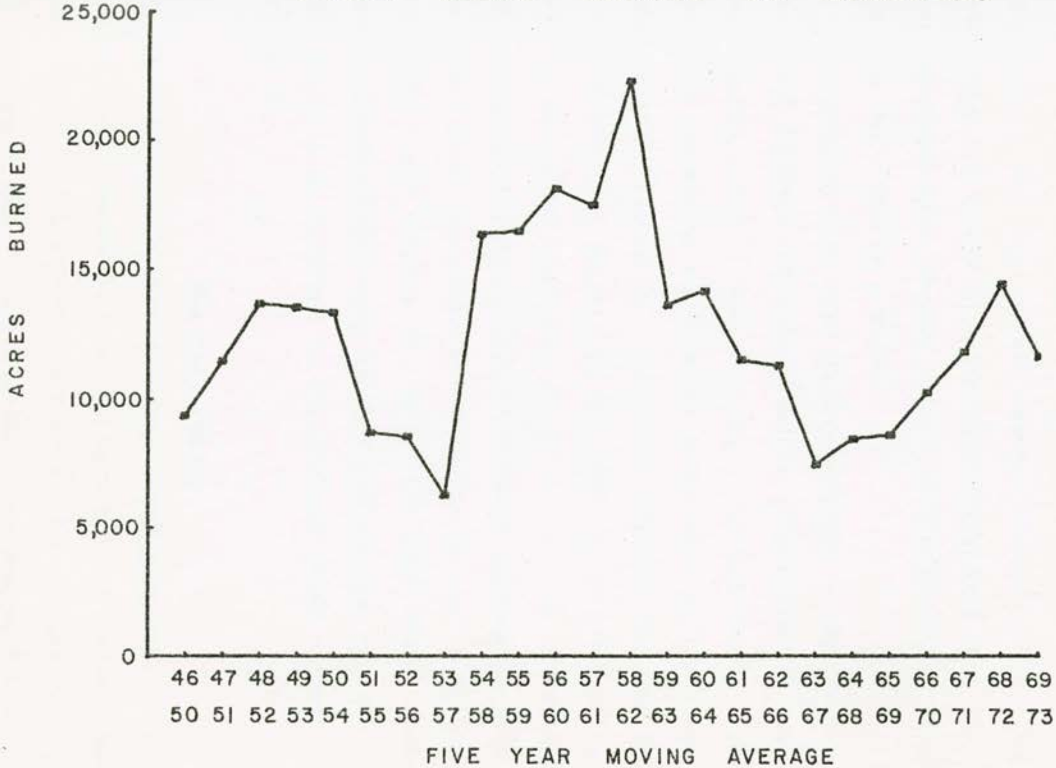
Five Year Moving Average Number of Acres Burned in Colorado 1942-1973

Figure 3

Five Year Moving Average Number of Acres

Burned in Colorado 1946-1973

TOTAL ACRES BURNED IN COLORADO



A similar analysis of five year moving averages was used to determine long term trends on National Forest lands. Data on the number of fires and acres burned on National Forests were compiled from annual National Forest Fire Reports (U.S.D.A. Forest Service 1946-1973 b). The total number of fires on National Forests have been increasing since 1946 (Figure 4) but at a much slower rate than for the State as a whole.

Analysis of five year moving averages on east and west slope National Forests revealed some variation between the two slopes. Both lightning and man caused fires have been increasing at a nearly equal pace on the Front Range forests (Figure 5). This may indicate that not only is man caused risk increasing but that we are more efficient in detecting lightning caused fires. On the western slope forests, lightning fires have been increasing while man caused fires have been more stable and show a slight decreasing trend (Figure 6). Since the late 1950's there has been considerably more acres burned on the eastern slope forests as compared to the western slope forests (Figure 7).

The Fire Season

Hazard and risk show seasonal variation. Due to increased winter recreation, man caused risk is present all year. Hazard is low during winter months. Usually fires are infrequent and of little consequence during the six

NATIONAL FOREST FIRES
TOTAL
LIGHTNING
MAN CAUSED
NUMBER OF FIRES
0
100
200
300
400
FIVE YEAR MOVING AVERAGE

Figure 4

Five Year Moving Average Number of Lightning, Man Caused, and Total Fires on Colorado National Forests 1946-1973

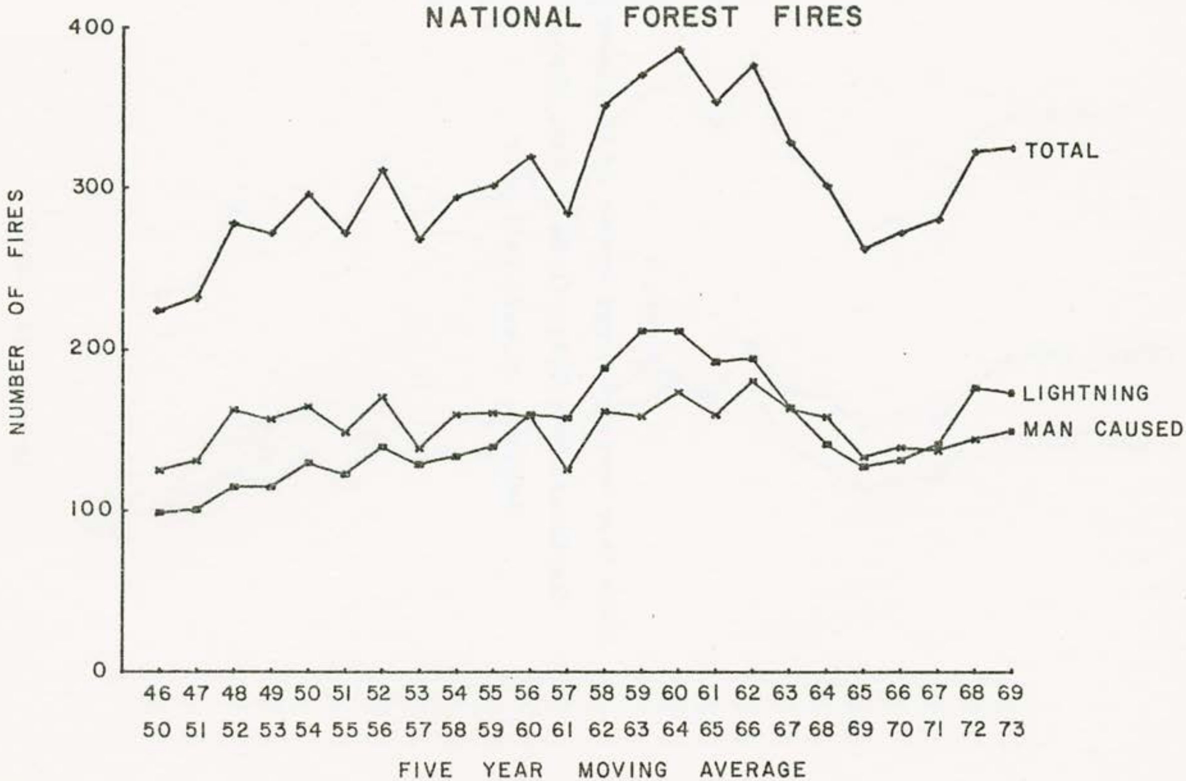

NATIONAL FOREST FIRES
400
300
200
100
0
NUMBER OF FIRES
TOTAL
LIGHTNING
MAN CAUSED
46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73
FIVE YEAR MOVING AVERAGE

Figure 5

Five Year Moving Average Number of Lightning, Man Caused, and Total Fires on East Slope National Forests 1946-1973

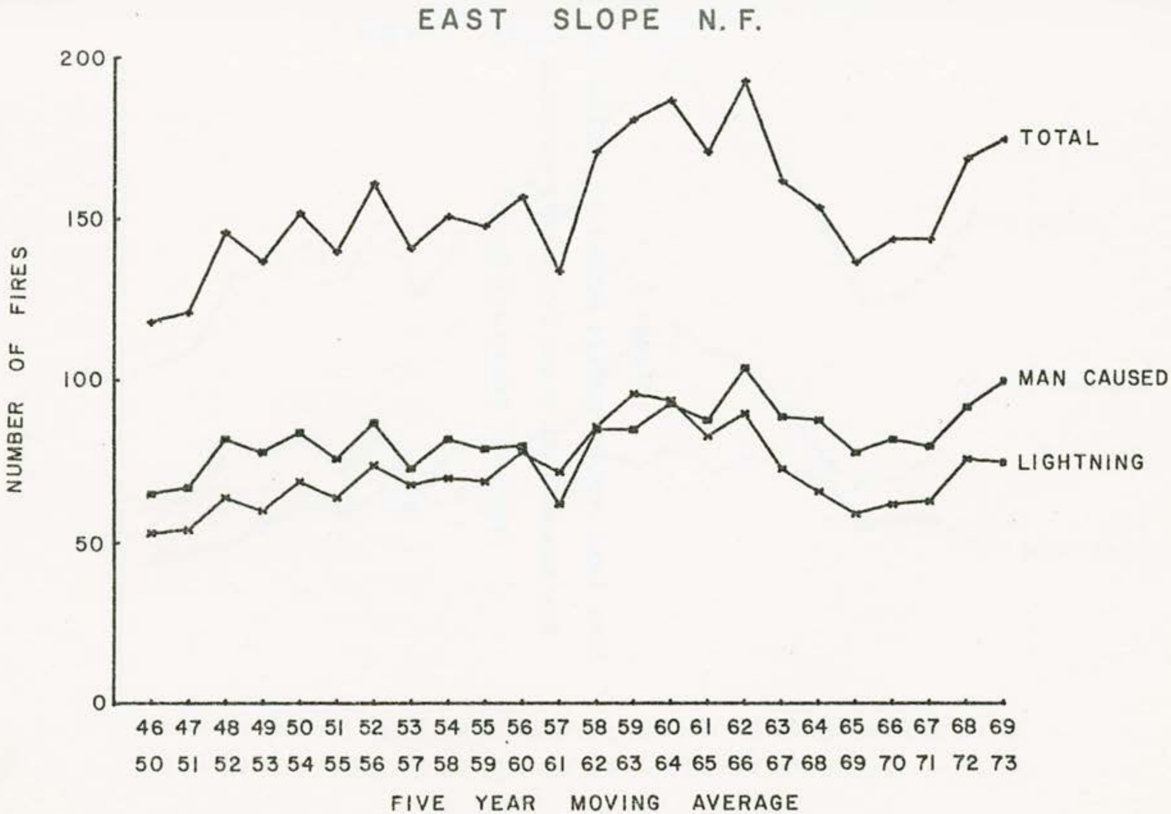

EAST SLOPE N. F.
200
150
100
50
0
NUMBER OF FIRES
TOTAL
MAN CAUSED
LIGHTNING
46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73
FIVE YEAR MOVING AVERAGE

Figure 6

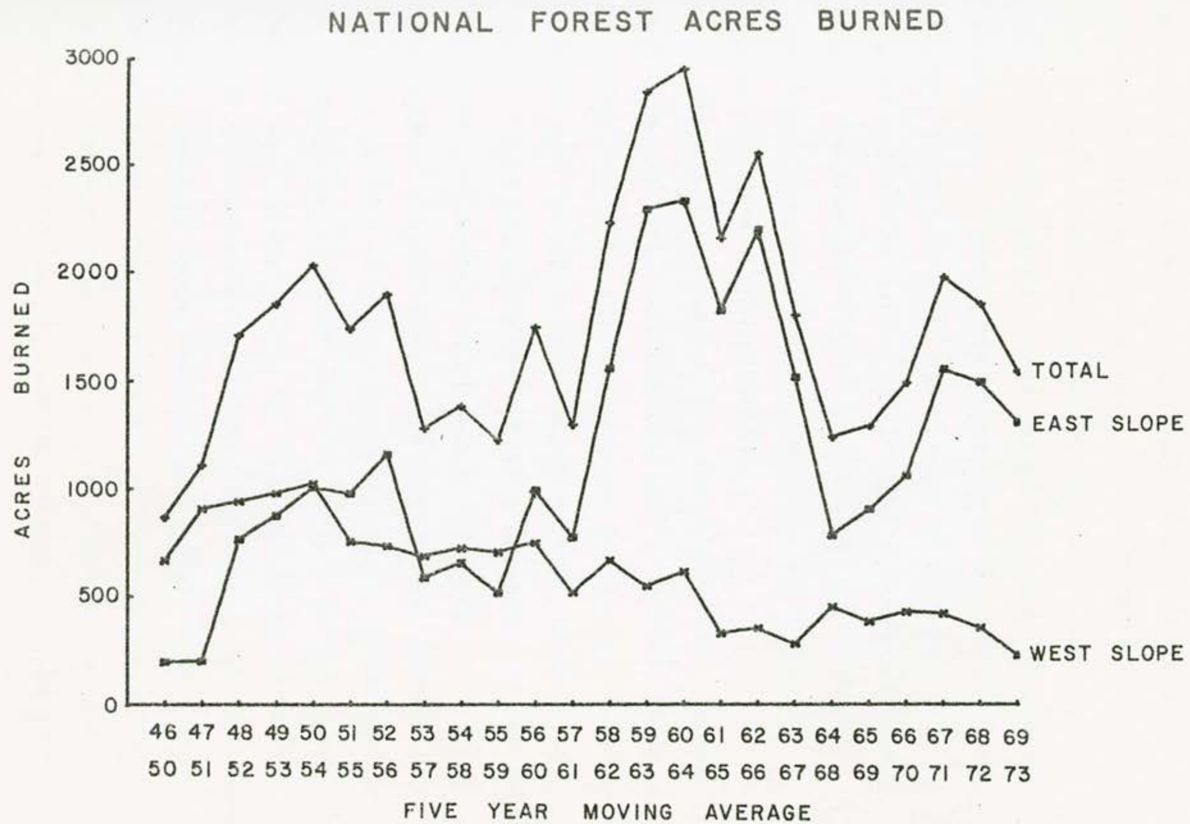
Five Year Moving Average Number of Lightning,

Man Caused, and Total Fires on West Slope

National Forests 1946-1973

Figure 7

Five Year Moving Average Number of Lightning, Man Caused, and Total Acres Burned on East and West Slope National Forests 1946-1973



NATIONAL FOREST ACRES BURNED
3000
2500
2000
1500
1000
500
0
ACRES BURNED
TOTAL
EAST SLOPE
WEST SLOPE
46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73
FIVE YEAR MOVING AVERAGE

month period of November through April. This period accounted for only 5.8 percent of the total fires and 7.8 percent of the acres burned (Table 4). During occasional dry periods, fuels become hazardous enough to support rapid initial spread during these months. As a result, 18.2 percent of the class C and larger fires burned during the generally low hazard months of March, April, and December (Table 5). The number of class C and larger fires is high in comparison to the total number of fires in these months.

The six month period, May through October, generally makes up the fire season in Colorado's National Forests. Over 94 percent of the fires and 92 percent of the acres burned were during this six month period. In May, the number of ignitions increased 242.1 percent over the month of April, reflecting increasing hazard and risk. By May, portions of all National Forests experience weather conditions suitable for ignition and spread. Although only 7.1 percent of the fires and 4.7 percent of the acres burned were in May (Table 4), 5.2 percent of the fires spread to 10 acres or more (Table 5). This is 1.8 percent higher than the annual average percent of class C and larger fires. The high percent of class C and larger fires indicates that fuels are periodically hazardous enough early in the fire season to support rapid initial spread.

Table 4
Fire Occurrence, Acres Burned and Average
Size per Fire by Month 1960-1973

Month	#	%	# of Acres	% of Total	Acres/ Fire
			East Slope National Forests		
January	7	.3	5	.0	.7
February	10	.4	21	.2	2.1
March	42	1.8	487	3.6	11.6
April	74	3.2	506	3.8	6.8
May	197	8.4	525	3.9	2.7
June	479	20.5	4,395	32.9	9.2
July	665	28.5	3,941	29.5	5.9
August	390	16.7	837	6.3	2.1
September	212	9.1	1,241	9.3	5.9
October	197	8.4	1,237	9.2	6.3
November	19	.8	7	.1	.4
December	44	1.9	172	1.3	3.9
Total	2,336		13,374		5.7
			West Slope National Forests		
January	...	...	...	...	...
February	2	.1	0	.0	.0
March	4	.2	4	.1	1.0
April	21	.9	178	2.9	8.5
May	128	5.7	395	6.5	3.1
June	382	16.9	1,103	18.1	2.9
July	603	26.7	517	8.5	.9
August	527	23.3	2,145	35.1	4.1
September	234	10.4	291	4.8	1.2
October	320	14.2	1,318	21.6	4.1
November	15	.7	19	.3	1.3
December	24	1.1	140	2.3	5.8
Total	2,260		6,110		2.[illegible]
			Total All National Forests		
January	7	.2	5	.0	.7
February	12	.3	21	.1	1.8
March	46	1.0	491	2.5	10.7
April	95	2.1	684	3.5	7.2
May	325	7.1	920	4.7	2.8
June	861	18.7	5,498	28.2	6.4
July	1,268	27.6	4,458	22.9	3.5
August	917	20.0	2,982	15.3	3.3
September	446	9.7	1,532	7.9	3.4
October	517	11.2	2,555	13.1	4.9
November	34	.7	26	.1	.8
December	68	1.5	312	1.6	4.6
Total	4,596		19,484		4.2

Table 5

Monthly Fire Occurrence by Size Class for All Colorado National Forests 1960-1973

Month	No. & %	Size Class[a]						Total	% of All Fires
		A	B	C	D	E	F		
Jan.	#	4	3	...	...	...	...	7	.2
	%	57.1	42.9	...	...	...	...		
Feb.	#	6	6	...	...	...	...	12	.3
	%	50.0	50.0	...	...	...	...		
March	#	21	17	6	2	...	...	46	1.0
	%	45.7	37.0	13.0	4.3	...	...		
April	#	40	40	15	...	...	...	95	2.1
	%	42.1	42.1	15.8	...	...	...		
May	#	206	102	15	2	...	...	325	7.1
	%	63.4	31.4	4.6	.6	...	...		
June	#	630	203	18	7	2	1	861	18.7
	%	73.2	23.6	2.1	.8	.2	.1		
July	#	1,079	176	8	2	2	1	1,268	27.6
	%	85.1	13.9	.6	.2	.2	.1		
Aug.	#	767	128	15	3	4	...	917	20.0
	%	83.6	14.0	1.6	.3	.4	...		
Sept.	#	368	67	9	1	...	1	446	9.7
	%	82.5	15.0	2.0	.2	...	.2		
Oct.	#	389	97	25	5	1	...	517	11.2
	%	75.2	18.8	4.8	1.6	.2	...		
Nov.	#	21	13	...	...	...	...	34	.7
	%	61.8	38.2	...	...	...	...		
Dec.	#	49	12	7	...	...	...	68	1.5
	%	72.1	17.6	10.3	...	...	...		
Total	#	3,580	864	118	22	9	3	4,596	
	%	77.9	18.8	2.6	.5	.2	.1		

[a]Size classes are coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

In June, the number of fires continues to increase. There were 164.9 percent more fires in June than in May. June accounted for 18.7 percent of all fires and 28.2 percent of the acres burned (Table 4). The 5,498 acres burned in June were more than burned in any other month (Table 4) and the 28 class C and larger fires were the second greatest number of large fires (Table 5). The average size per fire in June was 6.4 acres. This was higher than in any other fire season month (Table 4).

Colorado generally experiences a split fire season. The high hazard in June gives way to summer rains in July and August. As a result, hazard is reduced during the highest risk months. Both eastern and western slope forests have the greatest number of fires in July but they differ markedly in acres burned. East slope forests had 665 fires and 3,941 acres burned (Table 4). Sixty-seven percent of the acres burned resulted from one fire in early July. West slope forests had 603 fires and 517 acres burned (Table 4). The general lowering of flammability in July is reflected by the reduction of class C and larger fires. Only 1.1 percent of July's fires reached 10 acres or more (Table 5). September was the only fire season month which had fewer class C and larger fires than July.

On the western slope forests, the number of fires continued to be high in August but showed a marked reduction on the eastern slope forests. There was a 12.6 percent reduction in west slope fires and a 41.4 percent reduction in east slope fires (Table 4). West slope forests also burned 2.6 times more acreage than did east slope forests.

From August to September, there was a 51.4 percent reduction in fires and a 48.6 percent reduction in acres burned. The greatest decrease was on the western slope forests where there was a 55.6 percent decrease in fires and an 86.4 percent reduction in acres burned. On the east slope forests, there was a 45.6 percent reduction in fires but a 48.3 percent increase in acreage burned (Table 4). The percent of fires reaching 10 acres or more increases from August to September reflecting a slight increase in potential spread (Table 5).

In October, herbaceous fuels are fully cured and very susceptible to drying weather. Under these conditions fuels are very ignitable and fire often spreads. From September to October, there was a 15.9 percent increase in the number of fires and a 66.8 percent increase in the acres burned (Table 4). The high flammability of wildland fuels is reflected in the number of class C and larger fires. The 31 class C and larger fires which occurred in October were more than in any other month (Table 5). The 6.6 percent of class C and larger fires is almost twice the yearly average of large fires. Fires increased in October on the Gunnison, Rio Grande, Routt, San Isabel, San Juan and White River National Forests. Historically, October has been the highest fire occurrence month on the White River National Forest. The increase in the number of fires reflects the long term drying of heavy fuels, cured vegetation, and higher risk. Although an analysis of the specific types of man caused fires was not performed, hunters have been found to be the major source of forest fires during hunting seasons in Colorado (Hill and Boeker 1955).

Snows in the latter part of October generally mark the end of the fire season. The number of fires and acres burned drops to very low levels in November indicating hazard and risk are both low.

Analysis of Hazards

Introduction

Forest fire hazard refers to the fuel complex in which fires burn. To better understand forest fire hazard, it is helpful to describe the relative hazard potentials in different environments. Forest fire hazard varies by time and place. Daily and seasonal changes in fire weather have a profound effect on hazard. Long term effects of weather interacting with topography create a variety of fuel complexes with a wide range in potential hazard. Vegetative cover types and fuel types are integrators of these environmental factors. As integrators they provide valuable descriptors of the fuel complexes in which fires burn.

Elevation is probably the most important factor in determining vegetation, although aspect and slope may be locally important. Elevations on Colorado's National Forests range from near 5,000 feet to over 14,000 feet. Precipitation in the mountains ranges from near 10 inches at some lower elevations to over 50 inches at some higher elevations. There are five broad vegetation zones related to elevation. These zones and their approximate elevations are: the plains zone (below 6,000 feet), the foothills zone (6,000 to 8,000 feet), the montane zone (8,000 to 10,000 feet), the subalpine zone (10,000 to 11,500 feet feet), and the alpine zone (above 11,500 feet) (Kelly 1970). These zones are not always continuous nor are they always present (Oosting 1956). In the northern portion of the State, the foothills zone becomes indistinct and the remaining vegetation zones are found at relatively lower elevations. Southward all vegetation zones are found at somewhat higher elevations and the lower vegetation zones become broader (Oosting 1956). The effect of aspect is also visable on the vegetative landscape. On north facing slopes the dominants of one vegetation zone extend downward into lower elevations. On south facing slopes and dry ridgetops the dominants of one vegetative zone extend upward into higher elevations (Daubenmire 1943).

Cover Types

Ponderosa Pine

In Colorado, ponderosa pine (Pinus ponderosa Laws.) is prominent throughout the upper foothills and lower montane zones. At its lower elevational range of 5,000 feet it is found almost exclusively on north facing slopes. At its upper limit near 9,000 feet it is mainly restricted to south facing slopes and dry ridgetops (Oosting 1956). Between the two extremes there is a broad range of stand conditions.

The ponderosa pine type is generally considered to grow in a cool subhumid climate (Schubert 1974). The environment in Colorado is seldom optimum for ponderosa pine growth. Temperatures are most favorable at the lower elevations while moisture is most favorable at the higher elevations (Schubert 1974). Temperature is a limiting growth factor at the higher elevations (Pearson 1950). Annual precipitation extremes range from 11 inches at the lower fringe to as much as 22 inches at the higher elevations (Hull and Johnson 1955). On the east slope precipitation averages from 12 to 20 inches with two-thirds of the annual moisture being distributed from April through September (Currie 1975; Smith 1967). Historically, July and August have been the wettest months (Currie 1975). On the western slope, precipitation in the ponderosa pine averages 14-18 inches with approximately half occurring as rain from April through September (Currie 1975). June is the dryest month and July and August are generally the wettest (Currie 1975; Schubert 1974). Precipitation as high as 22 inches a year occurs in the ponderosa pine type in the San Juan Mountains (Schubert 1974).

Wildfire potential in the ponderosa pine type is dependent upon stand age, density, and the understory vegetation. On dryer sites ponderosa pine often grows in open stands with a rich understory of grasses, forbs, and shrubs. Depending on the condition of the understory vegetation, slope, and wind, fires in these stands may exhibit very high rates of spread (Barrows 1951 b). These fires are usually of low intensity, seldom causing mortality to mature trees (Doubenmire 1943). Because these stands occupy dry sites and are fully exposed to wind and radiation, favorable conditions for fire spread are present much of the year (Lynch 1974). Depending upon the prominance of ponderosa pine in the fuel complex these types of stands are best characterized by NFDR fuel model A of C (Deeming et al. 1972).

On north facing slopes and at higher elevations, stands are usually much denser. The understory is protected from intense solar insolation and drying. As a result, fires in these denser stands usually exhibit lower rates of spread than seen in the more open stands. However, fires in these stands are much more intense. Crown fire potential is higher due to the increased intensity and vertical fuel development. Under these stand conditions NFDR fuel model E is a more appropriate classification (Deeming et al. 1972).

During the fourteen year period 1960-1973, ponderosa pine has had the greatest number of ignitions. Fires in the ponderosa pine type have accounted for 41.8 percent of all fires on Colorado's National Forests (Table 6). Although the 4,966 acres burned were more than in any other type, they only accounted for 25.5 percent of the total acreage burned. The ponderosa pine type had the third lowest average size per fire (Table 6). However, the large acreage burned and the numerous class C and larger fires indicate that a major portion of the fire suppression problem is in the ponderosa pine type. There were 31 class C and larger fires in ponderosa pine (Table 7). This is second only to the frequency of large fires in the grass and sagebrush type.

Over 76 percent of ponderosa pine fires were controlled at less than .25 acres. This is slightly below the average percent of class A fires for all cover types. Ponderosa pine is also below average in the percent of class C and larger fires, but is above average in the

Table 6

Fire Occurrence, Acres Burned and Average Size per Fire by Forest Cover Type 1960-1973

Forest Cover[a] Type	#	%	# of Acres	% of Total	Acres/ Fire
		East Slope National Forests			
PP	1,026	43.9	4,226	31.6	4.1
LP	321	13.7	4,318	32.3	13.5
SF	239	10.2	2,519	18.8	10.5
DF	280	12.0	172	1.3	.6
AW	95	4.1	133	1.0	1.4
PJ	27	1.2	180	1.3	6.7
DEC	76	3.3	291	2.2	3.8
HB	27	1.2	159	1.2	5.9
GS	243	10.4	1,376	10.3	5.7
Total	2,334		13,374		
		West Slope National Forests			
PP	892	39.5	740	12.1	.8
LP	164	7.3	495	8.1	3.0
SF	356	15.8	1,086	17.8	3.1
DF	117	5.2	353	5.8	3.0
AW	187	8.3	180	2.9	1.0
PJ	133	5.9	1,426	23.3	10.7
DEC	139	6.2	475	7.8	3.4
HB	57	2.5	206	3.4	3.6
GS	211	9.3	1,149	18.8	5.4
Total	2,256		6,110		
		Total All National Forests			
PP	1,918	41.8	4,966	25.5	2.6
LP	485	10.6	4,813	24.7	9.9
SF	595	13.0	3,605	18.5	6.1
DF	397	8.6	525	2.7	1.3
AW	282	6.1	313	1.6	1.1
PJ	160	3.5	1,606	8.2	10.0
DEC	215	4.7	766	3.9	3.6
HB	84	1.8	365	1.9	4.3
GS	454	9.9	2,525	13.0	5.6
Total	4,590		19,484		

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce-fir, (DF) Douglas-fir, (AW) alpine fir-white pine-subalpine type, (PJ) pinjon-juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass-sage brush.

Table 7

Fire Occurrence by Forest Cover Type and Size Class for All Colorado National Forests

1960-1973

Forest Cover Type[a]	No. & %	Size Class[b] A	B	C	D	E	F	Total	%
PP	#	1,462	425	27	1	2	1	1,918	41.7
	%	76.2	22.2	1.4	.1	.1	.1		
LP	#	391	80	7	4	2	1	485	10.6
	%	80.6	16.5	1.4	.8	.4	.2		
SF	#	511	63	13	4	3	1	595	12.9
	%	85.8	10.6	2.2	.7	.5	.2		
DF	#	341	50	5	1	...	...	397	8.6
	%	85.9	12.6	1.3	.3	...	...		
AW	#	252	26	3	1	...	...	282	6.1
	%	89.4	9.2	1.1	.4	...	...		
PJ	#	130	19	7	2	2	...	160	3.5
	%	81.3	11.9	4.4	1.3	1.3	...		
DEC	#	161	40	12	2	...	...	215	4.7
	%	74.9	18.6	5.6	.9	...	...		
HB	#	46	30	7	1	...	...	84	1.8
	%	54.8	35.7	8.3	1.2	...	...		
GS	#	280	131	37	6	...	...	454	9.9
	%	61.7	28.9	8.1	1.3	...	...		
Total	#	3,574	864	118	22	9	3	4,590	
	%	77.9	18.8	2.6	.5	.2	.1		

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce-fir, (DF) Douglas-fir, (AW) alpine fir-white pine-subalpine type, (PJ) pinyon-juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass-sage brush.

[b]Size classes are coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

percent of class B fires (Table 7). The high proportion of class B fires indicates that the ponderosa pine fires are frequently fast spreading but generally containable at small acreage. In the case of ponderosa pine, actual containment may be more dependent upon early detection, reduced attack time, and accessibility rather than actual fire behavior.

The ponderosa pine type is fairly evenly distributed between east and west slope forests (Table 2). Ponderosa pine fires occurred in nearly equal numbers on both east and west slope National Forests, but they burned 5.7 times as many acres on the east slope National Forests. Over 85 percent of the acreage burned was on the east slope forests. Ponderosa pine fires accounted for 43.9 percent of the east slope fires and 31.6 percent of the acres burned. In west slope forests ponderosa pine accounted for 39.5 percent of all fires, but only 12.1 percent of the acreage burned (Table 6).

The San Juan and Pike National Forests are the two highest fire occurrence forests in Colorado. Data on fire occurrence in the ten National Forests are in Appendicies A through J. In both forests ponderosa pine fires accounted for over 60 percent of the fires. There appears to be a relationship between the high number of fires in these forests and the ignitability of ponderosa pine fuels. The two forests combined accounted for 71.8

percent of all ponderosa pine fires and 48.9 percent of all fires. However, the Pike National Forest appears to have a unique situation in that approximately 55 percent of all class C and larger ponderosa pine fires and 75 percent of all ponderosa pine acres burned were in this one forest. Fire weather and risk may be related to the large ponderosa pine fires in the Pike National Forest. The Forest frequently experiences periods of severe fire weather early in the fire season. Also the ponderosa pine zone on the Pike National Forest is the area of highest lightning and man caused ignitions in the Colorado National Forests. Thus ignition sources are prevalent during periods of high fuel hazard.

With the exception of the Pike National Forest, there does not appear to be any significant difference in the fire potential of ponderosa pine. In the other National Forests ponderosa pine fires are generally small, averaging only .5 acres per fire.

Historically, the peak fire occurrence in the ponderosa pine type has been in July. However, large fires have burned most frequently in June (Table 8). There have been fires during every month of the year with class C fires occurring as early as March and as late as October. Of the class C and larger fires, 71.0 percent have occurred prior to the peak fire month of July. The frequency of large fires early in the year is probably due to the

Table 8

Monthly Fire Occurrence by Forest Cover Type and Size for All Colorado National Forests 1960-1973

Month	Size[a]	Forest Cover Type[b]									Monthly Total
		PP	LP	SF	DF	AW	PJ	DEC	HB	GS	
January	A	2	...	...	1	...	...	1	...	...	4
	B	1	...	...	1	...	...	...	...	1	3
	Total	3	...	...	2	...	...	1	...	1	7
February	A	5	...	...	...	...	...	...	...	1	6
	B	4	...	...	...	...	...	...	...	2	6
	Total	9	...	...	...	...	...	...	...	3	12
March	A	13	...	1	2	...	2	1	2	...	21
	B	7	...	...	1	...	1	...	2	6	17
	C	2	...	...	...	...	1	...	...	3	6
	D	...	...	...	...	...	1	...	...	1	2
	Total	22	...	1	3	...	5	1	4	10	46
April	A	19	...	3	4	...	...	2	1	11	40
	B	17	...	1	1	...	...	4	2	15	40
	C	6	...	...	1	...	1	2	1	4	15
	Total	42	...	4	6	...	1	8	4	30	95
May	A	96	19	3	31	11	15	9	5	17	206
	B	51	3	4	10	3	2	9	2	18	102
	C	3	...	2	2	...	...	...	...	8	15
	D	...	...	...	...	...	...	1	1	...	2
	Total	150	22	9	43	14	17	19	8	43	325
June	A	290	52	54	78	49	29	18	11	49	630
	B	114	13	11	19	5	6	6	3	26	203
	C	9	2	1	...	1	1	...	...	4	18
	D	1	3	1	1	1	...	...	...	...	7
	E	...	...	1	...	...	1	...	...	...	2
	F	1	...	...	...	...	...	...	...	...	1
	Total	415	70	68	98	56	37	24	14	79	861
July	A	459	117	160	97	94	32	41	7	71	1,078
	B	103	25	10	8	5	2	2	9	12	176
	C	4	1	1	...	...	1	...	1	...	8
	D	...	...	1	...	...	1	...	...	...	2
	E	1	...	1	...	...	...	...	...	...	2
	F	...	1	...	...	...	...	...	...	...	1
	Total	567	144	173	105	99	36	43	17	83	1,267

Table 8-Continued

Month	Size[a]	Forest Cover Type[b]									Monthly Total
		PP	LP	SF	DF	AW	PJ	DEC	HB	GS	
August	A	287	97	138	67	50	31	41	11	42	764
	B	58	22	14	8	6	6	1	2	11	128
	C	...	2	2	1	1	3	2	1	3	15
	D	...	...	1	...	...	...	1	...	1	3
	E	1	1	1	...	...	1	...	...	...	4
	Total	346	122	156	76	57	41	45	14	57	914
September	A	160	46	54	25	23	10	13	3	32	366
	B	35	6	11	1	2	1	3	2	6	67
	C	2	...	1	...	...	...	2	2	2	9
	D	...	...	...	...	...	...	...	...	1	1
	E	...	...	...	...	...	...	...	...	...	...
	F	...	...	1	...	...	...	...	...	...	1
	Total	197	52	67	26	25	11	18	7	41	444
October	A	103	55	80	30	24	9	31	5	52	389
	B	32	9	9	...	3	1	13	5	25	97
	C	1	1	6	1	1	...	4	...	11	25
	D	...	1	1	...	...	...	...	...	3	5
	E	...	1	...	...	...	...	...	...	...	1
	Total	136	67	96	31	28	10	48	10	91	517
November	A	9	2	4	2	1	1	...	1	1	21
	B	3	1	1	...	2	...	1	2	3	13
	Total	12	3	5	2	3	1	1	3	4	34
December	A	19	3	14	4	...	1	4	...	4	49
	B	...	1	2	1	...	...	1	1	6	12
	C	...	1	...	...	...	...	2	2	2	7
	Total	19	5	16	5	...	1	7	3	12	68
Total	A	1,462	391	511	341	252	130	161	46	280	3,574
	B	425	80	63	50	26	19	40	30	131	864
	C	27	7	13	5	3	7	12	7	37	118
	D	1	4	4	1	1	2	2	1	6	22
	E	2	2	3	...	...	2	...	...	...	9
	F	1	1	1	...	...	...	...	...	...	3
	Total	1,918	485	595	397	282	160	215	84	454	4,590

[a]Size classes are coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

[b]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce/fir, (DF) Douglas-fir, (AW) alpine fir/white pine/subalpine type, (PJ) pinyon/juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass/sage brush.

cured condition of understory vegetation and the sensitivity of these fuels to short drying periods. Although class C and larger fires were infrequent in the later months, class E fires have burned in July and August (Table 8).

Lodgepole pine

Lodgepole pine (*Pinus contorta* Dougl.) communities are widespread in the northern two-thirds of the State (Costello 1964), mainly in the upper montane and the lower subalpine zones (Oosting 1956). Lodgepole pine is an intolerant tree requiring high sunlight and bare soil to regenerate (Smith 1962). This coupled with serotinous cones, makes lodgepole pine ideally suited to burned areas. Like aspen, it is a common pioneer following fire. Lodgepole pine is favored over aspen on dry sites and following intense burns (Daubenmire 1943). Fire has been recognized as the dominant force in the establishment of lodgepole pine forests in Colorado (Clements 1910; Stahelin 1943). As a result of the past occurrence of large fires, lodgepole pine generally grows in extensive even-aged or nearly even-aged stands. Stands are often so dense that the forest floor is covered completely with litter (Moir 1969). In more open stands the understory, although dense, is usually of limited diversity.

Lodgepole pine grows in a cool humid climatic zone. Annual precipitation in the lodgepole pine zone is variable, approximately 28 inches, with the majority coming during the winter months (Leaf 1975 b). Best development occurs where annual precipitation exceeds 21 inches (Alexander 1974). Summer is the dryest season and moisture is often deficient (Alexander 1974), but summer showers are frequent (Leaf 1975 b).

Due to short summers with frequent rain showers, fires in the lodgepole pine type are not as common as would be expected in such a dense, continuous fuel complex, but the type can become extremely hazardous during short periods of dry weather. Rates of spread vary depending upon stand conditions. In more open stands, fires generally spread in surface fuels. In dense "dog-hair" stands high intensity crown fires often develop (Lynch 1974). In Colorado the lodgepole pine fuel complex is generally classified as NFDR fuel model G which has the third highest energy release component in the system (Deeming et al. 1972).

In the National Forests of Colorado, lodgepole pine fires accounted for 10.6 percent of all fires and 24.7 percent of the total acres burned. Because of the relatively few fires and the large number of acres burned, lodgepole pine had the second largest average size per fire (Table 6). Over 80 percent of all lodgepole pine fires were under .25 acres (Table 7). The large average size per fire in the type is the result of two class E fires and one class F fire which burned on the Roosevelt National Forest. Almost 84 percent of the acres burned in lodgepole pine resulted from these three fires. Elsewhere, lodgepole pine fires have usually been contained at a relatively small size. The large acreage burned on the Roosevelt National Forest is due to the coincidental occurrence of man caused ignitions during high fire danger periods rather than being due to inherent differences in the lodgepole fuel complex.

During the fourteen year period covered by this data, over 66 percent of the lodgepole pine fires and almost 90 percent of the acres burned in lodgepole pine were on east slope forests (Table 6). The average size per lodgepole pine fire was 13.5 acres on the east slope forests compared to 3.0 acres on the west slope forests. This difference can be attributed entirely to the 3,853 acres burned in the three aforementioned fires on the Roosevelt National Forest. If these three fires are excluded from the data the average size per fire would be reduced to 1.5 acres on east slope forests.

Lodgepole pine fires have occurred from May through December (Table 8). July and August were the highest fire occurrence months. More class C and larger fires burned in June but large fires were almost as common in July, August, and October.

Spruce-fir

The subalpine zone is often referred to as the spruce-fir zone because of the predominance of Engelmann spruce (Picea engelmanii Perry) and subalpine fir (Abies lasiocarpa (Hook.) Nutt.). The spruce-fir extend from 8,500 feet to timberline, which ranges from 11,500 feet in northern Colorado to 12,000 feet in southern Colorado (Costello 1964). Near timberline and on dry rocky ridges, subalpine fir drops out of the association and Engelmann spruce forms a Krummholz forest of distorted dwarf trees (Daubenmire 1943).

Spruce-fir forests grow in a cold, humid climatic zone where average annual precipitation usually exceeds 25 inches and there is only moderate or no seasonal dif-ficiency (Alexander 1958). Annual precipitation generally ranges from 25 to 35 inches (Alexander 1958) but may be as great as 65 inches (Leaf 1975 a). Summer is the dryest season west of the Continental Divide and north of the San Juan Mountains (Alexander 1958). On the eastern slope and in the San Juan Mountains late summer precipitation measured at four subalpine stations ranged from 10 to nearly 22 inches (Leaf 1975 a).

Spruce-fir communities are usually stable due to exclusive reproduction and the relative absence of major disturbances such as fire, insect damage, and wind throw. The relative absence of major disturbance is indicated by the abundance of over mature timber in the spruce-fir (Miller and Choate 1964). In Colorado it is estimated that over two-thirds of the approximately 3.5 million acres of spruce-fir are over mature.

Fires in the spruce-fir seem to have been conflagrations at intervals of centuries (Jones 1974). Melting snows and frequent summer rains reduce the chances of forest fires (Marr 1961). However, the large volume of dead woody material and the highly developed vertical continuity of fuels, usually present in these communities create extremely hazardous conditions during periods of high fire danger.

Depending upon the fuel complex present, spruce-fir stands can be represented by either of two NFDR fuel models (Deeming et al. 1972). Most stands are over mature and are best classified as fuel model G. Immature and mature stands with lesser accumulations of downed woody material may better fit into fuel model H, as will many dry site stands. Rates of spread can vary from low to

Rates of spread can vary from low to high in spruce-fir communities depending on fuel continuity, slope, wind, and fuel moisture (Barrows 1951 a). The usually moist conditions and deep duff increase the liklihood of hold-over fires. When conditions are dryer, high intensity fires can develop causing crowning and spotting (Barrows 1951 a).

During the fourteen year period 1960-1973, there were almost 600 fires in the spruce-fir type in the ten National Forests in Colorado. These fires consumed over 3,600 acres of forested watershed resulting in an average size of 6.1 acres per fire (Table 6). Although the type has the second highest fire occurrence and the third largest number of acres burned, the number of fires and acres burned are small relative to the total acreage of spruce-fir type. The absolute frequency of large fires is high in the spruce-fir type. More class D and larger fires have occurred in the spruce-fir type than in any other type (Table 7). The frequent occurrence of large fires in the type may be due as much to inaccessibility, increased detection time, and resistance to control, as it is to initial fire behavior. Regardless of the reason for the large fires, the potential for devastating fires must be recognized.

Although spruce-fir fires have been more frequent on the western slope forests, they have burned fewer acres. On western slope forests, 356 spruce-fir fires burned 1,086 acres resulting in an average size of 3.1 acres per fire. There were 117 fewer spruce-fir fires on the east slope forests but they burned 1,433 more acres resulting in an average size of 10.5 acres per fire (Table 6). On the east slope forests, 40 percent of the spruce-fir acres burned resulted from one class F fire on the Arapaho National Forest. If this one fire were excluded from the data, the average size per fire on the eastern slope would still be two times higher than on the western slope. This difference appears to be due to greater man caused risk which results in more fires occurring under dryer conditions.

As would be expected, at the higher elevations where spruce-fir grows, the fire season is shorter than it is in the lower elevation forests. Forest fires in the spruce-fir type are uncommon prior to June and after October, leaving only five months which are of concern to the fire manager. Fires in the spruce-fir type have been most frequent in July, August, and October (Table 8). The lower number of fires in June is due to low hazard, whereas the lower number in September appears more likely the result of lower risk. The increase in fire occurrence from September to October indicates both an increase in hazard and risk. The presence of hunters combined with seasonally dry weather and fully cured vegetation create favorable conditions for ignition and spread. Although the three class E and F spruce-fir fires occurred prior to October, there were more class C and D fires in October than in any other month (Table 6).

Douglas-fir

Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) is scattered throughout Colorado from the upper foothills zone to the lower subalpine zone. Douglas-fir usually grows on moister sites than does ponderosa pine, but moisture is still likely to be deficient during part of the year. The elevational range of Douglas-fir is from 7,000 feet to 11,000 feet. It is generally limited to north facing slopes at its lower fringe in the foothills zone and to south facing slopes and dry ridgetops at its upper altitudinal limit in the subalpine zone. Between these two elevational extremes is a broad transition zone where ponderosa pine and Douglas-fir share dominance (Oosting 1956). In general, ponderosa pine is the climax species below 7,000 feet and Douglas-fir is climax above 8,000 feet (Oosting 1956). Because of its wide elevational range, Douglas-fir may be found in association with most of the conifer species of Colorado. It reaches its best development in the montane zone between 8,000 feet and 10,000 feet, especially in the southern part of the State (Miller and Choate 1964).

Douglas-fir often grows in such dense stands that herbaceous vegetation is negligible (Oosting 1956). Large amounts of fine fuels and advanced reproduction are usually present which results in horizontally and vertically continuous fuel bed. Because ground fuels are shaded, rates of spread are usually moderate (Barrows 1951 a). However, vertical development of this fuel complex creates a high crown fire potential during periods of high fire danger. The Douglas-fir fuel complex is best represented by NFDR fuel Model H (Deeming et al. 1972). This fuel model has the lowest maximum rate of spread of any fuel model.

During the period 1960-1973, nearly 400 Douglas-fir fires occurred in the ten National Forests in Colorado. These fires burned 525 acres for an average size of 1.3 acres per fire (Table 6). There were six class C and larger fires with the largest fire being class D (Table 7). Almost 86 percent of all Douglas-fir fires were controlled at less than .25 acres (Table 7). The relative infrequency of class C and larger fires indicates that fires in the type are rarely fast spreading.

Although the east slope forests had over twice as many Douglas-fir fires as the west slope forests, they burned half as many acres (Table 6). The larger acreage burned on the western slope forests is the result of one 280 acre fire on the White River National Forest. Over 53 percent of the Douglas-fir acres burned in Colorado resulted from this one fire. If this fire were deleted from the data there would be no difference in the average size per fire between the east and west slope. The average size per fire would then be .6 acres.

Historically, there have been Douglas-fir fires during every month except February but they are infrequent prior to May and after October. Although July is the highest fire occurrence month, the hazard appears to be quite low. This is evidenced by the lack of any fires larger than class B (Table 8). Like ponderosa pine most of the class C and larger fires burned prior to July, indicating that hazard is somewhat higher early in the fire season. There was also a slight increase in fire activity from September to October. This is probably due to an increase in hazard resulting from curing vegetation, long term drying, and an increase in risk associated with the hunting season.

Fir-Subalpine-White Pine Group

This is not a recognized cover type in Colorado, rather it is a composit of three cover types. Because fires were infrequent in these types, they were combined to reduce the number of computations. The fir classification includes pure stands of subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.), corkbark fir (*Abies lasiocarpa* var. *arizonica* (Merriam) Lemm.), and white fir (*Abies concolor* (Gord. and Glend.) Lindl.). The subalpine type refers to bogs, willow bottoms, and other areas in the subalpine zone which are not included in other cover types. The white pine group refers to limber pine (*Pinus flexilis* James) and bristlecone pine (*Pinus aristata* Engelm.). Since all of these types occur in relatively small isolated areas, fires are infrequent and generally small. Fir and subalpine areas remain wet throughout most of the year and do not usually present much of a fire problem. Limber pine and bristlecone pine are generally restricted to dry ridgetops where fuels are sparse and fires seldom spread.

Although 6.1 percent of the fires in the National Forests were in these three combined types only 1.6 percent of the acres burned were in this group (Table 6). Almost 90 percent of the fires in the group were less than .25 acres and the four class C and larger fires are less than occurred in any other type (Table 8).

Pinyon-Juniper

The pinyon-juniper type consists of pinyon-pine (*Pinus edulis* Engelm.) and juniper (*Juniperus* spp.). The type forms a climax woodland at elevations ranging from 5,500 feet to 7,500 feet in the foothills zone. It is common as far north as Colorado Springs on the eastern slope and at all latitudes on the western slope. East of the divide annual precipitation averages 12 to 18 inches in the pinyon-juniper type with about 75 percent falling from April to September. In western Colorado the pinyon-juniper grows where the annual precipitation averages 12 to 15 inches. About half of the precipitation falls during the growing season. Spring is typically a dry season on the western slope while July and August are wet (Paulsen 1975).

This vegetative type is typified by a forest of widely spaced small trees with limbs extending to the ground. This condition creates an excellent "fuel ladder" (Lynch 1974). The understory vegetation is typically that of the short grass prairie with variable amounts of desert schrubs (Oosting 1956). The condition of the understory vegetation has a most pronounced effect on wildfire potential (Lynch 1974). Savannah like pinyon-juniper stands with a continuous ground cover of cured grasses may exhibit extremely high rates of spread. This type of stand is best represented by NFDR fuel model A (Deeming et al. 1972). Denser stands of pinyon-juniper with less grass cover exhibit lower rates of spread and are more typical of NFDR fuel model C (Deeming et al. 1972). Some local situations may be dense enough to be classified as fuel model B. In many areas heavy grazing has depleted the grass understory. Such stands exhibit very low rates of spread except during severe fire weather.

During the 1960 to 1973 period, 160 pinyon-juniper fires occurred in the National Forests in Colorado. These fires consumed over 1,600 acres, averaging 10 acres per fire (Table 6). The pinyon-juniper type had the largest average size per fire of all cover types. Fourteen fires reached a size greater than 10 acres and two fires were larger than 300 acres (Table 7).

The pinyon-juniper type is more common on the western slope. As a result, 83.1 percent of the fires and 88.8 percent of the acres burned in the type were in western slope forests (Table 6). Most of the approximately 4.7 million acres of the pinyon-juniper type in Colorado lie outside the National Forest. For this reason, the data may not be representative of the type. However, from the data that is available pinyon-juniper appears to be one of the more problematic fuel complexes in the region.

Pinyon-juniper fires have occurred from March through December. Peak fire occurrence was in August but there was little difference in the level of fire activity from June through October. Large fires have burned as early as March and are fairly evenly distributed through August (Table 8). This seems to indicate hazard is relatively uniform throughout much of the fire season.

Deciduous

In the National Forests of Colorado the deciduous cover type consists almost exclusively of aspen (Populus tremuloides Michx.). Aspen stands are common throughout much of the State in areas which have been disturbed by fire, logging, or avalanche (Lynch 1974). Because of its wide elevational range, 6,000 feet to 11,000 feet, it is found in association with most of the conifer species of the State. Like lodgepole pine, aspen is a common pioneer species following fire. Of the two, aspen is generally favored after light burns and on moister sites (Oosting 1956). In the southern and western parts of the State where lodgepole pine is lacking, aspen is the primary pioneer species even on dry sites (Daubenmire 1943). Annual precipitation on aspen forests averages from less than 15 inches to over 45 inches (Jones 1971). There is an estimated 2.8 million acres of commercial aspen timber (Miller and Choate 1964) in addition to the many acres of noncommercial aspen. Aspen is the second most common cover type in Colorado's National Forests. Because of its wide range and variety of sites, there is considerable variability in stand composition and vigor.

The condition of the stand will determine to a large extent its fire potential. Vigorous stands are characterized by rank herbaceous understories of forbs (Costello 1964). Due to luxuriant vegetation, usually moist conditions, and low flammability, wildfire potential is low throughout most of the year (Lynch 1974). Fire spread usually drops drastically when the flame front enters a vigorous aspen stand. Such a stand may even provide an effective barrier against a crown fire. Because of the relatively low fire behavior potential of vigorous aspen stands, it may be possible to use them as fuel breaks (Fechner, Sandburg, and Barrows 1975). This type of stand is best suited to NFDR fuel model H which has the lowest maximum spread rate of any fuel model (Deeming et al. 1972).

Decadent, dry site, and overgrazed aspen stands are generally more open and have understories composed predominantly of grass and brush species (Costello 1964). These stands may exhibit fire behavior characteristics quite different from the denser more vigorous stands. Rates of spread will usually be higher than in the more luxuriant stands. Depending upon the volume of downed logs in the stand, the fire intensity may also be higher.

Because aspen is a deciduous species, its flammability varies with the season of the year. During a short period in the fall when the herbaceous vegetation is cured and snow has not yet compacted the fuel bed, fires can spread rapidly even in vigorous stands. Fire potential may also be high early in the spring prior to greening up of the understory. Dormant aspen stands are best characterized by NFDR fuel model E (Deeming et al. 1972).

During the 1960 to 1973 period, there were 215 fires in the aspen cover type (Table 6). These fires burned 766 acres for an average size of 3.6 acres per fire. The aspen type accounted for 4.7 percent of the total fires and 3.9 percent of the acres burned. The 4.7 percent of fires is low compared to the vast acreages of aspen in the National Forests.

Data show fourteen class C and larger fires burned in the aspen cover type (Table 7). The largest fire was size class D. The majority of the class C and larger fires occurred in August, September, and October (Table 8). Large fires were conspicuously absent in June and July despite the relatively high number of fires in these months. It appears that even though risk may be high in these summer months, fire spread is generally very low. Due to the seasonal change in aspen fire potential, October is the highest fire load month. There were more fires and class C fires in October than in any other month (Table 8).

The aspen type is more common west of the Continental Divide. This is reflected by the greater number of aspen fires and acres burned on western slope forests. Nearly 65 percent of the aspen fires and 62 percent of the acres burned occurred on western slope forests. There is very little difference from east to west in the average size per aspen fire and there does not appear to be any difference in potential fire behavior.

Heavy Brush

Brush communities are common throughout the foothills zone. Major species in the type include Gambel's oak (*Quercus gambellii* Nutt.), mountain mahogany (*Cercocarpus montanus* Raf.), and service-berry (*Amelanchier* spp.). On the eastern slope Gambel's oak and mountain mahogany form a climax shrub community as far north as Denver, Colorado (Daubenmire 1943). Farther north the oak drops out of the association and mountain mahogany dominates the narrow mountain shrub zone on the lower slopes of the hogbacks with ponderosa pine dominating the ridges above 6,000 feet (Costello 1964). The brush zone is broader and better developed in the southern part of the State and on the western slope. Although the type more often occurs in discontinuous clumps separated by grassland or forest, dense stands covering extensive areas, do occur on the southwestern mesas. Farther north on the western slope, there is an abrupt transition from brush to lodgepole pine and aspen forests at an elevation near 8,000 feet (Costello 1964). There are approximately 3.7 million acres of the brush type in Colorado (Miller and Choate 1964). Most of it is on the western slope and outside the National Forests.

Brush communities generally have understories composed predominantly of grasses. Rates of spread will vary with the condition of the understory. With the exception of continuous dense stands, fire spread is dependent more upon the continuity of the grass understory and leaf litter than upon the crowns. Fires in shrub communities can have very high rates of spread when the grass understory is cured (Barrows 1951 b). The intensity of fires in mountain shrub communities is dependent upon the density and height of the brush (Lynch 1974). Depending upon the fuel complex involved, brush stands may be characterized by NFDR fuel model D or F (Deeming et al. 1972). Some isolated areas of heavy brush in southwestern Colorado may be hazardous enough to warrant being considered fuel model B.

During the 1960 and 1973 period, 84 fires burned in the heavy brush type. This constituted 1.8 percent of the total fires. The brush type had fewer fires than any other type. These fires burned 365 acres for an average size of 4.3 acres per fire (Table 6). Although the acreage burned is small by comparison with other types, the heavy brush had the highest percentage of class B fires and the highest percent of class C and larger fires. Over 45 percent of all brush fires were larger than class A (Table 7). The high relative frequency of class C and larger fires indicates that rapid initial rates of spread are common in the type. In spite of the rapid initial rate of spread the largest fire was size class D.

Brush fires are more frequent on the western slope forests because there is considerably more acres of brush in the western regions of the State. Almost 68 percent of the heavy brush fires and 57 percent of the acres burned were on the western slope National Forests (Table 6). The average size per brush fire was larger on the eastern slope National Forests. This is due to one large brush fire on the Pike National Forest. Brush fires occurred from March through December but were most frequent during the middle of the summer. Hazard appears to be generally high throughout most of the fire season as evidenced by the fact that class C and larger fires have been fairly evenly distributed from April through September (Table 8).

Despite the number of fires increasing in October, there were no class C or larger fires in October (Table 8). The absence of large fires in October is probably due to the low absolute frequency of class C or larger fire occurrence rather than to any appreciable reduction in hazard.

Most of the brush country in Colorado lies outside the National Forest boundaries. It is, therefore, not well represented in this data. The data that are contained in this study indicate that large fires are likely to burn frequently where heavy brush occurs.

Grass and Sagebrush

In region II of the Forest Service, the grass and sagebrush types have been combined for fire reporting purposes. Combining the two types as one results in classifying a wide variety of range types and a correspondingly wide variety of fuel complexes as an entity. Included in these cover types are dense sagebrush stands, sagebrush-grass associations, mountain grasslands and mountain meadow types. This general cover type encompasses a large number of western grass species, several species of sagebrush (*Artemisia* spp.) and other associated forbs and shrubs. Depending upon the specific fuel complex involved this type may be classified into NFDR fuel model A, C, or D (Deeming et al. 1972).

The grass and sagebrush types are common on thousands of acres in the mountains of western Colorado. They dominate the intermountain parks and the lower slopes of most of the major drainages. Mountain grasslands and sagebrush ranges are best developed below 7,000 feet but grassy meadows and sagebrush parks are common up to 10,000 feet (Costello 1964). The types occur as peninsulas extending upward to break the zonal pattern of the conifers and as islands within the conifer zone. Their distribution adds tremendously to the diversity of the vegetative mosiac. Because of the wide range of associations characterized by this general cover type it is difficult to define moisture conditions in the type. Annual precipitation on pine-grass ranges varies from 12 inches at the lower elevations to 20 or more inches at the higher elevations. Summer precipitation is common in these areas (Currie 1975). Sagebrush ranges in the northwestern mountains annually receive from 8 to 20 inches with approximately 40 percent coming in small evenly distributed showers during the fire season (Sturges 1975). Mountain meadows receive variable amounts of precipitation depending upon elevation and location. Average annual precipitation varies from 20 to 40 inches with 6 to 10 inches of summer rainfall (Paulsen 1975).

Fire behavior in the grass type is dependent upon the condition of the range which varies both seasonally and according to use patterns. There is a marked seasonal difference in the flammability of the grass fuel complex. When more than 75 percent of the grass cover is green, moist, and succulent, grasses may form an effective fire barrier. As the grass cures it becomes progressively more hazardous. Fires in fully cured grass can spread faster than in any other fuel type (Barrows 1951 b). The grass fuel model has a higher maximum normalized rate of spread than any other fuel model (Deeming et al. 1972). Fires in the grass type generally have low intensities (Rothermel 1972) and are relatively easy to control unless high winds create erratic spread. Fires in mountain grasslands will generally spread more slowly when the range is depleted (Barrows 1951 b). However, under windy conditions even light patchy grass fuels may have very high rates of spread.

Mountain meadows are usually confined to the flat land along valley bottoms. Because soil moisture is rarely limiting meadow grasses do not cure out until very late in the fire season. As a result, fires in mountain meadows generally exhibit low rates of spread throughout most of the year (Barrows 1951 b). Although these areas are generally considered to be safe (Lynch 1974), high rate of spread fires can develop during the late fall when grasses are fully cured (Barrows 1951 b).

Native sagebrush stands, when properly grazed, support luxuriant herbaceous understories (Costello 1964). Under some conditions sagebrush may develop in such dense stands that subordinate vegetation is sparse. Over grazing has denuded many sagebrush stands to the extent that understory vegetation is virtually nonexistent (Costello 1964). Due to overgrazing many mountain areas, which were formerly grassland park, are now dominated by sagebrush. Such areas may retain enough grass to carry a fire through the understory.

Wildfire potential will vary depending upon the height and density of the sagebrush and the continuity of ground fuels. Sagebrush will burn readily during much of the fire season. In tall dense stands fires can spread rapidly (Barrows 1951 b) and develop high intensities (Lynch 1974). In less dense stands, where the herbaceous understory is the primary carrier of fire, spread will be dependent largely upon the condition of the understory vegetation. If ground fuels are continuous and fuel moisture is low, fires can spread rapidly. In very sparse stands with light ground fuels, fires spread slowly in the absence of high wind (Barrows 1951 b).

Colorado's National Forests reported over 450 grass and sagebrush fires during the period 1960 to 1973. These fires burned over 2,500 acres resulting in an average size of 5.6 acres per fire (Table 6). The grass and sagebrush types accounted for 9.9 percent of the total number of fires and 13 percent of the acres burned. Both the number of fires and acres burned were the fourth largest of the nine cover types.

Initial rates of spread are frequently high as is indicated by the frequency of class C and larger fires. Almost one out of every ten fires was class C or larger (Table 7). The 43 class C and larger fires were more than burned in any other type (Table 7). That these fires are generally easy to control is reflected in the fact that no class E or F fires occurred despite the numerous fires larger than class B. Some larger fires did occur on National Grasslands administered by the Forest Service but they are not included in the data analysis.

Grass and sagebrush fires occurred in nearly equal numbers on both east and west slope National Forests (Table 6). There was also little difference in the number of acres burned or average size per fire (Table 6). There does not appear to be any difference in the flammability of grass and sagebrush fuels on east and west slope forests.

There were grass and sagebrush fires during every month of the year (Table 8). Class B or larger fires occurred in every month indicating that fuels may be flammable any time of the year. Grass and sagebrush fires can spread readily as early as March. Of the ten fires which burned during March, six were class B and the remaining four were class C and D. October had the greatest number of fires and July had the second greatest number. The effect of the green condition of grasses during July is reflected in the absence of class C or D fires despite the high fire occurrence. With the exception of July, class C and D fires are fairly even distributed from March through September. In addition to having more fires, October had the highest occurrence of class C and D fires. One-third of all class C and D grass and sagebrush fires burned during October indicating these fuels are highly flammable in the fall.

Fuel Types

Examination of fire performance in Colorado forests provides insight into the effectiveness of the rate of spread concept in describing fire hazards. Approximately 97 percent of the fires and 95 percent of the acres burned were in the low, medium, and high rate of spread fuels. The largest number of fires were in the medium fuel type but the greatest number of acres burned were in the high classification (Table 9). Both east and west slope forests had the greatest number of fires in the medium rate of spread fuels but there were some differences between east and west in the distribution by other fuel types. Most east slope fires were in the low and medium classes, whereas west slope fires were fairly evenly distributed in the low, medium, and high types. Also east slope

Table 9

Fire Occurrence, Acres Burned and Average Size per Fire by Fuel Rate of Spread Classification

1960-1973

Fuel ROS Class.	#	%	# of Acres	% of Total	Acres/ Fire
			East Slope National Forests		
Low	549	35.1	3,206	34.9	5.8
Medium	661	42.2	1,507	16.4	2.3
High	321	20.5	4,125	45.0	12.9
Extreme	34	2.2	337	3.7	9.9
Total	1,565		9,175		
			West Slope National Forests		
Low	500	30.9	859	16.6	1.7
Medium	553	34.1	2,337	45.0	4.2
High	505	31.2	1,703	32.8	3.4
Extreme	62	3.8	291	5.6	4.7
Total	1,620		5,190		
			Total All National Forests		
Low	1,049	32.9	4,065	28.3	3.9
Medium	1,214	38.0	3,844	26.8	3.2
High	826	25.9	5,828	40.6	7.1
Extreme	96	3.0	628	4.4	6.5
Total	3,185		14,365		

forests had more acres burned in the low spread type than in medium but had the greatest acreage burned in high rate of spread fuels. West slope forests had the majority of acres burned in the medium fuel type (Table 9). Over 75 percent of the acres burned in the low type on the eastern slope resulted from one fire. If this one fire were excluded from the data analysis, the average size per fire in the low type would be 1.4 acres, roughly the same as on the west slope.

The majority of the class C and larger fires were in the high rate of spread fuels (Table 10). Although half of the class C and larger fires were in the high type, a greater percent of fires in the extreme fuel type spread to class C or larger size (Figure 8). Despite the few fires in the extreme type it appears that the fuel type maps were effective in delineating flashy fuel complexes. The rates of perimeter increase used in Region II fuel types are much higher than those in the original system developed by Hornby (1933). From the low number of fires it appears that few situations were hazardous enough to warrant the extreme classification.

Topography

The topographic factors of elevation, aspect, and slope steepness are interrelated with vegetation cover type in an analysis of forest fire hazard, as they create a variety of fuel complexes and fire environments.

Table 10

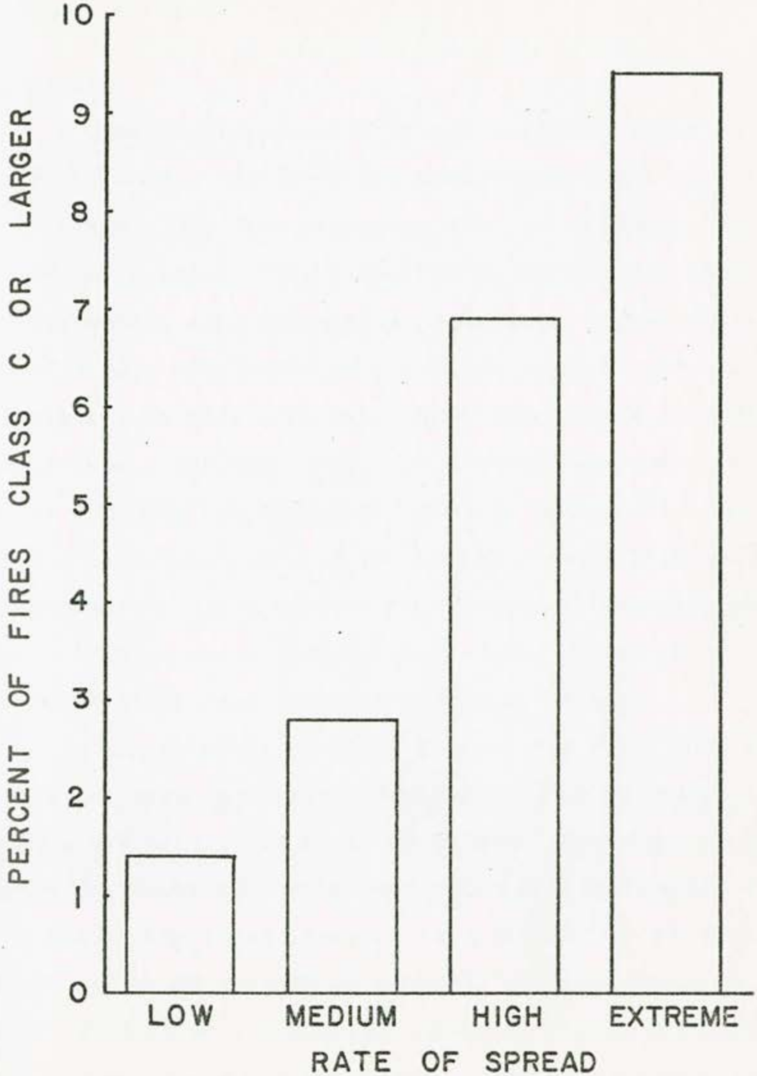
Fire Occurrence by Fuel Rate of Spread Classification and Size Class for All Colorado National Forests 1960-1969

Fuel ROS Class.	# & % by ROS	Size Class[a]						Total
		A	B	C	D	E	F	
Low	#	925	109	12	...	2	1	1,049
	%	88.2	10.4	1.1	...	.2	.1	
Medium	#	934	246	23	8	3	...	1,214
	%	76.9	20.3	1.9	.7	.2	...	
High	#	579	190	48	4	4	1	826
	%	70.1	23.0	5.8	.5	.5	.1	
Extreme	#	67	20	7	2	...	...	96
	%	69.8	20.8	7.3	2.1	...	...	
Total	#	2,510	566	90	14	9	2	3,191
	%	78.7	17.7	2.8	.4	.3	.1	

[a]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

Figure 8

Percent of Fires Reaching Class C or Larger Size in the Fuel Type Rate of Spread Classification for All Colorado National Forests 1960-1969


PERCENT OF FIRES CLASS C OR LARGER
10
9
8
7
6
5
4
3
2
1
0
LOW
MEDIUM
HIGH
EXTREME
RATE OF SPREAD

Environmental factors, or gradients, resulting from topography are exhibited by the zonation of vegetation (Daubenmire 1943).

Elevation

A general comparison of fires and their behavior shows that the warmer and dryer low elevational zones have longer fire seasons and fuel complexes that are flashier. As altitude increases, air temperatures decline and there is a corresponding rise in relative humidity. Higher elevations receive more precipitation resulting in plant communities that are generally more mesic than those found at lower elevations. The fire season is shorter at higher elevations and fuel complexes have greater volumes of large fuels. Increased biomass production coupled with slow decomposition rates creates heavy accumulations of potential fuels in high elevation forests. Under dry windy conditions conflagrations have developed in these forests.

In the Colorado National Forests the total fire load increases with increasing elevation. This is due to the geographic distribution of the National Forests with respect to elevation. It is estimated that less than .7 percent of the Forest Service land is below 6,500 feet while nearly 80 percent is above 8,500 feet (Table 3). On a per million acre basis the number of fires, acres burned, and number of class C and larger fires all decrease with with increasing elevation (Table 11). In general, it

Table 11

Number of Fires, Acres Burned and Number of Class C and Larger Fires per Million Acres by Elevation Zone 1960-1973

Elevation	#/MMAC	Ac. Burned/ MMAC	#C and Larger /MMAC
	East Slope National Forests		
5,501-6,500	1,562.0	3,941.5	73.0
6,501-7,500	1,371.8	12,328.8	46.1
7,501-8,500	811.0	1,580.9	21.1
Over 8,500	216.2	1,519.2	7.8
	West Slope National Forests		
5,501-6,500	1,034.9	4,995.9	71.4
6,501-7,500	854.5	3,921.5	25.8
7,501-8,500	586.1	1,207.9	12.1
Over 8,500	148.8	388.6	6.5
	Total All National Forests		
5,501-6,500	1,409.0	4,247.6	72.5
6,501-7,500	1,072.5	7,464.3	34.4
7,501-8,500	662.3	1,334.3	15.2
Over 8,500	179.5	903.3	7.1

appears that hazard decreases with elevation. Although the total magnitude of the National Forest fire problem is greater above 8,500 feet, both ignitions and large fires per million acres are greater below 8,500 feet.

Because there were only two fires in the 4,501 to 5,500 foot zone, this zone was not considered in this analysis. Although less than 19 percent of the fires were in the 5,501 to 6,500 and 6,501 to 7,500 elevation zones, these zones accounted for 27.7 percent of all acres burned (Table 12). These zones ranked first and second respectively in the percent of class C and larger fires (Table 12).

In the mid elevation zone (7,501-8,500 feet) 1,571 fires burned 3,165 acres (Table 12). Although this zone had the second greatest number of fires, it had the lowest average size per fire (Table 12) and percent of class C and larger fires (Table 13). The data do not reveal any clear indication as to why the average size per fire and percent of class C and larger fires are so low.

The large acreage above 8,500 feet is reflected in the high fire load above that altitude. A comparison of fires in the National Forests by elevational zones shows that 47.2 percent of the total fires were above 8,500 feet. The 2,168 fires above 8,500 feet burned 10,912 acres for an average size of 5.0 acres per fire (Table 12). The 86 class C and larger fires were 2.4 times the number of fires

Table 12

Fire Occurrence, Acres Burned and Average Size per Fire by Elevation Zones 1960-1973

Elevation Zone	#	%	# of Acres	% of Total	Acres/ Fire
		East Slope National Forests			
4,501-5,500	1	.0	0[a]	.0	.0
5,501-6,500	107	4.6	270	2.0	2.5
6,501-7,500	387	16.6	3,478	26.0	9.0
7,501-8,500	652	27.9	1,271	9.5	1.9
Above 8,500	1,189	50.9	8,355	62.5	7.0
Total	2,336		13,374		
		West Slope National Forests			
4,501-5,500	1	.0	0	.0	.0
5,501-6,500	29	1.3	140	2.3	4.8
6,501-7,500	331	14.6	1,519	24.9	4.6
7,501-8,500	919	40.7	1,894	31.0	2.1
Above 8,500	979	43.3	2,557	41.8	2.6
Total	2,259		6,110		
		Total All National Forests			
4,501-5,500	2	.0	0	.0	.0
5,501-6,500	136	3.0	410	2.1	3.0
6,501-7,500	718	15.6	4,997	25.6	7.0
7,501-8,500	1,571	34.2	3,165	16.2	2.0
Above 8,500	2,168	47.2	10,912	56.0	5.0
Total	4,595		19,484		

[a]All fires less than one acre are coded as zero acres on the fire report forms.

that occurred in the next highest zone (Table 13). Almost 57 percent of the Class C and larger fires and 58 percent of the class E and larger fires were above 8,500 feet. despite the numerous large fires only 4.0 percent of all fires above 8,500 feet were class C or larger (Table 13). Elevations above 8,500 feet had the third lowest relative frequency of class C and larger fires of the four elevation zones.

In comparing the east and west slope forests, the data shows the east slope forests had a greater portion of the total fires above 8,500. East slope forests had 67.8 more fires per million acres above 8,500 feet. Almost 51 percent of the east slope fires were above 8,500 feet compared with 43.3 percent on the west slope forests (Table 12). The east slope forests also burned 3.3 times as many acres above 8,500 feet.

Aspect

Aspect plays an important role in determining the vegetation and resulting fuel complex in mountanous terrain as it determines, to a large extent, the amount of solar radiation incident upon mountain slopes. In the Northern Hemisphere a south-facing slope annually receives more insolation per unit area than a flat surface, whereas a north-facing slope receives less. Thus, southerly exposures are warmer and dryer than northerly ones. Plant communities are usually more xerophytic on southerly

Table 13

Fire Occurrence by Elevation Zone and Size Class

for All Colorado National Forests 1960-1973

Elevation Zone	# & %	Size Class[a]						Total
		A	B	C	D	E	F	
4,501-5,500	#	2	...	...	...	...	...	2
	%	100	...	...	...	...	...	100.0
5,501-6,500	#	93	36	6	1	...	...	136
	%	68.4	26.5	4.4	.7	...	...	100.0
6,501-7,500	#	511	184	17	2	3	1	718
	%	71.2	25.6	2.4	.3	.4	.1	100.0
7,501-8,500	#	1,227	308	28	7	1	...	1,571
	%	78.1	19.6	1.8	.4	.1	...	100.0
Above 8,500	#	1,746	336	67	12	5	2	2,168
	%	80.5	15.5	3.1	.6	.2	.1	100.0
Total	#	3,579	864	118	22	9	3	4,595
	%	77.9	18.8	2.6	5	.2	.1	100.0

[a]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

exposures. South-facing slopes are generally less densely vegetated. Within the range of environmental conditions found in Colorado south slope communities generally have flashier fuel complexes than found on adjacent north slopes.

In addition to the long term effects of aspect which are generally apparent in the vegetative community, there are more subtle seasonal and diurnal variations which are important to fire hazard. Snow melt occurs earlier in the spring on southerly exposures (Lee 1963) and as a result, fuels on southerly aspects may be flammable much earlier in the fire season. Because southerly exposures are warmer and dryer, herbaceous fuels also cure out earlier in the fall. During the fire season daily temperature, humidity, and fuel moisture extremes are greater on south-facing slopes (Hayes 1941). Byram and Jemison (1943) found direct sunlight to be the most important factor in the drying of exposed forest fuels.

The influence of aspect is apparent in fire occurrence. In a study of forest fires in the northern Rocky Mountains (Barrows 1951 a) found both the number of ignitions and the percent of large fires were greater on southerly aspects. Maxey and Lee (1973) found similar results in West Virginia and were able to relate the frequency of fire occurrence to the radiation index for various aspects and slopes.

In this study over 4,400 fires were analyzed to determine the effect of slope orientation on wildfire potential. Ridgetops had the lowest fire load (Table 14). The one class C fire was also less than the number for any other orientation (Table 15). It appears that few fires actually start on the crests of ridges and the few fires which do start are probably detected soon after ignition. Fuels are generally sparse on ridgetops and there is little opportunity to spread upslope. As a result, fires are controlled at small acreages.

In the central Rocky Mountains flat areas are limited to valley bottoms and the western mesas. These lands are typically accessible and are preferred recreation areas. The accessibility is reflected in the higher number of ignitions, but like ridgetops, there appears to be little chance of fires spreading unchecked. As a result, flat areas had the second lowest number of acres burned (Table 14). They also had the second lowest percent of class C and larger fires (Table 15).

The data indicate that fire potential increases from north to south. However, there is variability depending on whether one looks at fire occurrence, acres burned or class C and larger fires. The north aspect had the least number of fires and class C and larger fires (Table 15). The south aspect had the greatest number of fires and acres burned (Table 14). Fires on southwest aspect spread to

Table 14
Fire Occurrence, Acres Burned and Average Size
per Fire by Aspect 1960-1973

Aspect	#	%	# of Acres	% of Total	Acres/ Fire
East Slope National Forests					
North	146	6.5	166	1.2	1.1
North East	236	10.5	231	1.7	1.0
East	330	14.7	2,598	19.5	7.9
South East	298	13.3	1,737	13.0	5.8
South	404	18.0	3,569	26.8	8.8
South West	213	9.5	788	5.9	3.7
West	221	9.9	3,032	22.8	13.7
North West	154	6.9	972	7.3	6.3
Ridgetop	95	4.2	41	.3	.4
Flat	146	6.5	177	1.3	1.2
Total	2,243		13,311		5.9
West Slope National Forests					
North	134	6.1	233	3.9	1.7
North East	151	6.9	509	8.5	3.4
East	286	13.1	310	5.2	1.1
South East	219	10.0	488	8.1	2.2
South	388	17.8	813	13.6	2.1
South West	290	13.3	2,242	37.4	7.7
West	296	13.6	727	12.1	2.5
North West	145	6.7	540	9.0	3.7
Ridgetop	71	3.3	21	.3	.3
Flat	200	9.2	116	1.9	.6
Total	2,180		5,999		2.8
Total All National Forests					
North	280	6.3	399	2.1	1.4
North East	387	8.7	740	3.8	1.9
East	616	13.9	2,908	15.1	4.7
South East	517	11.7	2,225	11.5	4.3
South	792	17.9	4,382	22.7	5.5
South West	503	11.4	3,030	15.7	6.0
West	517	11.7	3,759	19.5	7.3
North West	299	6.8	1,512	7.8	5.1
Ridgetop	166	3.8	62	.3	.4
Flat	346	7.8	293	1.5	.8
Total	4,423		19,310		4.4

Table 15

Fire Occurrence by Aspect and Size Class
for All Colorado National Forests
1960-1973

Aspect	# & %	Size Class[a]						Total
		A	B	C	D	E	F	
North	#	226	47	7	...	...	...	280
	%	80.7	16.8	2.5	...	...	...	
North East	#	294	85	7	...	1	...	387
	%	76.0	22.0	1.8	...	.3	...	
East	#	478	124	10	1	2	1	616
	%	77.6	20.1	1.6	.2	.3	.2	
South East	#	375	115	21	4	2	...	517
	%	72.5	22.2	4.1	.8	.4	...	
South	#	593	170	22	6	...	1	792
	%	74.9	21.5	2.8	.8	...	.1	
South West	#	373	98	25	4	3	...	503
	%	74.2	19.5	5.0	.8	.6	...	
West	#	422	78	13	3	...	1	517
	%	81.6	15.1	2.5	.6	...	.2	
North West	#	241	52	1	4	1	...	299
	%	80.6	17.4	.3	1.3	.3	...	
Ridgetop	#	137	28	1	...	...	...	166
	%	82.5	16.9	.6	...	...	...	
Flat	#	301	39	6	...	...	...	346
	%	87.0	11.3	1.7	...	...	...	
Total	#	3,440	836	113	22	9	3	4,423
	%	77.8	18.9	2.6	.5	.2	.1	

[a]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

class C and larger size more often than fires on other aspects (Table 15). The largest average size per fire was on the west aspect (Table 14). However, over 70 percent of the acres burned on the west aspect resulted from one class F fire. Severe fire weather was the driving force behind this fire and it is doubtful that aspect had much influence on the fire's size.

The percent of fires, percent of acres burned, and percent of class C and larger fires by aspect has been summarized (Table 16). The average of the three percents has been computed (Table 16), and used to develop a conceptual model of hazard potential by aspect (Figure 9). It is obvious from the graph that a major portion of wildfire potential is on the south and southwest aspects. More and larger fires occur on these southern exposures.

Between east and west slope National Forests there were some differences in the distribution of fires by aspect. East slope forests had a greater portion of the total fire load on northeast, east, and southeast aspects (Table 14). Both east and west slope forests had approximately the same portion of the fire load on the south aspect. East slope forests burned the greatest number of acres on south aspects whereas west slope forests burned the greatest acreage on southwest aspects. These variations may reflect differences in the physical "lay of the land" and differences in storm patterns.

Table 16

Forest Fire Potential[a] by Aspect

for Colorado National Forest

1960-1973

Aspect	% of Fires	# of Acres Burned	% of C and Larger Fires	Average %
North	7.2	2.1	5.0	4.8
Northeast	9.9	3.9	5.7	6.5
East	15.8	15.3	10.0	13.7
Southeast	13.2	11.7	19.3	14.7
South	20.3	23.1	20.7	21.4
Southwest	12.9	16.0	22.9	17.3
West	13.2	19.8	12.1	15.0
Northwest	7.6	8.0	4.3	6.6
Total	100.0	100.0	100.0	100.0

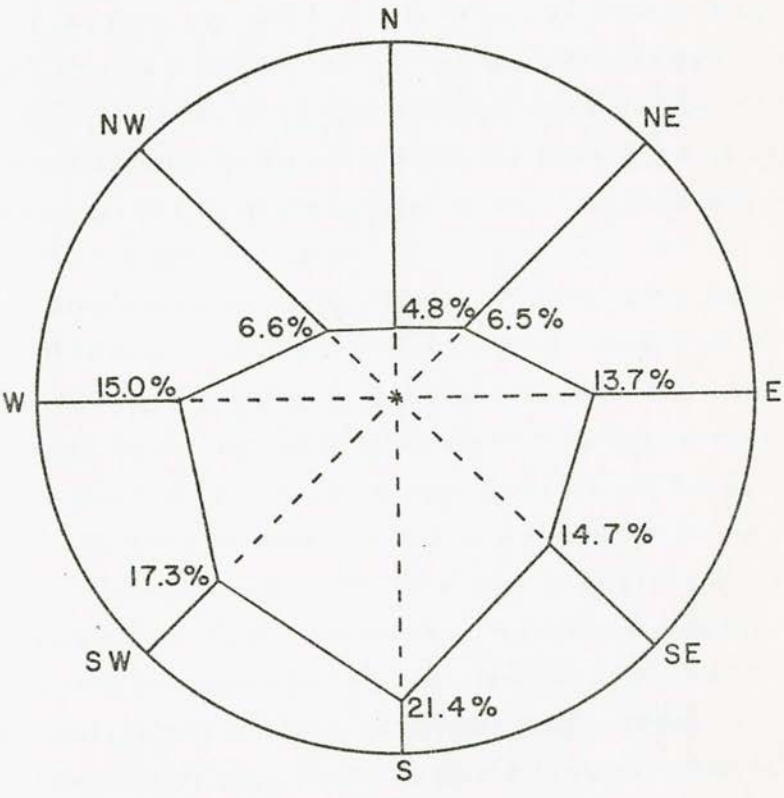
[a]Forest fire potential is expressed as a percent of the total number of fires, acres burned, and number of class C and larger fires for the purpose of computing an average hazard on a scale of 0 to 100.

Figure 9

Forest Fire Potential by Aspect for All Colorado National Forests

1960-1973

FOREST FIRE POTENTIAL BY ASPECT



Slope

Slope is an important component in the mountain environment and like aspect has an effect on radiation. For example, on southerly exposures a 40 percent slope annually receives more insolation than a 20 percent slope. Slope also affects the amount of run off and soil moisture. Due to the gravitational flow of moisture, soils become dryer on steeper slopes. In the absence of overriding elevational influences the plant environment becomes progressively dryer towards the top of a slope.

More important to an analysis of forest fire hazard is the effect of slope on fire spread. Other things being equal, fires spread faster as slope steepens. The effect of slope is to increase rate of spread by exposing potential fuels ahead of the fire to direct flame contact and increased heating by radiation and convection (Rothermel 1972). Byram et al. (1966) found that the rate of spread in experimental crib fires increased rapidly at slopes greater than roughly 36 percent. The Colorado State Forest Service's wildfire hazard guidelines recognize the slope-spread effect by placing restrictions on building on slopes greater than 30 percent (Colorado State Forest Service 1974). The slope-spread effect has also be recognized in the development of a hazard severity classification for California (Helm et al. 1973). This system defines three slope classes (0-40%, 41-60%, and over 60%) associated with increasing hazard. The National Fire Danger Rating System (Deeming et al. 1972) utilizes a mathematical spread model developed by Rothermel (1972) to calculate rate of spread by three slope classes (0-20%, 21-40%, and over 40%).

The effect of slope has been shown to be interdependent upon other fire related factors. Utilizing experimental fires, Curry and Fons (1939) found that light winds had a more than additive effect on rate of spread with increasing slope. Rothermel (1972) found that the rate of spread increase associated with slope is also dependent on the density of the fuel bed.

Although the precise effect of slope is difficult to quantify in field situations, the result will surely be an increase in the rate of spread relative to the steepness of the slope. The effect of slope on actual fires in the northern Rocky Mountains was analyzed by Barrows (1951 a). The results of his data indicated that the potential for class C and larger fires on steep slopes (over 60%) was 1.8 times greater than on gentle slopes (under 20%).

Over 3,800 wildfires were analyzed to determine the effect of slope on fire behavior. Approximately 55 percent of all fires and 42 percent of the acres burned were on slopes less than 20 percent (Table 17). The average size per fire was two times greater on 0 to 9 percent slopes than on 10-19 percent slopes. Over 50 percent of the acres burned in the 0-9 percent slope class resulted from one

Table 17
Fire Occurrence, Acres Burned and Average
Size per Fire by Percent Slope 1960-1973

Percent Slope	#	%	# of Acres	% of Total	Acres/ Fire
			East Slope National Forests		
0-9	533	26.6	4,230	34.7	7.9
10-19	494	24.6	863	7.1	1.7
20-29	313	15.6	4,257	34.7	13.6
30-39	250	12.5	888	7.3	3.6
40-49	185	9.2	1,096	9.0	5.9
50-59	75	3.7	368	3.0	4.9
60-69	78	3.9	217	1.8	2.8
70-79	34	1.7	77	.6	2.3
80-100	32	1.6	176	1.4	5.5
Over 100	12	.6	13	.1	1.1
Total	2,006		12,185		
			West Slope National Forests		
0-9	569	31.0	1,019	17.5	1.8
10-19	463	25.2	1,438	24.7	3.1
20-29	285	15.5	1,159	19.9	4.1
30-39	216	11.8	1,166	20.1	5.4
40-49	121	6.6	220	3.8	1.8
50-59	51	2.8	273	4.7	5.4
60-69	67	3.7	381	6.6	5.7
70-79	29	1.6	99	1.7	3.4
80-100	28	1.5	51	.9	1.8
Over 100	5	.3	9	.2	1.8
Total	1,834		5,815		
			Total All National Forests		
0-9	1,102	28.7	5,249	29.2	4.8
10-19	957	24.9	2,301	12.8	2.4
20-29	598	15.6	5,416	30.1	9.1
30-39	466	12.1	2,054	11.4	4.4
40-49	306	8.0	1,316	7.3	4.3
50-59	126	3.3	641	3.6	5.1
60-69	145	3.8	598	3.3	4.1
70-79	63	1.6	176	1.0	2.8
80-100	60	1.6	227	1.3	3.8
Over 100	17	.4	22	.1	1.3
Total	3,840		18,000		

fire which occurred during severe fire weather. Excluding this one fire from the data analysis would result in reducing the average size per fire in the 0-9 percent slope class to 2.4 acres, the same size as in the 10-19 percent class. The majority of fires occurred on gentle slopes and the majority of large fires also occurred there. However, the percent of fires in the 0-9 percent and 10-19 percent slope classes which reached class C or larger size was less than in any other slope classes. Fires in the 20-29 percent slope class accounted for 15.6 percent of all fires and 30.1 percent of the total acres burned. The average size of 9.1 acres per fire was the largest average size (Table 17). At slopes greater than 70 percent, the average size per fire became smaller. This may be the result of the reduced fuel continuity often found on steep slopes.

The number of fires and acres burned decrease with increasing slope because of the reduced amount of land available at the steeper slopes. For this reason it is necessary to compare fire performance between slope classes by a variable which is independent of area. This was done by looking at the percent of fires in each slope class which reached class C or larger size. As the percent of slope steepness increased, there was a general increase in the percentage of fires reaching a size of ten or more acres (Figure 10). The greatest percent of class C and larger fires was in the 80-100 percent slope class (Table 18).

There was little difference between east and west slope forests in the fire occurrence rates at the various slopes (Table 17). However, there were some noticeable differences in the percent of acres burned in the various slope classes. The east slope forests had the majority of the acres burned in the 10-19 and 30-39 percent slope classes (Table 17). The major source of this difference appears to be the skewness in the data brought about by three class F fires on the east slope. These three fires accounted for 31 percent of all acres burned during the 1960 to 1973 period.

Analysis of Risk

Introduction

Risk, like hazard, is highly variable but the transient nature of ignition sources is less predictable than the variations in hazard. Some forest areas are exposed almost exclusively to lightning ignition sources. Others are exposed almost exclusively to ignitions resulting from human activity. Still others are exposed to both sources of ignition.

Lightning risk is restricted mainly to the summer months. It is greater on some forests and is strongly

Figure 10

Percent of Fires Reaching Class C or Larger Size by Slope Class for All National Forests 1960-1973

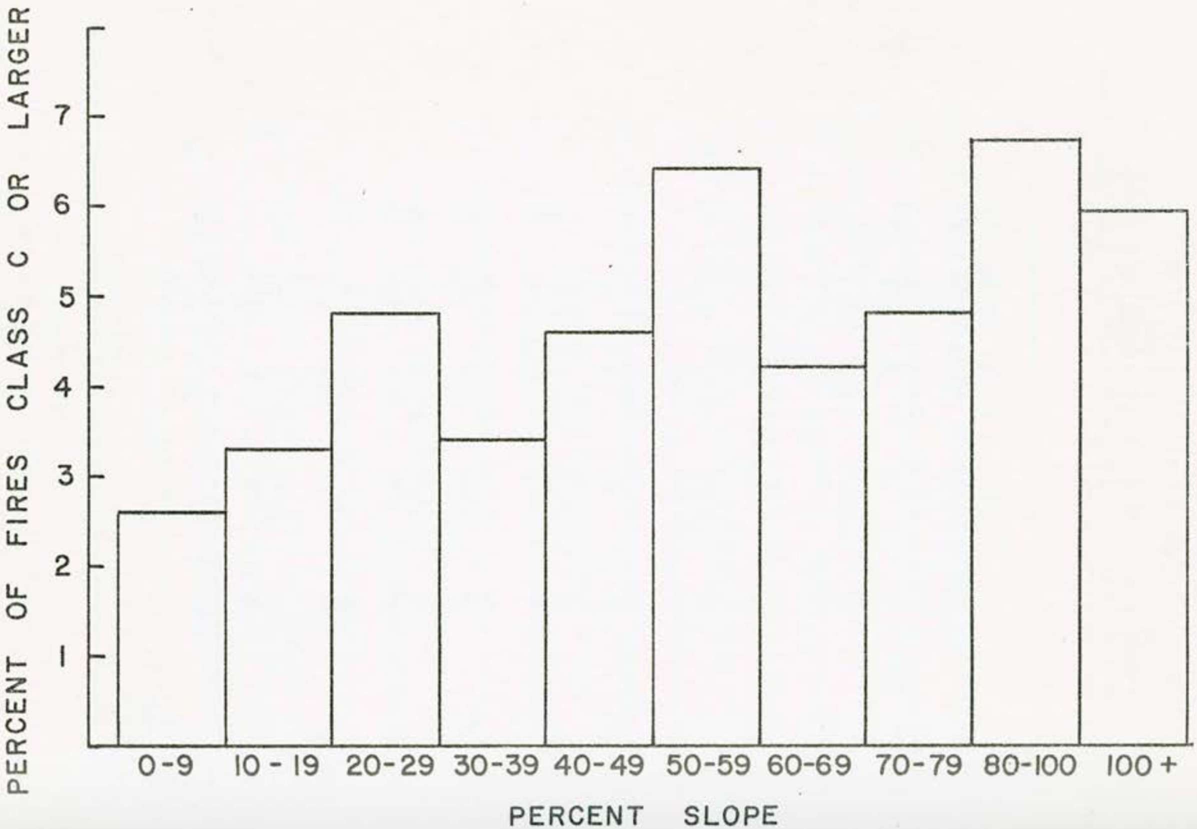

PERCENT OF FIRES CLASS C OR LARGER
1
2
3
4
5
6
7
0-9
10 - 19
20-29
30-39
40-49
50-59
60-69
70-79
80-100
100 +
PERCENT SLOPE

Table 18

Fire Occurrence by Percent Slope and Size Class for All Colorado National Forests 1960-1973

Percent Slope	# & %	Size Class[a]						Total
		A	B	C	D	E	F	
0-9	#	909	164	23	4	1	1	1,102
	%	82.5	14.9	2.1	.4	.1	.1	
10-19	#	741	184	25	6	1	...	957
	%	77.4	19.2	2.6	.6	.1	...	
20-29	#	433	136	20	5	3	1	598
	%	72.4	22.2	3.3	.8	.5	.2	
30-39	#	339	111	12	2	2	...	466
	%	72.7	23.8	2.6	.4	.4	...	
40-49	#	223	69	11	1	2	...	306
	%	72.9	22.5	3.6	.3	.7	...	
50-59	#	87	31	6	2	...	...	126
	%	69.0	24.6	4.8	1.6	...	...	
60-69	#	103	35	6	1	...	...	145
	%	71.0	24.1	4.1	.1	...	...	
70-79	#	46	14	3	...	...	...	63
	%	73.0	22.2	4.8	...	...	...	
80-100	#	44	12	3	1	...	...	60
	%	73.3	20.0	5.0	1.7	...	...	
Above 100	#	13	3	1	...	...	...	17
	%	76.5	17.6	5.9	...	...	...	
Total	#	2,938	759	110	22	9	2	3,840
	%	76.5	19.8	2.9	.6	.2	.1	

[a]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

influenced by elevation and cover type. Human risk, although highest in the summer months, is present year round and ignitions are largely dependent upon the hazardousness of the fuel complex. Man caused risk is a function of the activities, attitudes, and habits of people. It is strongly affected by the accessibility of the forests to people. The data are not suitable for quantifying the total amount of risk in terms of the number of lightning strikes or ignitions per thousand user days. However, they do provide a measure of the amount of risk available when fuels are ignitable.

That risk is not uniformly distributed is reflected in the number of fire days and the number of multiple fire days in the various National Forests (Table 19). The average annual number of fire days ranged from a low of 9.4 days on the Gunnison National Forest to a high of 53.9 days on the San Juan National Forest. The greatest number of fires to start in a single day was twelve on the San Juan National Forest. The data indicate that the majority of multiple fire days are either lightning fire days or man caused fire days but rarely a combination of the two.

Another indicator of non-uniformity of risk is the variability in recreation user days (Figure 11).[1] Recreation visitor days nearly doubled between 1966 and 1973.

---

[1]Data on recreation user days for Colorado National Forests was provided by U.S. Forest Service Region II Recreation and Lands Staff, Denver, Colorado.

Table 19

Number of Fire Days and Multiple Fire Days by National Forest in Colorado 1960-1973

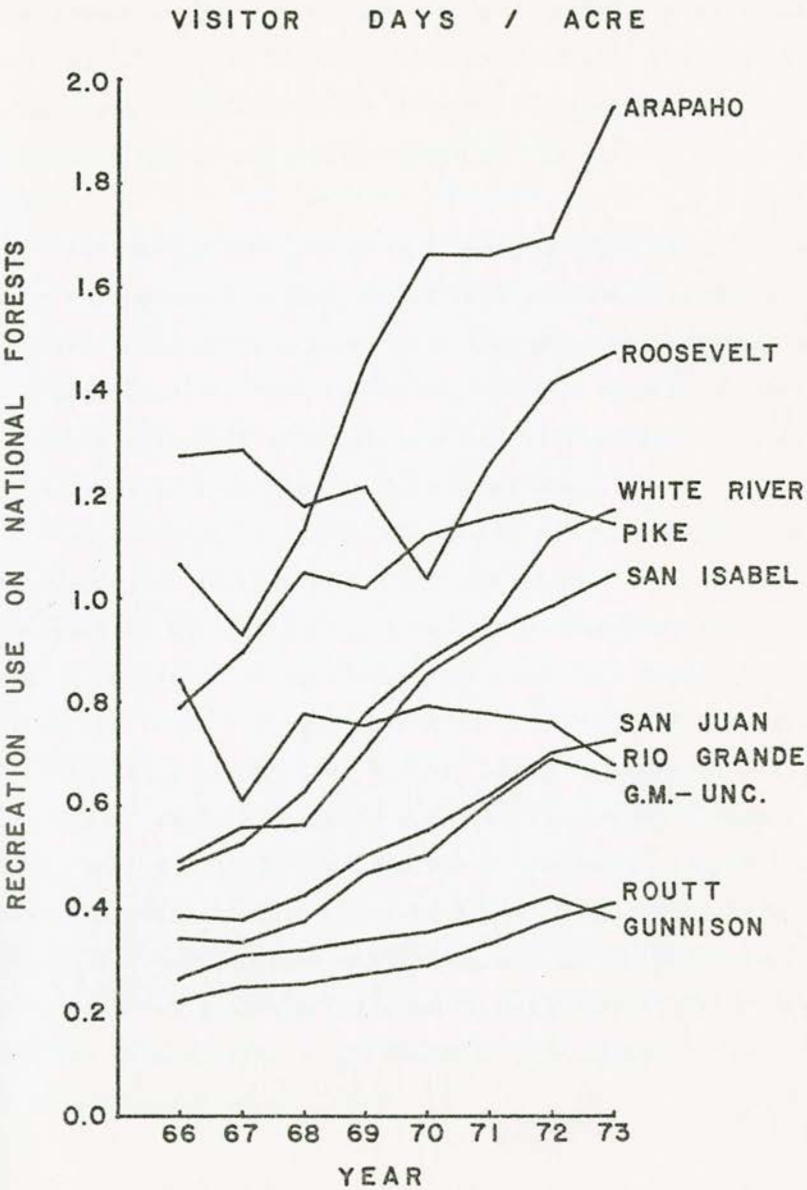
Number of Fire per Day	Arapaho	GM-Unc	Gunnison	Pike	Rio Grande	Roosevelt	Routt	San Isabel	San Juan	White River
1	215	208	122	537	197	296	145	240	521	276
2	18	33	10	120	17	53	17	32	120	48
3	2	2	...	40	2	6	2	5	57	7
4	1	5	...	12	...	8	1	3	29	4
5	...	...	...	9	1	2	...	...	8	...
6	...	...	...	4	...	...	...	...	9	...
7	...	...	...	...	...	...	...	...	...	...
8	...	...	...	2	...	...	...	...	4	...
9	...	...	...	...	...	...	...	...	...	...
10	...	...	...	...	...	1	...	...	1	...
11	...	...	...	...	...	...	...	...	2	...
12	...	...	...	...	...	...	...	...	1	...
Total Number Fire Days	236	248	132	724	217	366	165	280	752	335
Annual Average Fire Days	16.9	17.7	9.4	51.7	15.5	26.1	11.8	20.0	53.7	23.9

Figure 11

Recreation Visitor Days per Acre for

the Ten National Forests

1966-1973



VISITOR DAYS / ACRE
RECREATION USE ON NATIONAL FORESTS
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
66 67 68 69 70 71 72 73
YEAR
ARAPAHO
ROOSEVELT
WHITE RIVER
PIKE
SAN ISABEL
SAN JUAN
RIO GRANDE
G.M.-UNC.
ROUTT
GUNNISON

The lowest number of visitor days per million acres in 1973 was 384,100 on the Gunnison National Forest. The highest number was 1,945,100 on the Arapaho National Forest. Recreational use is generally higher on the eastern slope forests.

Estimating the amount and source of risk has always been an important ingredient of fire prevention efforts. It is also important for predicting the expected fire load on a protection unit (Deeming et al. 1972). Because of the variable nature of risk patterns, local determinations of risk are very important in fire management.

An analysis of specific types of man caused fires was not performed in this study for two reasons. First, data on specific sources of man caused fires are published annually by forest in the National Forest Fire Reports (U.S.D.A. Forest Service 1946-1973 b). The data base used in this study is the same as that which is published and, therefore, would not add to existing knowledge. Second, local analysis of fire causes was completed in conjunction with the National Fire Planning recently conducted on each National Forest. These statistics are being used along with expected activity patterns to subjectively determine the man caused risk in the National Fire Danger Rating System (Deeming et al. 1972).

Risk in the National Forests

In the ten National Forests in Colorado there was not a significant difference in the number of fires by cause but man caused fires burned considerably more acres. Lightning fires accounted for 52.9 percent of the ignitions but only 22.6 percent of the acres burned (Table 20). Lightning fires burned 4,399 acres compared to 15,085 acres burned by man caused fires. The average size per man caused fire was 3.9 times larger than for lightning. There were eighteen more lightning fires per million acres than man caused fires. Annually, this is less than 1.3 more lightning fires per million acres. Lightning burned 289 acres per million acres compared to 991 acres per million for man caused fires (Table 20). This is approximately fifty acres per year more man caused acres burned. Man caused fires are consistently larger than lightning fires. Approximately 82 percent of all lightning fires and 74 percent of all man caused fires were class A (Table 21). Only 1.5 percent of all lightning fires spread to class C or larger size compared to 5.3 percent of all man caused fires. Man caused fires accounted for 76.3 percent of all class C and larger fires.

On the east slope forests, lightning accounted for 46.3 percent of all fires and 12.5 percent of the acres burned (Table 20). The number of man caused fires was not significantly greater than lightning but man caused fires burned seven times more acres. On west slope forests,

Table 20

Fire Occurrence per Million Acres, Acres Burned per Million Acres and Average Size per Fire by Cause 1960-1973

Cause[a]	#	%	#/ MM Ac.	# Ac. Burned	% of Total	Acres Burned MM Ac.	Acres/ Fire
East Slope National Forests							
LC	1,081	46.3	162	1,668	12.5	251	1.5
MC	1,255	53.7	188	11,706	87.5	1,758	9.3
Total	2,336		350	13,374		2,009	5.7
West Slope National Forests							
LC	1,350	59.7	158	2,731	44.7	319	2.0
MC	910	40.3	106	3,379	55.3	395	3.7
Total	2,260		264	6,110		714	2.7
Total All National Forests							
LC	2,431	52.9	160	4,399	22.6	289	1.8
MC	2,165	47.1	142	15,085	77.4	991	7.0
Total	4,596		302	19,484		1,280	4.2

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table 21

Fire Occurrence by Size Class and Cause

1960-1973

Cause[a]	# & %	Size Class[b] A	B	C	D	E	F	Total
		East Slope National Forests						
LC	#	826	243	.9	1	2	...	1,081
	%	76.4	22.5	.8	.1	.2	...	46.3
MC	#	919	270	49	11	3	3	1,255
	%	73.2	21.5	3.9	.9	.2	.2	53.7
Total	#	1,745	513	58	12	5	3	2,336
	%	74.7	22.0	2.5	.5	.2	.1	
		West Slope National Forests						
LC	#	1,157	169	18	3	3	...	1,350
	%	85.7	12.5	1.3	.2	.2	...	59.7
MC	#	678	182	42	7	1	...	910
	%	74.5	20.0	4.6	.8	.1	...	40.3
Total	#	1,835	351	60	10	4	...	2,260
	%	81.2	15.5	2.7	.4	.2	...	
		Total All National Forests						
LC	#	1,983	412	27	4	5	...	2,431
	%	81.6	16.9	1.1	.2	.2	...	52.9
MC	#	1,597	452	91	18	4	3	2,165
	%	73.8	20.9	4.2	.8	.2	.1	47.1
Total	#	3,580	864	118	22	9	3	4,596
	%	77.9	18.8	2.6	.5	.2	.1	

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

[b]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

there were 19.4 percent more lightning fires but they burned 10.6 percent fewer acres than man caused fires. The average size per man caused fire was 1.9 times greater than lightning.

There were also some differences in the size distribution of fires between the two slopes. East slope forests had more class B but fewer class C and larger lightning fires. West slope forests had nine more class C and larger lightning fires. On the east slope forests, 15.4 percent of the class C and larger fires were caused by lightning compared to 32.4 percent on the west slope (Table 21). There was little difference between the two slopes in the size distribution of man caused fires with the exception that the east slope had five more class E and F man caused fires. The percent of man caused class C and larger fires was 5.2 on the east slope and 5.5 on the west slope (Table 21).

Lightning fire occurrence per million acres was nearly the same on both slopes but the acres burned per million was greater on the western slope. On the west slope, lightning started 158 fires and burned 319 acres on a per million acre basis. On east slope forests, lightning started 162 fires and burned 251 acres per million (Table 20). The difference of 68 acres burned per million is less than 5 acres per million acres annually. Thus there appears to be little difference in lightning fire potential between the two slopes.

The major difference between the east and west slope forests is the greater man caused fire load in the east. Both man caused ignitions and the damage resulting from man caused fires is greater on the eastern slope. There were 188 man caused fires per million acres on the east slope forests compared to 106 on the west. Although this difference of 82 fires represents an annual average of only six more fires per million acres, it reflects a significantly greater potential for damage. Man caused fires burned 1,758 acres per million acres on the east slope forests and 395 acres per million acres on the west. Annually this is a difference of 97.4 acres per million acres.

The variation in the volume of fire business between the two slopes results from differences in ignition patterns. Lightning ignitions and the average size of lightning fires are nearly the same on both slopes, but man caused ignitions and the average size per man caused fire are much greater on the eastern slope. Since lightning is the greater source of ignitions on western slope forests, lightning fires account for a greater portion of the class C and larger fires. Due to the greater number of people on the eastern slope, man caused ignitions are higher than lightning ignitions. As a result, a greater portion of large fires are man caused.

Man caused fires pose greater problems on both sides of the Continental Divide. Despite the differences in the number of lightning and man caused ignitions, man caused fires burned more acres regardless of slope. The frequency of large man caused fires is consistently higher than the frequency of large lightning fires. As regional development of the western slope progresses man caused risk will increase and a greater volume of fire business seems probable.

Topography

Elevation

Elevation exerts a strong influence on patterns of fire occurrence. The number of fires increased with rise in elevation (Figure 12). This resulted from the greater acreage available at the higher elevations. On a per million acre basis the number of ignitions decreased with increasing elevation. Although total risk per million acres decreased uniformly with increasing elevation, there was variation in the source of ignitions (Figure 13).

In the 6,501 to 7,500 foot elevation zone there were more lightning fires per million acres than in any other zone (Figure 13). Man caused risk, although much lower than in the 5,501 to 6,500 foot elevation zone, is also high between 6,500 and 7,500 feet. Over 1,070 fires per million acres burned in the 6,501 to 7,500 foot elevation zone (Figure 13). Approximately 63 percent of these fires were lightning and 37 percent were man caused (Table 22).

Figure 12

Number of Fires by Cause and Elevation Zone

for All Colorado National Forests

1960-1973

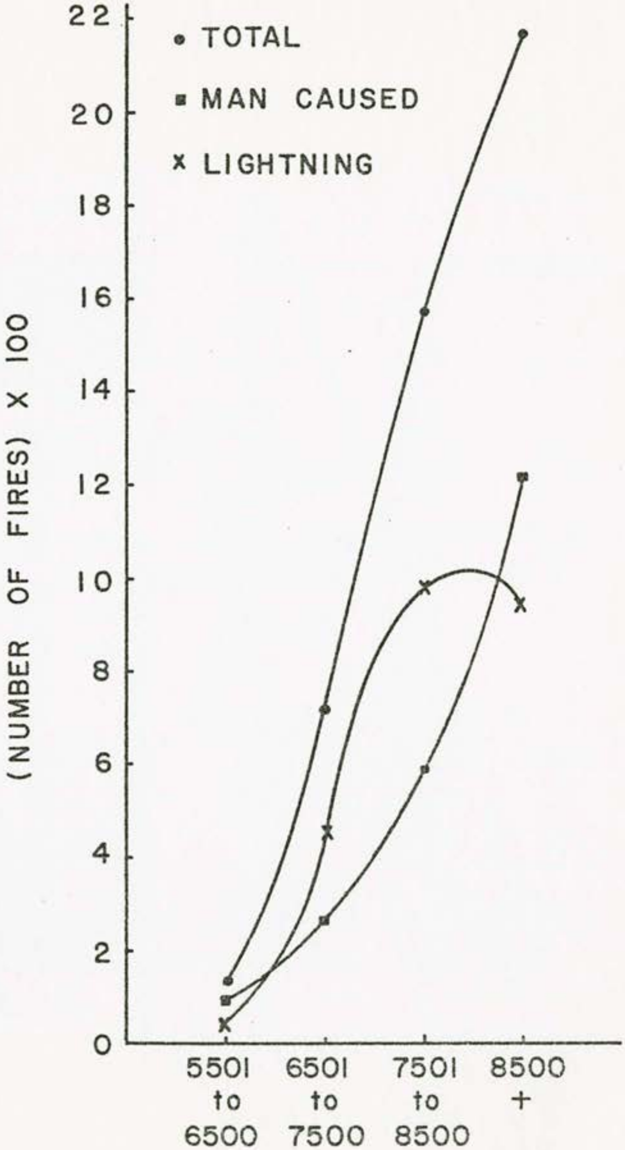

TOTAL
MAN CAUSED
LIGHTNING
(NUMBER OF FIRES) X 100
0
2
4
6
8
10
12
14
16
18
20
22
5501 to 6500
6501 to 7500
7501 to 8500
8500 +

Figure 13

Number of Fires per Million Acres by Elevation Zone

and Cause for All Colorado National Forests

1960-1972

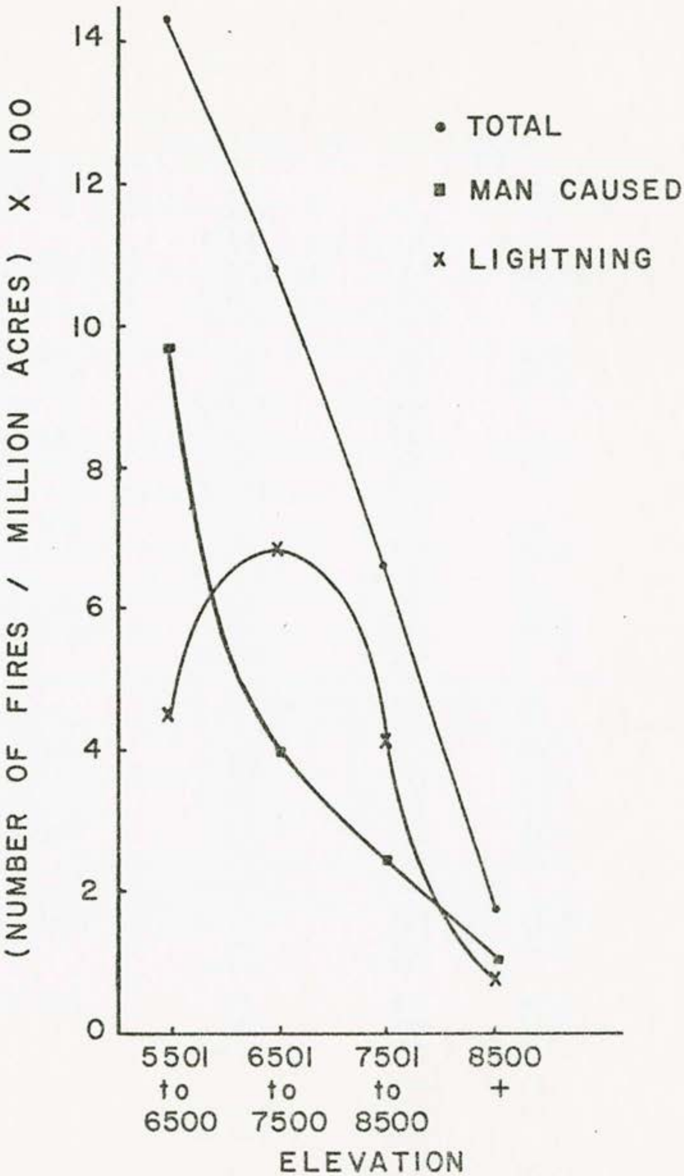

14
12
10
8
6
4
2
0
(NUMBER OF FIRES / MILLION ACRES) X 100
TOTAL
MAN CAUSED
LIGHTNING
5501 to 6500
6501 to 7500
7501 to 8500
8500 +
ELEVATION

Table 22

Fire Occurrence by Elevation Zones

1960-1973

Elevation	Cause[a]	#	%	% of Total
East Slope National Forests				
4,501-5,500	LC	1	100.0	
	MC	...	...	
	Total	1		.0
5,501-6,500	LC	33	30.8	
	MC	74	69.2	
	Total	107		4.6
6,501-7,500	LC	227	58.7	
	MC	160	41.3	
	Total	387		16.6
7,501-8,500	LC	360	55.2	
	MC	292	44.8	
	Total	652		27.9
Above 8,500	LC	460	38.7	
	MC	729	61.3	
	Total	1,189		50.9
Total All Elevations	LC	1,081	46.3	
	MC	1,255	53.7	
	Total	2,336		
West Slope National Forests				
4,501-5,500	LC	1	100.0	
	MC	...	...	
	Total	1		.0
5,501-6,500	LC	10	34.5	
	MC	19	65.5	
	Total	29		1.3
6,501-7,500	LC	228	68.9	
	MC	103	31.1	
	Total	331		14.6
7,501-8,500	LC	620	67.5	
	MC	299	32.5	
	Total	919		40.7
Above 8,500	LC	490	50.1	
	MC	489	49.9	
	Total	979		43.3
Total All Elevations	LC	1,349	59.7	
	MC	910	90.3	
	Total	2,259		

Table 22-Continued

Elevation	Cause[a]	#	%	% of Total
4,501-5,500	LC	2	100.0	
	MC	...	...	
	Total	2		.0
5,501-6,500	LC	43	31.6	
	MC	93	68.4	
	Total	136		3.0
6,501-7,500	LC	455	63.4	
	MC	263	36.6	
	Total	718		15.6
7,501-8,500	LC	980	62.4	
	MC	591	37.6	
	Total	1,571		34.2
Above 8,500	LC	950	43.8	
	MC	1,218	56.2	
	Total	2,168		47.2
Total All Elevations	LC	2,430	52.9	
	MC	2,165	47.1	
	Total	4,595		

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

This elevation zone represents only 4.4 percent of the total area within the National Forest boundaries but accounted for 15.6 percent of the fires.

Although the maximum number of lightning ignitions was in the 7,501 to 8,500 foot elevation zone, this zone had the third highest density of lightning fires per million acres. Over 62 percent of the 62.3 fires per million acres were started by lightning (Table 22). There were also 249 man caused fires per million acres which is the third highest density by elevation zone. The 7,501 to 8,500 foot elevation zone represents only 15.8 percent of the total land area but had 34.2 percent of the fires.

Although the 6,501 to 8,500 foot elevations are areas of high lightning occurrence, it can be questioned whether or not lightning ignitions are as much greater than man caused ignitions as the data indicate. One factor which may result in lightning risk being higher than man caused is the distribution of lands. There is considerable development on over 1.5 million acres of private inholdings. Much of inholdings are in valleys whereas more of the higher slope land is managed by the Forest Service. Many of the man caused fires are suppressed by agencies other than the Forest Service. Since lightning fires are more likely to occur on the higher slopes it is quite possible that the data are skewed toward lightning fires.

The elevations above 8,500 feet make up approximately 80 percent of the total land within the National Forest boundaries. Because of the vast acreage in this zone there were more ignitions than in any other elevation zone. Over 47 percent of all fires were above 8,500 feet (Table 22). Therefore, the greatest total risk in National Forest lands is above 8,500 feet. Despite the large volume of fires the number of fires per million acres was less than in any other zone (Figure 13). The 2,168 fires represents 179.5 fires per million acres. Annually this averages 12.8 fires per million acres. The elevations above 8,500 feet had the second highest number of lightning fires and the highest number of man caused fires. Over 56 percent of the fires were man caused (Table 22). The large number of man caused fires above 8,500 feet is a reflection of the intense recreational use in the high country of Colorado. In a survey of 608 Forest Service recreation sites, 70.6 percent were above 8,500 feet.

<u>Aspect</u>

Aspect is of relatively little importance in determining the risk of forest fires. There was a slight tendency for more lightning fires on the westerly aspects. This may result from thunderstorm buildup along the prominent western ridges of Colorado's mountain ranges. The only other differences were in fires on ridgetops and flat areas. Lightning fires were 2.3 times more frequent than man caused fires on ridgetops whereas man caused fires were 2.7 times more frequent than lightning on flat areas (Table 23).

Table 23
Fire Occurrence by Aspect and Cause for
All Colorado National Forests
1960-1973

Aspect	Cause				Total	
	Lightning		Man			
	#	%	#	%	#	%
North	144	6.2	136	6.5	280	6.3
North East	223	9.6	164	7.8	387	8.7
East	326	14.0	290	13.8	616	13.9
South East	278	11.9	239	11.4	517	11.7
South	384	16.5	408	19.5	792	17.9
South West	273	11.7	230	11.0	503	11.4
West	303	13.0	214	10.2	517	11.7
North West	187	8.0	112	5.3	299	6.8
Ridgetop	116	5.0	50	2.4	166	3.8
Flat	94	4.0	252	12.0	346	7.8
Total	2,328		2,095		4,423	

Slope

Although the amount and source of risk varied with slope steepness, the percent slope is not an important determinator of risk. Data are not available on acreages in each slope class but it is estimated that the majority of land is in the lower slope classes. The majority of fires were on gentle slopes. Almost 54 percent of all fires were in the 0 to 9 and 10 to 19 percent slope classes. Almost 38 percent of all fires were at moderate slopes between 20 and 49 percent and less than 11 percent of the fires were at slopes steeper than 49 percent (Table 24).

The source of risk varied with slope steepness. The greatest man caused risk was in the 0 to 9 percent slope class (Table 24). Man caused risk was 1.6 times greater than lightning risk in this class. The highest lightning risk was in the 10 to 19 percent slope class. Lightning risk was 1.2 times greater than man caused in this class. Lightning risk averaged 1.8 times higher than man caused risk at slopes steeper than 19 percent (Table 24).

Special Interest Areas

Fires were examined in sixteen special interest areas to gain insight into risk patterns around select high use areas within the National Forest boundaries (Table 25). The areas were selected on the basis of recent development or because of wilderness values. Three of the areas were

Table 24

Fire Occurrence by Percent Slope and Cause for All Colorado National Forests 1960-1973

Percent Slope	Cause				Total	
	Lightning		Man			
	#	%	#	%	#	%
0-9	430	20.5	672	38.5	1,102	28.7
10-19	512	24.5	445	25.5	957	24.9
20-29	375	17.9	223	12.8	598	15.6
30-39	298	14.2	168	9.6	466	12.1
40-49	203	9.7	103	5.9	306	8.0
50-59	84	4.0	42	2.4	126	3.3
60-69	96	4.6	49	2.8	145	3.8
70-79	46	2.2	17	1.0	63	1.6
80-100	41	2.0	19	1.1	60	1.6
Over 100	9	.4	8	.5	17	.4
Total	2,094		1,746		3,840	

Table 25

Fire Occurrence per Million Acres in

Special Interest Areas 1960-1973

Area	Cause	#	# per MM Ac.	% per Area	% of Forest Total
Allenspark-Lyons	LC	26	307	59.1	5.5
Roosevelt N.F.	MC	18	213	40.9	3.8
	Total	44	520	100.0	9.3
Aspen	LC	2	26	9.1	.5
White River N.F.	MC	20	258	90.9	4.9
	Total	22	284	100.0	5.4
Big Thompson	LC	31	352	56.4	6.6
Roosevelt N.F.	MC	24	272	43.6	5.1
	Total	55	624	100.0	11.7
Boulder-Ward-	LC	33	192	24.6	7.0
Nederland	MC	101	587	75.4	21.4
Roosevelt N.F.	Total	134	779	100.0	28.4
Dillon-	LC	10	77	10.1	3.8
Breckenridge	MC	89	681	89.9	34.1
Arapaho N.F.	Total	99	758	100.0	37.9
Flat Tops	LC	3	29	27.3	.7
White River N.F.	MC	8	79	72.7	2.0
	Total	11	108	100.0	2.7
Gore-Eaglenest	LC	2	32	22.0	.3
Arapaho-	MC	7	113	78.0	1.0
White River N.F.	Total	9	145	100.0	1.3
Idaho Springs	LC	11	185	34.4	4.2
Arapaho N.F.	MC	21	353	65.6	8.1
	Total	32	538	100.0	12.3
Lake George	LC	92	587	59.0	8.9
Pike N.F.	MC	64	408	41.0	6.2
	Total	156	995	100.0	15.1
Maroon Bells	LC	0	0	0	0
White River N.F.	MC	6	84	100.0	1.5
	Total	6	84	100.0	1.5

Table 25-Continued

Area	Cause	#	# per MM Ac.	% per Area	% of Forest Total
Pikes Peak	LC	61	281	38.1	5.9
Pike N.F.	MC	99	456	61.9	9.6
	Total	160	737	100.0	15.5
Redfeather-Rustic	LC	58	284	63.0	12.3
Roosevelt N.F.	MC	34	167	37.0	7.2
	Total	92	451	100.0	19.5
Reudi Reservoir-	LC	5	66	18.5	1.2
Fryingpan River	MC	22	290	81.5	5.4
White River N.F.	Total	27	356	100.0	6.6
South Platt	LC	291	889	55.3	28.3
Pike N.F.	MC	235	718	44.7	22.8
	Total	526	1,607	100.0	51.1
Vail	LC	3	37	7.7	.7
White River N.F.	MC	36	443	92.3	8.8
	Total	39	480	100.0	9.5
Winter Park	LC	2	87	33.3	.8
Arapaho N.F.	MC	4	173	66.7	1.5
	Total	6	260	100.0	2.3

wildernesses and the remaining thirteen were intense recreation and/or highly developed areas. Legal descriptions for each area are in Appendix K.

In the wilderness areas risk per million acres was lower than in the National Forest as a whole. Total ignitions per million acres were also lower than the total ignitions for all lands above 8,500 feet. Man caused ignitions in the Gore-Eagles Nest Wilderness was slightly higher than the average man caused ignitions above 8,500 feet. The data indicate the major portion of wilderness fires result from man caused ignition sources.

The thirteen high use areas present a much different picture from wilderness lands. Of the thirteen areas only the Winter Park area was below average in total fire occurrence per million acres. Man caused risk in the Winter Park area was considerably higher than the average man caused risk above 8,500 feet. The remaining twelve areas accounted for over 35 percent of all man caused fires and were well above average in the number of ignitions per million acres. The western slope areas of Aspen, Vail, Dillon-Breckenridge, and Reudi Reservoir-Fryingpan River were below average in lightning ignitions but well above average in man caused ignitions per million acres. The highest fire occurrence area was in the South Platt drainage on the Pike National Forest. The area encompasses only 2 percent of the Forest Service lands but had 11.4

percent of all fires. This intensely developed area had 889 lightning and 718 man caused fires per million acres (Table 25). The density of ignitions per million acres was 5.3 times greater than the average for all National Forest lands.

Integration of Hazard and Risk

In order to compare the integrated components of hazard and risk between the cover types, it was necessary to make an assumption about the acres available in the cover type. It was assumed that the commercial and reserved forest acreage figures provided by the U.S. Forest Service Region II Timber Management Staff represented the total acres in a given cover type. It was also assumed that the noncommercial and nonreserved acres were made up entirely of the noncommercial timber species. The validity of the assumption is questionable. There are some noncommercial and nonreserved acres in the ponderosa pine, lodgepole pine, spruce-fir, Douglas-fir, and deciduous cover types. As a result, the calculated fire potentials per million acres in these types are probably a little high whereas the calculated fire potentials for the other cover types are somewhat low. However, when normalized on a per million acre basis all deviations are probably small because the number of fires and acres burned are large relative to the number of million acres.

Hazard and risk both vary between cover types. Ponderosa pine had more lightning and man caused ignitions per million acres than any other type (Table 26). In the National Forests, 53.9 percent of all lightning fires and 28.2 percent of all man caused fires were in the ponderosa pine type. Over 68 percent of all ponderosa pine fires were started by lightning. Ponderosa pine was also the leader in the number of both lightning and man caused acres burned per million acres. Almost 73 percent of the acres burned in ponderosa pine resulted from man caused fires. Ponderosa pine also had the greatest number of class C and larger lightning and man caused fires per million acres (Table 27). Over 58 percent of the class C and larger fires were started by man. Man caused risk in the ponderosa pine was greater in the 5,501 to 6,500 foot elevation zone. Lightning was the greater source of fires at all elevations above 8,500 feet (Table 28).

In the lodgepole pine type may caused fires per million acres was greater than lightning. Over 68 percent of the lodgepole pine fires were man caused. Lodgepole pine had the third highest number of lightning ignitions and the second highest number of man caused ignitions per million acres (Table 26). Lodgepole pine also had the second highest man caused acres burned per million acres. Lodgepole pine had the third highest number of class C and larger fires per million acres (Table 27). Over 92 percent

Table 26

Fire Occurrence and Acres Burned per Million Acres by Forest Cover Type for All Colorado National Forests 1960-1973

Forest Cover Type[a]	Cause				Total	
	Lightning		Man			
	#/MM Ac.	Ac./MM Ac.	#/MM Ac.	#/MM Ac.	#/MM Ac.	#/MM Ac.
PP	1,358	1,410	632	3,742	1,990	5,152
LP	97	218	207	2,799	304	3,016
SF	67	378	115	726	182	1,104
DF	301	431	150	165	451	596
DEC	37	15	77	391	114	406
Other Cover Types	80	204	110	729	190	933
Total All Types	160	289	142	991	302	1,280

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce-fir, (DF) Douglas-fir, (DEC) deciduous (primarily aspen), (Other) subalpine group, pinyon-juniper, heavy brush, and grass-sagebrush.

Table 27

Number of Class C and Larger Fires per Million Acres by Cause and Forest Cover Type for All Colorado National Forests 1960-1973

Forest Cover Type[a]	Lightning	Man	Total
PP	13.5	18.7	32.2
LP	2.5	6.3	8.8
SF	1.2	5.2	6.4
DF	3.4	3.4	6.8
DEC	.5	6.9	7.4
Other Cover Types	2.0	10.8	12.8
Total All Types	2.4	7.6	10.0

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce-fir, (DF) Douglas-fir, (DEC) deciduous (primarily aspen), (Other) subalpine group, pinyon-juniper, heavy brush, and grass-sagebrush.

Table 28

Fire Occurrence by Elevation Zone, Size Class, Forest Cover Type and Cause
for All Colorado National Forests 1960-1973

Elevation Zone	Size[a] Class	Forest Cover Type[b] and Cause[c]																	
		PP		LP		SF		DF		AW		PJ		DEC		HB		GS	
		LC	MC	LC	MC	LC	MC	LC	MC	LC	MC	LC	MC	LC	MC	LC	MC	LC	MC
4,501-5,500	A	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...
Total		1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...
5,501-6,500	A	19	35	...	1	...	...	1	5	...	...	4	2	...	3	...	10	...	13
	B	12	10	...	...	...	...	...	1	...	...	1	...	...	1	1	1	2	7
	C	1	1	...	...	...	...	...	...	...	...	1	1	...	...	1	...	...	1
	D	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
Total		32	46	...	1	...	...	1	6	...	...	6	3	...	4	2	11	2	22
6,501-7,500	A	230	107	5	1	2	6	27	15	3	1	57	12	2	6	6	6	5	20
	B	87	40	1	4	...	...	4	4	...	1	10	1	...	...	4	6	2	20
	C	2	7	...	...	...	...	...	1	...	...	3	1	...	...	1	1	1	...
	D	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	...
	E	2	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...
	F	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total		321	155	6	5	2	6	31	20	3	2	71	15	2	6	11	14	8	40
7,501-8,500	A	585	218	17	29	22	18	73	30	32	16	30	6	23	21	9	5	24	68
	B	123	75	9	10	1	1	14	6	2	1	3	...	...	9	2	13	4	35
	C	5	6	...	...	...	1	1	2	...	...	...	...	...	...	...	3	...	10
	D	...	1	...	...	...	...	1	...	...	...	...	...	...	2	...	...	...	3
	E	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...
Total		713	300	26	39	23	20	89	38	34	17	33	7	23	32	11	21	28	116

Table 28-Continued

Elevation Zone	Size Class[a]	Forest Cover Type[b] and Cause[c]																	
		PP		LP		SF		DF		AW		PJ		DEC		HB		GS	
		LC	MC	LC	MC	LC	MC	LC	MC	LC	MC	LC	MC	LC	MC	LC	MC	LC	MC
Above 8,500	A	200	67	94	244	165	298	127	63	141	59	12	6	39	67	6	4	20	130
	B	39	39	25	31	25	36	16	5	13	9	2	2	4	26	1	2	5	56
	C	3	2	2	5	1	11	1	...	1	2	...	1	1	11	...	1	2	23
	D	...	...	2	2	1	3	...	...	...	1	...	1	...	...	...	...	...	...
	E	...	...	...	2	2	1	...	...	...	...	...	...	...	...	...	...	...	...
	F	...	...	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...
Total		242	108	123	285	193	350	144	68	155	71	14	10	44	104	7	7	27	211
Total All Elevations	A	1,035	427	116	275	189	322	228	113	176	76	104	26	64	97	21	25	49	231
	B	261	164	35	45	26	37	34	16	15	11	16	3	4	36	8	22	13	118
	C	11	16	2	5	1	12	2	3	1	2	4	3	1	11	2	5	3	34
	D	...	1	2	2	1	3	1	...	...	1	...	2	...	2	...	1	...	6
	E	2	...	...	2	2	1	...	...	...	...	1	1	...	...	...	...	...	...
	F	...	1	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...
Total		1,309	609	155	330	219	376	265	132	192	90	125	35	69	146	31	53	65	389

[a]Size classes are coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

[b]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce-fir, (DF) Douglas-fir, (AW) alpine fir/white pine/subalpine type, (PJ) pinyon/juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass/sage brush.

[c]Cause is coded as follows: (LC) lightning caused and (MC) man caused.

of the acres burned and over 71 percent of the class C and larger fires were man caused (Table 28). The cause of fires did not differ below 7,500 feet but man caused fires were 2.2 times greater at all elevations above 7,500 feet.

The 182 ignitions per million acres in the spruce-fir type was the second lowest ignition rate by cover type (Table 26). Man caused ignitions per million acres were 1.7 times greater than lightning. Fires in the spruce-fir type had the fewest class C and larger fires per million acres (Table 27). Man caused fires accounted for 81 percent of these class C and larger fires. There was little difference in the source of ignitions below 8,500 feet but there were 1.8 times more man caused fires above 8,500 feet (Table 28).

In the Douglas-fir type ignitions per million acres were high but the acres burned per million were low. Approximately 67 percent of the fires and 72 percent of the acres burned resulted from lightning. The Douglas-fir type had the second highest lightning and third highest man caused ignitions of all cover types (Table 26). Despite the high ignitions the type had the second lowest acres burned per million acres (Table 26) and the second lowest number of class C and larger fires per million acres (Table 27). Man caused ignitions were higher than lightning at elevations below 6,500 feet but lightning ignitions were higher above that elevation.

The deciduous cover type (primarily aspen) had the lowest number of ignitions and acres burned per million acres (Table 26). In the hazard analysis it was pointed out that the deciduous fuel complex was not very hazardous during the summer but could be very flammable in the spring and fall. The low hazard during the lightning season is reflected in the fire load. Approximately 68 percent of the fires and 96 percent of the acres burned in the deciduous type resulted from man caused ignition sources. Also 92.9 percent of the class C and larger fires were man caused (Table 27). Man caused fires are considerably greater than lightning fires at all elevations (Table 28).

The classification other cover types consists of the subalpine group, pinyon-juniper, heavy brush, and grass and sagebrush types. Hazard and risk are highly variable in this composit cover type. In the hazard analysis it was pointed out that the pinyon-juniper, heavy brush, and grass and sagebrush types present some serious spread problems whereas the subalpine group is probably the least hazardous fuel complex.

Lightning fires were more common than man caused at all elevations in the pinyon-juniper and subalpine group (Table 28). There was not a significant difference by cause in the number of class C and larger fires in either type but man caused fires burned more acres.

The source of ignitions in the heavy brush varied only slightly in the different elevation zones (Table 28) but man caused fires were approximately two times larger than lightning fires. Over 81 percent of the acres burned in the type resulted from man caused fires. In the heavy brush type there were 3.5 times more man caused class C and larger fires than lightning.

In the grass and sagebrush type there were more man caused fires per million acres at all elevations (Table 28). The average size for all man caused fires was 1.9 times larger than for lightning fires. Approximately 92.6 percent of all acres burned in the type resulted from man caused fires. There were 13.3 times more class C and larger man caused fires than lightning (Table 28). The high man caused load in the type is largely due to seasonal differences in hazard in the type. As pointed out in the hazard analysis section the flammability of this fuel complex is low during much of the lightning season. This fuel complex is also very sensitive to humidity increases and light precipitation which usually accompany lightning producing storms in Colorado.

Fire Potential

The available data indicate that the ignition potential is influenced by both the nature and frequency of the fire brands and the flammability of the fuel to specific types of fire brands. For example, the nature of a forest stand may make it either more or less ignitable to specific types of ignition sources.

The potential for fire spread also varies according to ignition sources. In every forest cover type in the National Forests of Colorado man caused fires exhibit a higher potential for reaching class C or larger size (Table 28). However, the potential for spreading to class C or larger size does not in itself present a full assessment of the potential for large fires. The total environment of the fuel complex including its size and topographic site must also be considered. The speed of detection and the speed and strength of initial attack affect a fire's potential for spread. Some cover types are less accessible than others so fires have the potential for spreading unsuppressed for some time. The size and location of the fuel complex are also related to the potential for burning large acreages in some cover types.

All of these factors indicate that an evaluation of fire potential should include ignition, spread, and magnitude components. Fire ignition, spread, and magnitude components per million acres show that there is wide variation in the hazard and risk potential by cover types (Table 29).

The conceptual model assigns equal weight to each of the components of fire ignition, spread, and magnitude. To

Table 29

Analysis of Forest Fire Potential Components in Colorado National Forests 1960-1973

Forest Cover Type	Fire Ignition[a]			Fire Spread[b]			Fire Magnitude[c]		
	LC[d]	MC[e]	Total	LC	MC	Total	LC	MC	Total
Ponderosa pine	97.00	45.14	142.14	.96	1.34	2.30	100.71	267.29	368.00
Lodgepole pine	6.93	14.79	21.72	.18	.45	.63	15.57	199.93	215.50
Spruce-fir	4.79	8.21	13.00	.09	.37	.46	27.00	51.86	78.86
Douglas-fir	21.50	10.71	32.21	.24	.24	.48	30.79	11.79	42.58
Deciduous	2.64	5.50	8.14	.04	.49	.53	1.07	27.93	29.00
Other cover types	5.71	7.86	13.57	.14	.77	.91	14.57	52.07	66.64
Average All Types	11.43	10.14	21.57	.17	.54	.71	20.64	70.79	91.43

[a]Average annual number of fires per million acres.

[b]Average annual number of fires spreading to Class C or larger size per million acres.

[c]Average annual acres burned per million acres.

[d]Lightning caused fires.

[e]Man caused fires.

provide a uniform basis for evaluating interrelated hazard and risk factors each of the fire ignition, spread, and magnitude components were normalized on a scale of 100 (Table 30). A maximum value of 100 was assigned to the peak ignition, spread, and magnitude. Total fire potential was also normalized on a maximum rating of 100, the average of the three fire potential components.

From the fire potential ratings (Table 30), an ordered ranking of fire potential may be assigned to each major forest cover type in the Colorado National Forests (Table 31).

The integrated analysis of hazard and risk indicates that the total fire potential was highest in the ponderosa pine type and lowest in the deciduous type (Table 30). Ponderosa pine had the highest man caused and lightning potentials for ignitions, spread, and magnitude. The lightning ignition potential was greater than man caused in both the ponderosa pine and Douglas-fir types whereas in the lodgepole pine, spruce-fir, and deciduous cover types, man caused ignition potential was higher. The man caused spread, magnitude, and total fire potentials were higher than lightning in all cover types.

The relationship of elevation to the zonation of vegetation and the structure of forest cover types was brought out in the hazard analysis section. It was pointed out that elevation affects the level of hazard of the fuel

Table 30

Fire Potential Ratings for Major Forest Cover Types in Colorado National Forests 1960-1973

Forest Cover Type	Fire Ignition			Fire Spread			Fire Magnitude			Total Fire Potential		
	LC[a]	MC[b]	Total	LC	MC	Total	LC	MC	Total	LC	MC	Total
Ponderosa Pine	68.24	31.76	100.00	41.74	58.26	100.00	27.37	72.63	100.00	45.78	54.22	100.00
Lodgepole Pine	4.88	10.41	15.29	7.83	19.56	27.39	4.23	54.33	58.56	5.65	28.10	33.75
Spruce-fir	3.67	5.78	9.75	3.91	16.09	20.00	7.34	14.09	21.43	4.97	11.99	16.96
Douglas-fir	15.13	7.53	22.66	10.43	10.43	20.86	8.37	3.20	11.57	11.31	7.05	18.36
Deciduous	1.86	3.87	5.73	1.74	21.30	23.04	.29	7.59	7.88	1.30	10.92	12.22
Other Cover Types	4.02	5.53	9.55	6.09	33.48	39.57	3.96	14.15	18.11	4.69	17.72	22.41
Average All Types	8.04	7.13	15.17	7.39	23.48	30.87	5.61	19.24	24.85	7.01	16.62	23.63

[a]Lightning caused fires.

[b]Man caused fires.

Table 31

Fire Potential Ranking by Forest Cover Type and

Cause for All Colorado National Forests

1960-1973

Forest Cover Type	Fire Potential Ranking[a]		
	Lightning Fires	Man Caused Fires	Total Fires
Ponderosa Pine	1	1	1
Lodgepole Pine	3	2	2
Other Cover Types	5	3	3
Douglas-fir	2	6	4
Spruce-fir	4	4	5
Deciduous	6	5	6

[a]1 equals the highest ranking

complex. In the risk analysis section it was brought out that there were definite patterns of risk associated with the various elevation zones. An integration of elevational hazard and risk factors provided valuable insight into fire potential by elevation zones. The three components of ignition, spread, and magnitude were analyzed in the same manner as were the forest cover types (Table 32). Following this approach a similar ranking of fire potential was assigned to each elevation zone (Table 33).

The integrated analysis of hazard and risk indicates that fire potential decreased rapidly with increasing

Table 32

Fire Potential Ratings for Elevation Zones in Colorado National Forests 1960-1973

Elevation Zone	Fire Ignition			Fire Spread			Fire Magnitude			Total Fire Potential		
	LC[a]	MC[b]	Total	LC	MC	Total	LC	MC	Total	LC	MC	Total
5,501-6,500	31.62	68.38	100.00	50.00	50.00	100.00	15.55	41.36	56.91	37.82	62.18	100.00
6,501-7,500	48.24	27.88	76.12	20.63	26.82	47.45	33.74	66.26	100.00	39.94	50.98	90.92
7,501-8,500	29.32	17.68	47.00	4.08	16.89	20.97	3.76	14.12	17.88	14.47	18.95	33.42
Above 8,500	5.58	7.16	12.74	1.82	7.97	9.79	2.15	9.95	12.10	3.72	9.76	13.48
Average All Elevations	11.35	10.08	21.43	3.26	10.52	13.78	6.80	23.33	30.13	8.33	17.10	25.43

[a]Lightning caused fires.

[b]Man caused fires.

Table 33

Fire Potential Ranking by Elevation Zone and Cause for All Colorado National Forests 1960-1973

Elevation Zone	Fire Potential Ranking[a]		
	Lightning Fires	Man Caused Fires	Total Fires
5,501-6,500	2	1	1
6,501-7,500	1	2	2
7,501-8,500	3	3	3
Above 8,500	4	4	4

[a]1 equals the highest ranking

elevation (Table 32). The total man caused fire potential was highest in the 5,501 to 6,500 foot elevation zone. The tota lightning fire potential was highest in the 6,501 to 7,500 foot elevation zone (Table 33). Also, the total man caused fire potential was greater than the total lightning fire potential was greater than the total lightning fire potential at all elevations (Table 32).

The total ignition potential decreased with increasing elevation. Lightning ignition potential exceeded man caused ignition potential in the 6,501 to 8,500 foot elevations while man caused ignition potential was greater in the 5,501 to 6,500 foot elevation zone and above 8,500 feet.

The total spread potential also decreased with increasing elevation. Both lightning and man caused spread potential was greater than lightning spread potential at all elevations.

The cover type and elevation rankings provide only an approximation of relative fire potential. However, they present a useful insight to the interrelationships of fire hazard and risk. In detailed fire management and land use planning specific features of fuels, weather, and topography need to be used in refinement of the fire potential ratings.

The forest cover types are broad descriptors of fuel complexes and have a wide range in fire potential. For example, the ponderosa pine type may be represented by as many as three NFDR fuel models depending upon the specific fuel complex involved. The data indicate that ponderosa pine has the highest relative fire potential. Despite this there are some ponderosa pine fuel complexes which have a lower actual potential than some specific fuel situations in cover types generally having less relative fire potential than ponderosa pine.

Although elevation appears to be the most important topographic feature in determining fire potential, slope and aspect should also be considered by the fire manager and land use planner. Neither slope nor aspect are good indicators of risk but both have a marked effect on hazard.

Fire weather and the season of the year should also be considered. In evaluating fire potential daily fluctuations in fire weather and risk are more important than long term seasonal trends. However, the daily fluctuations are much more difficult to anticipate in the planning phases of management. Seasonal fluctuations provide a better means for planning. Analysis of fire history gives insight into the seasonal trends in hazard and risk in the various forest environments.

CHAPTER IV. DISCUSSION

The conceptual model of forest fire potential provides a means for integrating hazard and risk factors from the individual fire reports. The model brings together important components of forest fire potential and presents them in a readily usable form. The model combines three aspects of the fire load for a protection unit, in this case the ten National Forests in Colorado. The expected number of fires, acres burned, and the number of class C and larger fires are essential to effective fire planning. Their utility lies in describing the relative ignition, magnitude and spread potentials for forest fires under a variety of conditions. The number of ignitions, acres burned, and number of class C and larger fires are equally important in the conceptual model of fire potential. The fire report form records an event. It is the nature of the event that hazard and risk must be simultaneously present and above some minimal level. The ignition potential tells how often these conditions were met but does not qualify the level of hazard. The magnitude and spread potentials help to qualify the level of hazard. The magnitude potential describes the relative liklihood for burning large acreages. Its drawback is that it is strongly influenced by the occasional large fire. For example, if the Red Dirt fire which burned in October, 1975, on the White River National Forest were included in the data base the grass and sagebrush cover type would have had the highest magnitude potential. This fire started in the grass and sagebrush cover type and spread to the spruce-fir cover type where the majority of acres were burned. The fire burned 4,535 acres, almost as many as have been burned in the ponderosa pine in fourteen years. The value of the spread potential is that it reduces the effect of the occasional big fire by giving equal weight to all class C and larger fires. In effect it smooths out the variation between the ignition potential, which is dominated by numerous small fires, and the magnitude potential, which is so strongly effected by the occasional big fire. Using the ignition, magnitude, and spread potentials minimizes the effect that any one factor has on the total fire potential. For example, the Red Dirt fire would have changed the magnitude potential but would have had virtually no effect on the ignition and spread potentials. As a result, it would not have had as great of an effect on the total fire potential of the cover types.

By separating the ignition, magnitude, and spread potentials into their respective lightning and man caused portions it is evident that despite there being more lightning fires, man caused fires have a greater potential to do damage. From this two things are apparent. First, increasing man caused risk in any area may result in a much greater volume of fire business. Second, increasing the effectiveness of man caused fire prevention programs could result in large reductions in acres burned.

By comparing the normalized ignition, magnitude, and spread potentials between cover types, it is possible to rank areas as to their relative fire potentials. Ranking areas is essential for the effective development of management priorities. The rankings also indicate areas which may require special attention before modifying land use strategies. For example, the ponderosa pine type had the highest overall fire potential based on analysis of the fire reports. Development of a fire management plan for a large area should focus special attention on the ponderosa pine lands. However, the ponderosa pine cover type includes several fuel complexes of varying fire potential. Development of fire management plans on a smaller scale should direct attention to the specific ponderosa pine fuel complex involved. Evaluations on this scale need to be closely tied to what is actually on the ground. Special attention should also be given to the pinyon-juniper, heavy brush, and grass and sagebrush cover types as they are also problematic fuel complexes.

Using the conceptual model of fire potential for analyzing the distribution of fires by elevation zones clearly indicates that fire potential decreases with increasing elevation. The majority of land which is available for private development is in the lower elevation forests. These lands are characterized by high lightning and man caused ignition, magnitude, and spread potentials. Planned development of these areas should pay particular attention to the effect of increasing man caused risk on the overall forest fire potential. Careful attention should also be given to fuel problems around developments. Increasing the volume of fire business around these high value lands clearly raises the potential for unacceptable losses.

The major problem with the conceptual model is its reliance on data which is not always readily available. Meaningful comparisons of hazard and risk factors can only be made when the variables are normalized on an area basis. Acreage figures are not always available. For example, data was not available on the true acreage in each cover type. As a result, acreages in the cover types were normalized on a per million acre basis by using commercial timber acreages. The assumption was made that when ignition, magnitude, and spread potentials were normalized on a per million acre basis the deviations would be small. It is unfortunate that acreages are not available for the noncommercial species. Although the pinyon-juniper, heavy brush, and grass and sagebrush types had fewer fires than the ponderosa pine, they all exhibit a high potential for magnitude and spread. One or more of these types may actually have a higher total fire potential than the ponderosa pine. Acreage figures were also not available for lands at different aspects and in different slope classes. As a result, the conceptual model could not be used to evaluate fire potentials by these factors. These factors are important components of the overall fire potential of an area and need to be evaluated in fire planning. Another problem with the conceptual model is the need for large amounts of data. Applying the model to data from a single management unit could easily result in having too few fires for meaningful comparisons.

The individual fire reports provide valuable data on hazard and risk. The fire reports are the most readily available source of this information. However, there are problems with the data. The most limiting feature is the lack of continuity over long periods. Many of the variables on the forms changed during the fourteen year period. The most notable continuity problem encountered in this study was the use of six different and incompatable systems for recording the fire danger rating. Because the systems did not give comparable ratings of fire danger it was not possible to analyze the fire danger rating at the time of origin. As a result, it was necessary to rely solely on the acres burned and the number of class C and larger fires to evaluate long term levels of hazard by the different variables. It was not possible to compare the level of fire danger between lightning and man caused fires but the greater number of class C and larger fires and the larger acreage burned indicate a difference in wildfire potential. It appears that fuels are generally less hazardous during periods of lightning occurrence. Between summer storms fuels become more flammable. During these periods man caused ignitions are more likely to result in damaging fires.

The broad fuel descriptions on the fire report forms are also a problem. As has been pointed out, a single forest cover type may include as many three different NFDR fuel models. Also the rate of spread fuel types presently used on the reports are subjectively evaluated based on tables rather than maps as was done prior to the National Fire Planning. Pending establishment of the National Fuels Classification System, fuel information could be enhanced by placing the appropriate NFDR fuel model in the fuel type column. This would allow comparison of the manning class, a measure of fire danger rating based on the NFDR burning index, forest cover type, and the NFDR fuel model. The result would be a more complete picture of fuel hazard in relation to fire performance. It would also be useful to record the NFDR lightning and man caused risk levels, and the six NFDR indicies. This would permit evaluation of these parameters effectiveness in predicting the fire load on a protection unit.

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APPENDICES

APPENDIX TABLE OF CONTENTS

Appendix A

Arapaho National Forest

Fire Occurrence Tables

Table A.1.

Fire Occurrence per Million Acres, Acres Burned per Million Acres and Average Size per Fire by Cause 1960-1973

Cause[a]	#	%	#/ MM Ac.	# Ac. Burned	% of Total	Acres Burned/ MM Ac.	Acres/ Fire
LC	57	21.8	52	595	29.8	546	10.4
MC	204	78.2	187	1,404	70.2	1,288	6.9
Total	261		239	1,999		1,834	7.7

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table A.2.

Fire Occurrence by Size Class and Cause

1960-1973

Cause[a]	# & %	Size Class[b]						Total
		A	B	C	D	E	F	
LC	#	47	9	...	...	1	...	57
	%	82.5	15.8	...	...	1.8	...	21.8
MC	#	167	30	5	1	...	1	204
	%	81.9	14.7	2.5	.5	...	.5	78.2
Total	#	214	39	5	1	1	1	261
	%	82.0	14.9	1.9	.4	.4	.4	

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

[b]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

Table A.3.

Fire Occurrence in Special Interest Areas[a] 1960-1973

Area	Cause[b]	#	% per Area	% of Total	#MM Ac.
Gore-Eagles Nest	LC	1	14.3		
	MC	6	85.7		
	Total	7		2.7	193.4
Dillon-Breckenridge	LC	10	10.1		
	MC	89	89.9		
	Total	99		37.9	758.3
Winter Park	LC	2	33.3		
	MC	4	66.7		
	Total	6		2.3	260.4
Idaho Springs	LC	11	34.4		
	MC	21	65.6		
	Total	32		12.3	537.6
Other Forest Lands	LC	33	28.2		
	MC	84	71.8		
	Total	117		44.8	145.4
Total All Lands	LC	57	21.8		
	MC	204	78.2		
	Total	261		100.0	239.4

[a]Area calculations are based on the gross area within National Forest boundaries.

[b]Fire causes are coded as follows: (LC) lightning caused and (MC) man caused.

Table A.4.
Fire Occurrence, Acres Burned and Average
Size per Fire by Month
1960-1973

Month	#	%	# of Acres	% of Total	Acres/ Fire
March	2	.8	0	.0	.0
April	2	.8	0	.0	.0
May	15	5.7	26	1.3	1.7
June	42	16.1	607	30.4	14.4
July	76	29.1	24	1.2	.3
August	54	20.7	71	3.6	1.3
September	35	13.4	1,014	50.7	29.0
October	29	11.1	222	11.1	7.7
December	6	2.3	35	1.8	5.8
Total	261		1,999		

Table A.5.

Fire Occurrence, Acres Burned and Average Size per Fire by Forest Cover Type 1960-1973

Forest Cover[a] Type	#	%	# of Acres	% of Total	Acres/ Fire
PP	3	1.1	12	.6	4.0
LP	130	49.8	53	2.7	.4
SF	63	24.1	1,609	80.5	25.5
DF	5	1.9	5	.3	1.0
AW	11	4.2	0	.0	1.5
PJ	1	.4	0	.0	.0
DEC	11	4.2	17	.9	1.5
HB	1	.4	0	.0	.0
GS	36	13.8	303	15.2	8.4
Total	261		1,999		

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce/fir, (DF) Douglas-fir, (AW) alpine fir/white pine/subalpine type, (PJ) pinyon/juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass/sage brush.

Table A.6.

Fire Occurrence by Elevation Zones

1960-1973

Elevation	Cause[a]	#	%	% of Total
7,501-8,500	LC	5	38.5	
	MC	8	61.5	
	Total	13		5.0
Above 8,500	LC	52	21.0	
	MC	196	79.0	
	Total	248		95.0
Total All Elevations	LC	57	21.8	
	MC	204	78.2	
	Total	261		

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table A.7.

Fire Occurrence, Acres Burned and Average Size per Fire by Elevation Zones 1960-1973

Elevation Zone	#	%	# of Acres	% of Total	Acres/ Fire
7,501-8,500	13	5.0	181	9.1	13.9
Above 8,500	248	95.0	1,818	90.9	7.3
Total	261		1,999		

Table A.8.
Fire Occurrence, Acres Burned and Average Size per Fire by Aspect 1960-1973

Aspect	#	%	# of Acres	% of Total	Acres/ Fire
North	26	10.2	14	.7	.5
North East	17	6.7	12	.6	.7
East	38	14.9	1,016	51.1	26.7
South East	21	8.2	589	29.6	28.0
South	64	25.1	285	14.3	4.5
South West	21	8.2	7	.4	.3
West	25	9.8	10	.5	.4
North West	10	3.9	1	.1	.1
Ridgetop	5	2.0	5	.3	1.0
Flat	28	11.0	48	2.4	1.7
Total	255		1,987		7.8

Table A.9.

Fire Occurrence, Acres Burned and Average Size per Fire by Percent Slope 1960-1973

Percent Slope	#	%	# of Acres	% of Total	Acres/ Fire
0-9	75	32.8	61	6.2	.8
10-19	43	18.8	15	1.5	.3
20-29	40	17.5	233	23.8	5.8
30-39	24	10.5	599	61.1	25.0
40-49	16	7.0	54	9.2	3.4
50-59	14	6.1	10	1.0	.7
60-69	8	3.5	4	.4	.5
70-79	5	2.2	5	.5	1.0
80-100	2	.9	0	.0	.0
Over 100	2	.9	0	.0	.0
Total	229		981		

Appendix B

Grand Mesa-Uncompahgre National

Forest Fire Occurrence

Table B.1.

Fire Occurrence per Million Acres, Acres Burned per Million Acres and Average Size per Fire by Cause 1960-1973

Cause[a]	#	%	#/ MM Ac.	# Ac. Burned	% of Total	Acres Burned/ MM Ac.	Acres/ Fire
LC	201	67.0	144	570	50.1	408	2.8
MC	99	33.0	71	567	49.9	406	5.7
Total	300		215	1,137		814	3.8

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table B.2.

Fire Occurrence by Size Class and Cause

1960-1973

Cause[a]	# & %	Size Class[b]						Total
		A	B	C	D	E	F	
LC	#	155	39	6	...	1	...	201
	%	77.1	19.4	3	...	.5	...	67.0
MC	#	82	13	2	2	...	...	99
	%	82.8	13.1	2	2	...	...	33.0
Total	#	237	52	8	2	1	...	300
	%	79.0	17.3	2.7	.7	.3	...	

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

[b]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

Table B.3.

Fire Occurrence, Acres Burned and Average Size per Fire by Month

1960-1973

Month	#	%	# of Acres	% of Total	Acres/ Fire
April	1	.3	80	7.0	80.0
May	13	4.3	149	13.1	11.5
June	55	18.3	38	3.3	.7
July	95	31.7	347	30.5	3.7
August	70	23.3	446	39.2	6.4
September	36	12.0	24	2.1	.7
October	29	9.7	53	4.7	1.8
December	1	.3	0	.0	.0
Total	300		1,137		

Table B.4.
Fire Occurrence, Acres Burned and Average Size per Fire by Forest Cover Type
1960-1973

Forest Cover[a] Type	#	%	# of Acres	% of Total	Acres/ Fire
PP	140	46.7	388	34.1	2.8
LP	2	.7	1	.1	.5
SF	65	21.7	9	.8	.1
DF	5	1.7	6	.5	1.2
AW	10	3.7	65	5.7	6.5
PJ	49	16.3	509	44.8	10.4
DEC	16	5.3	146	12.8	9.1
HB	3	1.0	0	.0	.0
GS	10	3.3	13	1.1	1.3
Total	300		1,137		

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce/fir, (DF) Douglas-fir, (AW) alpine fir/white pine/subalpine type, (PJ) pinyon/juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass/sage brush.

Table B.5.
Fire Occurrence by Elevation Zones
1960-1973

Elevation	Cause[a]	#	%	% of Total
4,501-5,500	LC	1	100.0	
	MC	...	...	
	Total	1		.3
5,501-6,500	LC	3	60.0	
	MC	2	40.0	
	Total	5		1.7
6,501-7,500	LC	45	88.2	
	MC	6	11.8	
	Total	51		17.0
7,501-8,500	LC	108	79.4	
	MC	28	20.6	
	Total	136		45.3
Above 8,500	LC	44	41.1	
	MC	63	58.9	
	Total	107		35.7
Total All Elevations	LC	201	67.0	
	MC	99	33.0	
	Total	300		

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table B.6.
Fire Occurrence, Acres Burned and Average
Size per Fire by Elevation Zones
1960-1973

Elevation Zone	#	%	# of Acres	% of Total	Acres/ Fire
4,501-5,500	1	.3	0	0	.0
5,501-6,500	5	1.7	135	11.9	27.0
6,501-7,500	51	17.0	686	60.3	13.5
7,501-8,500	136	45.3	218	19.2	1.6
Above 8,500	107	35.7	98	8.6	.9
Total	300		1,137		

Table B.7.
Fire Occurrence, Acres Burned and Average Size per Fire by Aspect 1960-1973

Aspect	#	%	# of Acres	% of Total	Acres/ Fire
North	20	7.0	38	3.4	1.9
North East	32	11.2	24	2.1	.8
East	24	8.4	76	6.7	3.2
South East	22	7.7	3	.3	.1
South	48	16.8	162	14.3	3.4
South West	32	11.2	665	58.7	20.8
West	42	14.7	149	13.1	3.5
North West	19	6.6	12	1.1	.6
Ridgetop	4	1.4	0	0.0	0.0
Flat	43	15.0	4	.4	.1
Total	286		1,133		4.0

Table B.8.

Fire Occurrence, Acres Burned and Average Size per Fire by Percent Slope 1960-1973

Percent Slope	#	%	# of Acres	% of Total	Acres/ Fire
0-9	92	43.6	396	38.6	4.3
10-19	59	28.0	327	31.8	5.5
20-29	30	14.2	84	8.2	2.8
30-39	11	5.2	166	16.2	15.1
40-49	7	3.3	7	.7	1.0
50-59	3	1.4	0	.0	.0
60-69	7	3.3	11	1.1	1.6
70-79	1	.5	31	3.0	31.0
80-100	1	.5	5	.5	5.0
Over 100	...	...	...	...	...
Total	211		1,027		

Appendix C

Gunnison National Forest

Fire Occurrence Tables

Table C.1.

Fire Occurrence per Million Acres, Acres Burned per Million Acres and Average Size per Fire by Cause 1960-1973

Cause[a]	#	%	#/ MM Ac.	# Ac. Burned	% of Total	Acres Burned/ MM Ac.	Acres/ Fire
LC	75	52.8	42	411	39.5	232	5.5
MC	67	47.2	38	629	60.5	356	9.4
Total	142		80	1,040		588	7.3

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table C.2.

Fire Occurrence by Size Class and Cause

1960-1973

Cause[a]	# & %	Size Class[b]						Total
		A	B	C	D	E	F	
LC	#	52	17	5	1	...	...	75
	%	69.3	22.7	6.7	1.3	...	...	52.8
MC	#	41	16	8	2	...	...	67
	%	61.2	23.9	11.9	3.0	...	...	47.2
Total	#	93	33	13	3	...	...	142
	%	65.5	23.2	9.2	2.1	...	...	

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

[b]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

Table C.3.
Fire Occurrence, Acres Burned and Average
Size per Fire by Month
1960-1973

Month	#	%	# of Acres	% of Total	Acres/ Fire
February	1	.7	0	.0	.0
April	1	.7	0	.0	.0
May	6	4.2	116	11.2	19.3
June	23	16.2	2	.2	.1
July	34	23.9	37	3.6	1.1
August	38	26.8	622	59.8	16.4
September	8	5.6	6	.6	.8
October	24	16.9	250	24.0	10.4
November	3	2.1	1	.1	.3
December	4	2.8	6	.6	1.5
Total	142		1,040		

Table C.4.

Fire Occurrence, Acres Burned and Average Size per Fire by Forest Cover Type 1960-1973

Forest Cover[a] Type	#	%	# of Acres	% of Total	Acres/ Fire
PP	12	8.5	7	.7	.6
LP	29	20.4	55	5.3	1.9
SF	37	26.1	338	32.5	9.1
DF	20	14.1	63	6.1	3.2
AW	3	2.1	0	.0	.0
PJ	3	2.1	0	.0	.0
DEC	16	11.3	34	3.3	2.1
HB	1	.7	26	2.5	26.0
GS	21	14.8	517	49.7	24.6
Total	142		1,040		

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce/fir, (DF) Douglas-fir, (AW) alpine fir/white pine/subalpine type, (PJ) pinyon/juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass/sage brush.

Table C.5.
Fire Occurrence by Elevation Zones
1960-1973

Elevation	Cause[a]	#	%	% of Total
5,501-6,500	LC	1	100.0	
	MC	...	...	
	Total	1		.7
6,501-7,500	LC	1	20.0	
	MC	4	80.0	
	Total	5		3.5
7,501-8,500	LC	10	52.6	
	MC	9	47.4	
	Total	19		13.4
Above 8,500	LC	63	53.8	
	MC	54	46.2	
	Total	117		82.4
Total All Elevations	LC	75	52.8	
	MC	67	47.2	
	Total	142		

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table C.6.
Fire Occurrence, Acres Burned and Average
Size per Fire by Elevation Zones
1960-1973

Elevation Zone	#	%	# of Acres	% of Total	Acres/ Fire
5,501-6,500	1	.7	0	.0	.0
6,501-7,500	5	3.5	5	.5	1.0
7,501-8,500	19	13.4	341	32.8	17.9
Above 8,500	117	82.4	694	66.7	5.9
Total	142		1,040		

Table C.7.

Fire Occurrence, Acres Burned and Average Size per Fire by Aspect 1960-1973

Aspect	#	%	# of Acres	% of Total	Acres/ Fire
North	11	8.1	108	10.4	9.8
North East	7	5.1	1	.1	.1
East	18	13.2	59	5.7	3.3
South East	22	16.2	171	16.5	7.8
South	14	10.3	223	21.5	15.9
South West	20	14.7	141	13.6	7.1
West	16	11.8	66	6.4	4.1
North West	14	10.3	270	26.0	19.3
Ridgetop	6	4.4	0	0.0	0.0
Flat	8	5.9	0	0.0	0.0
Total	136		1,039		7.6

Table C.8.
Fire Occurrence, Acres Burned and Average
Size per Fire by Percent Slope
1960-1973

Percent Slope	#	%	# of Acres	% of Total	Acres/ Fire
0-9	29	24.8	38	3.7	1.3
10-19	16	13.7	477	46.1	29.8
20-29	22	18.8	136	13.2	6.2
30-39	25	21.4	17	1.6	.7
40-49	10	8.5	110	10.6	11.0
50-59	8	6.8	207	20.0	25.9
60-69	5	4.3	41	4.0	8.2
70-79	1	.9	8	.8	8.0
80-100	1	.9	0	.0	.0
Over 100	...	...	...	...	...
Total	117		1,034		

Appendix D

Pike National Forest Fire

Occurrence Tables

Table D.1.

Fire Occurrence per Million Acres, Acres Burned per Million Acres and Average Size per Fire by Cause 1960-1973

Cause[a]	#	%	#/ MM Ac.	# Ac. Burned	% of Total	Acres Burned/ MM Ac.	Acres/ Fire
LC	529	51.4	412	555	12.7	432	1.0
MC	501	48.6	390	3,805	87.3	2,965	7.6
Total	1,030		802	4,360		3,397	4.2

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table D.2.

Fire Occurrence by Size Class and Cause

1960-1973

Cause[a]	# & %	Size Class[b]						Total
		A	B	C	D	E	F	
LC	#	396	130	2	...	1	...	529
	%	74.9	24.6	.4	...	.2	...	51.4
MC	#	364	112	21	3	...	1	501
	%	72.7	22.4	4.2	.6	...	.2	48.6
Total	#	760	242	23	3	1	1	1,030
	%	73.8	23.5	2.2	.3	.1	.1	

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

[b]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

Table D.3.

Fire Occurrence in Special Interest Areas

1960-1973

Area[a]	Cause[b]	#	% per Area	% of Total	# Fires/ MM Ac.
Pikes Peak	LC	61	38.1		
	MC	99	61.9		
	Total	160		15.5	737
Lake George	LC	92	59.0		
	MC	64	41.0		
	Total	156		15.1	995
South Platt	LC	291	55.3		
	MC	235	44.7		
	Total			51.1	1,607
Other Forest Lands	LC	85	45.2		
	MC	103	54.8		
	Total	188		18.3	323
Total All Lands	LC	529	51.4		
	MC	501	48.6		
	Total	1,030		100.0	802

[a]Area calculations are based on the gross area within the National Forest.

[b]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table D.4.
Fire Occurrence, Acres Burned and Average
Size per Fire by Month
1960-1973

Month	#	%	# of Acres	% of Total	Acres/ Fire
January	4	.4	1	.0	.3
February	4	.4	6	.1	1.5
March	24	2.3	126	2.9	5.3
April	47	4.6	382	8.8	8.1
May	101	9.8	263	6.0	2.6
June	253	24.6	3,011	69.1	11.9
July	269	26.1	481	11.0	1.8
August	161	15.6	32	.7	.2
September	78	7.6	15	.3	.2
October	64	6.2	30	.7	.5
November	11	1.1	3	.1	.3
December	14	1.4	10	.2	.7
Total	1,030		4,360		

Table D.5.

Fire Occurrence, Acres Burned and Average Size per Fire by Forest Cover Type 1960-1973

Forest Cover[a] Type	#	%	# of Acres	% of Total	Acres/ Fire
PP	641	62.2	3,699	84.8	5.8
LP	37	3.6	7	.2	.2
SF	56	5.4	13	.3	.2
DF	151	14.7	150	3.4	1.0
AW	31	3.0	123	2.8	4.0
PJ	1	.1	0	.0	.0
DEC	17	1.7	60	1.4	3.5
HB	15	1.5	148	3.4	9.9
GS	81	7.9	160	3.7	2.0
Total	1,030		4,360		

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce/fir, (DF) Douglas-fir, (AW) alpine fir/white pine/subalpine type, (PJ) pinyon/juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass/sage brush.

Table D.6.

Fire Occurrence by Elevation Zones

1960-1973

Elevation	Cause[a]	#	%	% of Total
5,501-6,500	LC	9	15.5	
	MC	49	84.5	
	Total	58		5.6
6,501-7,500	LC	146	60.3	
	MC	96	39.7	
	Total	242		23.5
7,501-8,500	LC	211	54.7	
	MC	175	45.3	
	Total	386		37.5
Above 8,500	LC	163	47.4	
	MC	181	52.6	
	Total	344		33.4
Total All Elevations	LC	529	51.4	
	MC	501	48.6	
	Total	1,030		

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table D.7.

Fire Occurrence, Acres Burned and Average Size per Fire by Elevation Zones

1960-1973

Elevation Zone	#	%	# of Acres	% of Total	Acres/ Fire
5,501-6,500	58	5.6	64	1.5	1.1
6,501-7,500	242	23.5	3,202	73.4	13.2
7,501-8,500	386	37.5	690	15.8	1.8
Above 8,500	344	23.4	404	9.3	1.2
Total	1,030		4,360		

Table D.8.
Fire Occurrence, Acres Burned and Average Size per Fire by Aspect 1960-1973

Aspect	#	%	# of Acres	% of Total	Acres/ Fire
North	48	4.8	6	.1	.1
North East	118	11.8	132	3.0	1.1
East	139	14.0	87	2.0	.6
South East	131	13.2	671	15.4	5.1
South	166	16.7	2,635	60.5	15.9
South West	95	9.5	364	8.4	3.8
West	127	12.8	136	3.1	1.1
North West	72	7.2	290	6.7	4.0
Ridgetop	52	5.2	15	.3	.3
Flat	48	4.8	19	.4	.4
Total	996		4,355		4.4

Table D.9.

Fire Occurrence, Acres Burned and Average Size per Fire by Percent Slope

1960-1973

Percent Slope	#	%	# of Acres	% of Total	Acres/ Fire
0-9	235	27.2	477	11.1	2.0
10-19	231	26.7	409	9.6	1.8
20-29	146	16.9	2,652	61.9	18.2
30-39	103	11.9	119	2.8	1.2
40-49	78	9.0	501	11.7	6.4
50-59	22	2.5	29	.7	1.3
60-69	29	3.4	33	.8	1.1
70-79	9	1.0	56	1.3	6.2
80-100	9	1.0	5	.1	.6
Over 100	2	.2	0	.0	.0
Total	864		4,281		

Appendix E

Rio Grande National Forest

Fire Occurrence Tables

Table E.1.

Fire Occurrence per Million Acres, Acres Burned per Million Acres and Average Size per Fire by Cause 1960-1973

Cause[a]	#	%	#/ MM Ac.	# Ac. Burned	% of Total	Acres Burned/ MM Ac.	Acres/ Fire
LC	117	48.3	60	11	1.1	6	.1
MC	125	51.7	64	996	98.9	508	8.0
Total	242		124	1,007		514	4.2

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table E.2.

Fire Occurrence by Size Class and Cause

1960-1973

Cause[a]	# & %	Size Class[b]						Total
		A	B	C	D	E	F	
LC	#	108	9	...	...	...	...	117
	%	92.3	7.7	...	...	...	...	48.3
MC	#	78	36	9	1	1	...	125
	%	62.4	28.8	7.2	.8	.8	...	51.7
Total	#	186	45	9	1	1	...	242
	%	76.9	18.6	3.7	.4	.4	...	

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

[b]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

Table E.3.
Fire Occurrence, Acres Burned and Average
Size per Fire by Month
1960-1973

Month	#	%	# of Acres	% of Total	Acres/ Fire
January	1	.4	1	.1	1.0
February	1	.4	9	.9	9.0
March	3	1.2	191	19.0	63.7
April	10	4.1	77	7.6	7.7
May	23	9.5	172	17.1	7.5
June	45	18.6	16	1.6	.4
July	68	28.1	387	38.4	5.7
August	28	11.6	1	.1	.0
September	13	5.4	1	.1	.1
October	34	14.0	26	2.6	.8
November	3	1.2	0	.0	.0
December	13	5.4	126	12.5	9.7
Total	242		1,007		

Table E.4.

Fire Occurrence, Acres Burned and Average Size per Fire by Forest Cover Type 1960-1973

Forest Cover[a] Type	#	%	# of Acres	% of Total	Acres/ Fire
PP	37	15.3	17	1.7	.5
LP	10	4.1	79	7.8	7.9
SF	55	22.7	380	37.7	6.9
DF	41	16.9	2	.2	.0
AW	21	8.7	6	.6	.3
PJ	11	4.5	179	17.8	16.3
DEC	24	9.9	58	5.8	2.4
HB	...	...	...	...	...
GS	43	17.8	286	28.4	6.7
Total	242		1,007		

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce/fir, (DF) Douglas-fir, (AW) alpine fir/white pine/subalpine type, (PJ) pinyon/juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass/sage brush.

Table E.5.
Fire Occurrence by Elevation Zones
1960-1973

Elevation	Cause[a]	#	%	% of Total
7,501-8,500	LC	17	58.6	
	MC	12	41.4	
	Total	29		12.0
Above 8,500	LC	100	46.9	
	MC	113	53.1	
	Total	213		88.0
Total All Elevations	LC	117	48.3	
	MC	125	51.7	
	Total	242		

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table E.6.
Fire Occurrence, Acres Burned and Average
Size per Fire by Elevation Zones
1960-1973

Elevation Zone	#	%	# of Acres	% of Total	Acres/ Fire
7,501-8,500	29	12.0	80	7.9	2.8
Above 8,500	213	88.0	927	92.1	4.4
Total	242		1,007		

Table E.7.
Fire Occurrence, Acres Burned and Average Size per Fire by Aspect 1960-1973

Aspect	#	%	# of Acres	% of Total	Acres/ Fire
North	21	9.2	98	9.8	4.7
North East	27	11.8	11	1.1	.4
East	19	8.3	79	7.9	4.2
South East	25	11.0	226	22.5	9.0
South	39	17.1	34	3.4	.9
South West	32	14.0	138	13.7	4.3
West	26	11.4	29	2.9	1.1
North West	18	7.9	384	38.2	21.3
Ridgetop	8	3.5	2	.2	.3
Flat	13	5.7	3	.3	.2
Total	228		1,004		4.4

Table E.8.

Fire Occurrence, Acres Burned and Average Size per Fire by Percent Slope 1960-1973

Percent Slope	#	%	# of Acres	% of Total	Acres/ Fire
0-9	46	21.9	81	8.1	1.8
10-19	46	21.9	94	9.4	2.0
20-29	31	14.8	241	24.1	7.8
30-39	25	11.9	21	2.1	.8
40-49	20	9.5	423	42.3	21.2
50-59	11	5.2	2	.2	.2
60-69	11	5.2	117	11.7	10.6
70-79	11	5.2	0	.0	.0
80-100	8	3.8	10	1.0	1.3
Over 100	1	.5	12	1.2	12.0
Total	210		1,001		

Appendix F

Roosevelt National Forest

Fire Occurrence Tables

Table F.1.

Fire Occurrence per Million Acres, Acres Burned per Million Acres and Average Size per Fire by Cause 1960-1973

Cause[a]	#	%	#/ MM Ac.	# Ac. Burned	% of Total	Acres Burned/ MM Ac.	Acres/ Fire
LC	230	48.7	212	386	7.7	357	1.7
MC	242	51.3	224	4,601	92.3	4,251	19.0
Total	472		436	4,987		4,608	10.6

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table F.2.

Fire Occurrence by Size Class and Cause

1960-1973

Cause[a]	# & %	Size Class[b]						Total
		A	B	C	D	E	F	
LC	#	159	66	4	1	...	...	230
	%	69.1	28.7	1.7	.4	...	...	48.7
MC	#	173	57	6	3	2	1	242
	%	71.5	23.6	2.5	1.2	.8	.4	51.3
Total	#	332	123	10	4	1	1	472
	%	70.3	26.1	2.1	.8	.4	.2	

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

[b]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

Table F.3.

Fire Occurrence in Special Interest Areas

1960-1973

Area[a]	Cause[b]	#	% per Area	% of Total	# Fires/ MM Ac.
Redfeather-Rustic	LC	58	63.0		
	MC	34	37.0		
	Total	92		19.5	451
Big Thompson	LC	31	56.4		
	MC	24	43.6		
	Total	55		11.7	624
Allenspark-Lyons	LC	26	59.1		
	MC	18	40.9		
	Total	44		9.3	520
Boulder-Ward-Nederland	LC	33	24.6		
	MC	101	75.4		
	Total	134		28.4	779
Other Forest Lands	LC	82	55.8		
	MC	65	44.2		
	Total	147		31.1	276
Total All Lands	LC	230	48.7		
	MC	242	51.3		
	Total	472		100.0	436

[a]Area calculations are based on the gross area within the National Forest.

[b]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table F.4.
Fire Occurrence, Acres Burned and Average
Size per Fire by Month
1960-1973

Month	#	%	# of Acres	% of Total	Acres/ Fire
January	2	.4	3	.1	1.5
February	5	1.1	6	.1	1.2
March	6	1.3	30	.6	5.0
April	6	1.3	9	.2	1.5
May	21	4.4	9	.2	.4
June	70	14.8	259	5.2	3.7
July	153	32.4	3,005	60.3	19.6
August	93	19.7	664	13.3	7.1
September	65	13.8	183	3.7	2.8
October	39	8.3	816	16.4	20.9
November	3	.6	2	.0	.7
December	9	1.9	1	.0	.1
Total	472		4,987		

Table F.5.

Fire Occurrence, Acres Burned and Average Size per Fire by Forest Cover Type

1960-1973

Forest Cover[a] Type	#	%	# of Acres	% of Total	Acres/ Fire
PP	232	49.4	316	6.3	1.4
LP	103	21.9	4,033	80.9	39.2
SF	37	7.9	233	4.7	6.3
DF	32	6.8	11	.2	.3
AW	15	3.2	1	.0	.1
PJ	...	...	...	...	...
DEC	3	.6	107	2.1	35.7
HB	1	.2	0	.0	.0
GS	47	10.0	286	5.7	6.1
Total	470		4,987		

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce/fir, (DF) Douglas-fir, (AW) alpine fir/white pine/subalpine type, (PJ) pinyon/juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass/sage brush.

Table F.6.
Fire Occurrence by Elevation Zones
1960-1973

Elevation	Cause[a]	#	%	% of Total
4,501-5,500	LC	1	100.0	
	MC	...	...	
	Total	1		.2
5,501-6,500	LC	21	46.7	
	MC	24	53.3	
	Total	45		9.5
6,501-7,500	LC	54	51.4	
	MC	51	48.6	
	Total	105		22.2
7,501-8,500	LC	90	58.1	
	MC	65	41.9	
	Total	155		32.8
Above 8,500	LC	64	38.6	
	MC	102	61.4	
	Total	166		35.2
Total All Elevations	LC	230	48.7	
	MC	242	51.3	
	Total	472		

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table F.7.

Fire Occurrence, Acres Burned and Average Size per Fire by Elevation Zones 1960-1973

Elevation Zone	#	%	# of Acres	% of Total	Acres/ Fire
4,501-5,500	1	.2	0	.0	.0
5,501-6,500	45	9.5	202	4.1	4.5
6,501-7,500	105	22.2	224	4.5	2.1
7,501-8,500	155	32.8	283	5.7	1.8
Above 8,500	166	35.2	4,278	85.8	25.8
Total	472		4,987		

Table F.8.

Fire Occurrence, Acres Burned and Average Size per Fire by Aspect 1960-1973

Aspect	#	%	# of Acres	% of Total	Acres/ Fire
North	33	7.3	12	.2	.4
North East	54	11.9	46	.9	.9
East	73	16.2	1,383	27.8	18.9
South East	70	15.5	170	3.4	2.4
South	79	17.5	351	7.0	4.4
South West	45	10.0	96	1.9	2.1
West	27	6.0	2,853	57.3	105.7
North West	21	4.6	7	.1	.3
Ridgetop	16	3.5	10	.2	.6
Flat	34	7.5	51	1.0	1.5
Total	452		4,979		11.0

Table F.9.

Fire Occurrence, Acres Burned and Average Size per Fire by Percent Slope

1960-1973

Percent Slope	#	%	# of Acres	% of Total	Acres/ Fire
0-9	102	24.6	3,457	69.7	33.9
10-19	86	20.7	142	2.9	1.7
20-29	58	14.0	951	19.2	16.4
30-39	60	14.5	46	.9	.8
40-49	51	12.3	110	2.2	2.2
50-59	16	3.9	22	.4	1.4
60-69	21	5.1	59	1.2	2.8
70-79	7	1.7	8	.2	1.1
80-100	10	2.4	161	3.2	16.1
Over 100	4	1.0	1	.0	.3
Total	415		4,957		

Appendix G

Routt National Forest Fire

Occurrence Tables

Table G.1.

Fire Occurrence per Million Acres, Acres Burned per Million Acres and Average Size per Fire by Cause 1960-1973

Cause[a]	#	%	#/ MM Ac.	# Ac. Burned	% of Total	Acres Burned/ MM Ac.	Acres/ Fire
LC	68	35.6	55	548	47.3	439	8.1
MC	123	64.4	99	610	52.7	489	5.0
Total	191		154	1,158		828	6.1

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table G.2.

Fire Occurrence by Size Class and Cause

1960-1973

Cause[a]	# & %	Size Class[b]						Total
		A	B	C	D	E	F	
LC	#	57	9	...	1	1	...	68
	%	83.8	73.2	...	1.5	1.5	...	35.6
MC	#	93	22	6	2	...	...	123
	%	75.6	17.9	4.9	1.6	...	...	64.4
Total	#	150	31	6	3	1	...	191
	%	78.5	16.2	3.1	1.6	.5	...	

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

[b]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

Table G.3.

Fire Occurrence, Acres Burned and Average Size per Fire by Month 1960-1973

Month	#	%	# of Acres	% of Total	Acres/ Fire
March	1	.5	1	.1	1.0
May	2	1.0	15	1.3	7.5
June	12	6.3	213	18.4	17.8
July	53	27.7	60	5.2	1.1
August	55	28.8	413	35.6	7.5
September	25	13.1	25	2.2	1.0
October	41	21.5	429	37.0	10.5
November	2	1.0	2	.2	1.0
Total	191		1,158		

Table G.4.

Fire Occurrence, Acres Burned and Average Size per Fire by Forest Cover Type 1960-1973

Forest Cover[a] Type	#	%	# of Acres	% of Total	Acres/ Fire
PP	...	...	...	...	...
LP	73	38.2	378	32.6	5.2
SF	48	25.1	423	36.5	8.8
DF	5	2.6	0	.0	.0
AW	22	11.5	92	7.9	4.2
PJ	...	...	...	...	...
DEC	15	7.9	4	.3	.3
HB	1	.5	10	.9	10.0
GS	27	14.1	251	21.7	.9
Total	191		1,158		

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce/fir, (DF) Douglas-fir, (AW) alpine fir/white pine/subalpine type, (PJ) pinyon/juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass/sage brush.

Table G.5.

Fire Occurrence by Elevation Zones

1960-1973

Elevation	Cause[a]	#	%	% of Total
6,501-7,500	LC	...	...	
	MC	6	100.0	
	Total	6		3.2
7,501-8,500	LC	11	29.7	
	MC	26	70.3	
	Total	37		19.5
Above 8,500	LC	56	38.1	
	MC	91	61.9	
	Total	147		77.4
Total All Elevations	LC	67	35.3	
	MC	123	64.7	
	Total	190		

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table G.6.
Fire Occurrence, Acres Burned and Average
Size per Fire by Elevation Zones
1960-1973

Elevation Zone	#	%	# of Acres	% of Total	Acres/ Fire
6,501-7,500	6	3.1	12	1.0	2.0
7,501-8,500	37	19.4	197	17.0	5.3
Above 8,500	147	77.0	949	82.0	6.5
Total	190		1,158		

Table G.7.
Fire Occurrence, Acres Burned and Average Size per Fire by Aspect 1960-1973

Aspect	#	%	# of Acres	% of Total	Acres/ Fire
North	15	8.2	50	4.3	3.3
North East	22	12.0	418	36.2	19.0
East	24	13.1	26	2.2	1.1
South East	15	8.2	127	11.0	8.5
South	22	12.0	6	.5	.3
South West	17	9.3	19	1.6	1.1
West	20	10.9	227	19.6	11.4
North West	16	8.7	177	15.3	11.1
Ridgetop	5	2.7	19	1.6	3.8
Flat	27	14.8	87	7.5	3.2
Total	183		1,156		

Table G.8.

Fire Occurrence, Acres Burned and Average Size per Fire by Percent Slope 1960-1973

Percent Slope	#	%	# of Acres	% of Total	Acres/ Fire
0-9	52	34.7	293	27.4	5.6
10-19	40	26.7	338	31.6	8.5
20-29	21	14.0	413	38.6	19.7
30-39	18	12.0	6	.6	.3
40-49	9	6.0	11	1.0	1.2
50-59	6	4.0	8	.7	1.3
60-69	2	1.3	1	.1	.5
70-79	...	...	...	...	...
80-100	2	1.3	0	.0	.0
Over 100	...	...	...	...	...
Total	150		1,070		

Appendix H

San Isabel National Forest

Fire Occurrence Tables

Table H.1.

Fire Occurrence per Million Acres, Acres Burned per Million Acres and Average Size per Fire by Cause 1960-1973

Cause[a]	#	%	#/ MM Ac.	# Ac. Burned	% of Total	Acres Burned/ MM Ac.	Acres/ Fire
LC	148	44.7	119	121	11.9	98	.8
MC	183	55.3	147	900	88.1	725	4.9
Total	331		266	1,021		823	3.1

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table H.2.

Fire Occurrence by Size Class and Cause

1960-1973

Cause[a]	# & %	Size Class[b]						Total
		A	B	C	D	E	F	
LC	#	116	29	3	...	...	...	148
	%	78.4	19.6	2.0	...	...	...	44.7
MC	#	137	35	8	3	...	...	183
	%	74.9	19.1	4.4	1.6	...	...	55.3
Total	#	253	64	11	3	...	...	331
	%	76.4	19.3	3.3	.9	...	...	

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

[b]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

Table H.3.
Fire Occurrence, Acres Burned and Average Size per Fire by Month
1960-1973

Month	#	%	# of Acres	% of Total	Acres/ Fire
March	7	2.1	140	13.7	20.0
April	9	2.7	38	3.7	4.2
May	37	11.2	55	5.4	1.5
June	69	20.8	502	49.2	7.3
July	99	29.9	44	4.3	.4
August	54	16.3	69	6.8	1.3
September	21	6.3	28	2.7	1.3
October	31	9.4	143	14.0	4.6
November	2	.6	2	.2	1.0
December	2	.6	0	.0	.0
Total	331		1,021		

Table H.4.
Fire Occurrence, Acres Burned and Average
Size per Fire by Forest Cover Type
1960-1973

Forest Cover[a] Type	#	%	# of Acres	% of Total	Acres/ Fire
PP	113	34.1	182	17.8	1.6
LP	41	12.4	146	14.3	3.6
SF	28	8.5	284	27.8	10.1
DF	51	15.4	4	.4	.1
AW	17	5.1	3	.3	.2
PJ	14	4.2	1	.1	.1
DEC	21	6.3	49	4.8	2.3
HB	10	3.0	11	1.1	1.1
GS	36	10.9	341	33.4	9.5
Total	331		1,021		

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce/fir, (DF) Douglas-fir, (AW) alpine fir/white pine/subalpine type, (PJ) pinyon/juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass/sage brush.

Table H.5.
Fire Occurrence by Elevation Zones
1960-1973

Elevation	Cause[a]	#	%	% of Total
5,501-6,500	LC	3	75.0	
	MC	1	25.0	
	Total	4		1.2
6,501-7,500	LC	27	67.5	
	MC	13	32.5	
	Total	40		12.1
7,501-8,500	LC	37	53.6	
	MC	32	46.4	
	Total	69		20.8
Above 8,500	LC	81	37.2	
	MC	137	62.8	
	Total	218		65.9
Total All Elevations	LC	148	44.7	
	MC	183	55.3	
	Total	331		

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table H.6.
Fire Occurrence, Acres Burned and Average
Size per Fire by Elevation Zones
1960-1973

Elevation Zone	#	%	# of Acres	% of Total	Acres/ Fire
5,501-6,500	4	1.2	4	.4	1.0
6,501-7,500	40	12.1	52	5.1	1.3
7,501-8,500	69	20.8	37	3.6	.5
Above 8,500	218	65.9	928	90.9	4.3
Total	331		1,021		

Table H.7.
Fire Occurrence, Acres Burned and Average Size
per Fire by Aspect 1960-1973

Aspect	#	%	# of Acres	% of Total	Acres/ Fire
North	18	5.8	36	3.7	2.0
North East	20	6.4	30	3.0	1.5
East	61	19.6	33	3.3	.5
South East	51	16.3	81	8.2	1.6
South	56	17.9	264	26.8	4.7
South West	20	6.4	183	18.6	9.2
West	16	5.1	4	.4	.3
North West	33	10.6	290	29.4	8.8
Ridgetop	14	4.5	9	.9	.6
Flat	23	7.4	56	5.7	2.4
Total	312		986		

Table H.8.

Fire Occurrence, Acres Burned and Average Size per Fire by Percent Slope

1960-1973

Percent Slope	#	%	# of Acres	% of Total	Acres/ Fire
0-9	75	26.0	154	16.0	2.1
10-19	88	30.6	203	21.0	2.3
20-29	38	13.2	180	18.7	4.7
30-39	38	13.2	103	10.8	2.7
40-49	20	6.9	8	.8	.4
50-59	12	4.2	305	31.6	25.4
60-69	9	3.1	4	.4	.4
70-79	2	.7	8	.8	4.0
80-100	3	1.0	0	.0	.0
Over 100	3	1.0	0	.0	.0
Total	288		965		

Appendix I

San Juan National Forest

Fire Occurrence Tables

Table I.1.

Fire Occurrence per Million Acres, Acres Burned per Million Acres and Average Size per Fire by Cause 1960-1973

Cause[a]	#	%	#/ MM Ac.	# Ac. Burned	% of Total	Acres Burned/ MM Ac.	Acres/ Fire
LC	904	74.2	430	235	18.7	112	.3
MC	314	25.8	149	1,019	81.3	485	3.2
Total	1,218		579	1,254		597	1.0

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table I.2.

Fire Occurrence by Size Class and Cause

1960-1973

Cause[a]	# & %	Size Class[b]						Total
		A	B	C	D	E	F	
LC	#	812	88	4	...	...	...	904
	%	89.8	9.7	.4	...	...	...	74.2
MC	#	213	84	16	...	1	...	314
	%	67.8	26.8	5.1	...	.3	...	25.8
Total	#	1,025	172	20	...	1	...	1,218
	%	84.2	14.1	1.6	...	.1	...	

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

[b]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

Table I.3.
Fire Occurrence, Acres Burned and Average
Size per Fire by Month
1960-1973

Month	#	%	# of Acres	% of Total	Acres/ Fire
February	1	.1	0	.0	.0
March	3	.2	3	.2	1.0
April	15	1.2	96	7.7	6.4
May	89	7.3	95	7.6	1.1
June	235	19.3	469	37.4	2.0
July	341	28.0	57	4.5	.2
August	269	22.1	45	3.6	.2
September	118	9.7	125	10.0	1.1
October	126	10.3	250	19.9	2.0
November	8	.7	15	1.2	1.9
December	13	1.1	99	7.9	7.6
Total	1,218		1,254		

Table I.4.

Fire Occurrence, Acres Burned and Average Size per Fire by Forest Cover Type 1960-1973

Forest Cover[a] Type	#	%	# of Acres	% of Total	Acres/ Fire
PP	737	60.5	345	27.5	.5
LP	...	...	...	...	...
SF	106	8.7	192	15.3	1.8
DF	65	5.3	3	.2	.0
AW	111	9.1	11	.9	.1
PJ	58	4.8	336	26.8	5.8
DEC	47	3.9	108	8.6	2.3
HB	36	3.0	124	9.9	3.4
GS	58	4.8	135	10.8	2.3
Total	1,218		1,254		

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce/fir, (DF) Douglas-fir, (AW) alpine fir, white pine/subalpine type, (PJ) pinyon/juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass/sage brush.

Table I.5.

Fire Occurrence by Elevation Zones

1960-1973

Elevation	Cause[a]	#	%	% of Total
5,501-6,500	LC	4	44.4	
	MC	5	55.6	
	Total	9		.7
6,501-7,500	LC	169	70.1	
	MC	72	29.9	
	Total	241		19.8
7,501-8,500	LC	471	73.7	
	MC	168	26.3	
	Total	639		52.5
Above 8,500	LC	260	79.0	
	MC	69	21.0	
	Total	329		27.0
Total All Elevations	LC	904	74.2	
	MC	314	25.8	
	Total	1,218		

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table I.6.

Fire Occurrence, Acres Burned and Average Size per Fire by Elevation Zones 1960-1973

Elevation Zone	#	%	# of Acres	% of Total	Acres/ Fire
5,501-6,500	9	.7	2	.2	.2
6,501-7,500	241	19.8	200	15.9	.8
7,501-8,500	639	52.5	720	57.4	1.1
Above 8,500	329	27.0	332	26.5	1.0
Total	1,218		1,254		

Table I.7.

Fire Occurrence, Acres Burned and Average Size per Fire by Aspect 1960-1973

Aspect	#	%	# of Acres	% of Total	Acres/ Fire
North	59	5.0	19	1.6	.3
North East	62	5.3	27	2.3	.4
East	166	14.1	35	2.9	.2
South East	131	11.1	163	13.6	1.2
South	225	19.1	210	17.5	.9
South West	173	14.7	479	39.9	2.8
West	162	13.8	168	14.0	1.0
North West	66	5.6	75	6.3	1.1
Ridgetop	50	4.2	2	.2	.0
Flat	84	7.1	22	1.8	.3
Total	1,178		1,200		

Table I.8.
Fire Occurrence, Acres Burned and Average
Size per Fire by Percent Slope
1960-1973

Percent Slope	#	%	# of Acres	% of Total	Acres/ Fire
0-9	308	30.7	194	15.9	.6
10-19	259	25.8	216	17.7	.8
20-29	159	15.8	450	36.9	2.8
30-39	106	10.6	141	11.6	1.3
40-49	69	6.9	65	5.3	.9
50-59	23	2.3	6	.5	.3
60-69	37	3.7	47	3.9	1.3
70-79	20	2.0	57	4.7	2.9
80-100	20	2.0	42	3.4	2.1
Over 100	3	.3	0	.0	.0
Total	1,004		1,218		

Appendix J

White River National Forest

Fire Occurrence Tables

Table J.1.

Fire Occurrence per Million Acres, Acres Burned per Million Acres and Average Size per Fire by Cause 1960-1973

Cause[a]	#	%	#/ MM Ac.	# Ac. Burned	% of Total	Acres Burned MM Ac.	Acres/ Fire
LC	102	24.9	50	967	63.6	471	9.5
MC	307	75.1	150	554	36.4	270	1.8
Total	409		200	1,521		741	3.7

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table J.2.

Fire Occurrence by Size Class and Cause

1960-1973

Cause[a]	# & %	Size Class[b]						Total
		A	B	C	D	E	F	
LC	#	81	16	3	1	1	...	102
	%	79.4	15.7	2.9	1.0	1.0	...	24.9
MC	#	249	47	10	1	...	...	307
	%	81.1	15.3	3.3	.3	...	...	75.1
Total	#	330	63	13	2	1	...	409
	%	80.7	15.4	3.2	.5	.2	...	

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

[b]Size class is coded as follows: (A) 0-.25 acres, (B) .26-9 acres, (C) 10-99 acres, (D) 100-299 acres, (E) 300-999 acres, and (F) 1,000-4,999 acres.

Table J.3.

Fire Occurrence in Special Interest Areas

1960-1973

Area[a]	Cause[b]	#	% per Area	% of Total	# Fires/ MM Ac.
Vail	LC	3	7.7		
	MC	36	92.3		
	Total	39		9.5	480
Aspen	LC	2	9.1		
	MC	20	90.9		
	Total	22		5.4	284
Flat Tops	LC	3	27.3		
Primitive Area	MC	8	72.7		
	Total	11		2.7	108
Maroonbells	LC	0	.0		
	MC	6	100.0		
	Total	6		1.5	84
Gore-Eagles Nest	LC	1	50.0		
Primitive Area	MC	1	50.0		
	Total	2		.5	77
Ruedi Reservoir-	LC	5	18.5		
Fryingpan River	MC	22	81.5		
	Total	27		6.6	356
Other Forest Lands	LC	88	29.1		
	MC	214	70.9		
	Total	302		73.8	187
Total All Lands	LC	102	24.9		
	MC	307	75.1		
	Total	409		100.0	200

[a]Area calculations are based on the gross area within the National Forest.

[b]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table J.4.

Fire Occurrence, Acres Burned and Average Size per Fire by Month

1960-1973

Month	#	%	# of Acres	% of Total	Acres/ Fire
April	4	1.0	2	.1	.5
May	18	4.4	20	1.3	1.1
June	57	13.9	381	25.0	6.7
July	80	19.6	16	1.1	.2
August	95	23.2	619	40.7	6.5
September	47	11.5	111	7.3	2.4
October	100	24.4	336	22.1	3.4
November	2	.5	1	.1	.5
December	6	1.5	35	2.3	5.8
Total	409		1,521		

Table J.5.
Fire Occurrence, Acres Burned and Average
Size per Fire by Forest Cover Type
1960-1973

Forest Cover[a] Type	#	%	# of Acres	% of Total	Acres/ Fire
PP	3	.7	0	.0	.0
LP	60	14.8	61	4.0	1.0
SF	100	24.7	124	8.2	1.2
DF	22	5.4	281	18.5	12.8
AW	41	10.1	12	.8	.3
PJ	23	5.7	581	38.2	25.3
DEC	45	11.1	183	12.0	4.1
HB	16	4.0	46	3.0	2.9
GS	95	23.5	233	15.3	2.5
Total	405		1,521		

[a]Forest cover types are coded as follows: (PP) ponderosa pine, (LP) lodgepole pine, (SF) spruce/fir, (DF) Douglas-fir, (AW) alpine fir/white pine/subalpine type, (PJ) pinyon/juniper, (DEC) deciduous (primarily aspen), (HB) heavy brush, and (GS) grass/sage brush.

Table J.6.

Fire Occurrence by Elevation Zones

1960-1973

Elevation	Cause[a]	#	%	% of Total
5,501-6,500	LC	2	14.3	
	MC	12	85.7	
	Total	14		3.4
6,501-7,500	LC	13	46.4	
	MC	15	53.6	
	Total	28		6.8
7,501-8,500	LC	20	22.7	
	MC	68	77.3	
	Total	88		21.5
Above 8,500	LC	67	24.0	
	MC	212	76.0	
	Total	279		68.2
Total All Elevations	LC	102	24.9	
	MC	307	75.1	
	Total	409		

[a]Cause is coded as follows: (LC) lightning caused, and (MC) man caused.

Table J.7.

Fire Occurrence, Acres Burned and Average Size per Fire by Elevation Zones

1960-1973

Elevation Zone	#	%	# of Acres	% of Total	Acres/ Fire
5,501-6,500	14	3.4	3	.2	.2
6,501-7,500	28	6.8	616	40.5	22.0
7,501-8,500	88	21.5	418	27.5	4.8
Above 8,500	279	68.2	484	31.8	1.7
Total	409		1,521		

Table J.8.

Fire Occurrence, Acres Burned and Average Size per Fire by Aspect 1960-1973

Aspect	#	%	# of Acres	% of Total	Acres/ Fire
North	29	7.3	18	1.2	.6
North East	28	7.1	39	2.7	1.4
East	54	13.6	114	7.7	2.1
South East	29	7.3	24	1.6	.8
South	79	19.9	212	14.4	2.7
South West	48	12.1	938	63.8	19.5
West	56	14.1	117	7.9	2.1
North West	30	7.6	6	.4	.2
Ridgetop	6	1.5	0	.0	.0
Flat	38	9.6	3	.2	.1
Total	397		1,471		

Table J.9.

Fire Occurrence, Acres Burned and Average Size per Fire by Percent Slope 1960-1973

Percent Slope	#	%	# of Acres	% of Total	Acres/ Fire
0-9	88	25.0	98	6.7	1.1
10-19	89	25.3	80	5.5	.9
20-29	53	15.1	76	5.2	1.4
30-39	56	15.9	836	57.0	14.9
40-49	26	7.4	27	1.8	1.0
50-59	11	3.1	52	3.5	4.7
60-69	16	4.5	281	19.2	17.6
70-79	7	2.0	3	.2	.4
80-100	4	1.1	4	.3	1.0
Over 100	2	.6	9	.6	4.5
Total	352		1,466		

Appendix K

Legal Descriptions for Special Interest Areas

Allenspark-Lyons Roosevelt N.F.	T3N, R71W-R73W T4N, R71W-R73W
Aspen White River N.F.	T10S, R84W-R85W T11S, R84W-R85W
Big Thompson Roosevelt N.F.	T5N, R70W-R72W T6N, R70W-R72W
Boulder-Ward- Nederland Roosevelt N.F.	T1N, R71W-R73W T2N, R71W-R73W T1S, R71W-R73W T2S, R71W-R72W
Dillon-Breckenridge Arapaho N.F.	T55, R77W-R78W T6S, R77W-R78W T7S, R77W Sections 1-11, 15-22, 22-32 T7S, R78W
Flat Tops White River N.F.	T1N, R89W Sections 22, 26, 27, 35 and 36 T1S, R87W Sections 3-10, 15-24, 29-34 T1S, R88W Sections 6, 7, 9-36 T1S, R89W Sections 1, 9-16, 20-36 T1S, R90W Sections 13, 14, 17-19 33-36
Gore Eaglesnest Arapaho White River N.F.	T3S, R79W Sections 7, 17-21, 27-34 T3S, R80W Sections 2, 3, 10-16, 19-36 T4S, R79W Sections 3-10, 15-23, 26-36 T4S, R80W Sections 3-5, 10-15, 23-26, 36 T5S, R79W Sections 1-6, 9-16, 22-24, 27, 34

Appendix K-Continued

Idaho Springs Arapaho N.F.	T3S, R73W-R74W T4S, R73W-R74W
Lake George Pike N.F.	T11S, R70W-R72W T12S, R70W-R72W T13S, T71W-R72W
Maroon Bells White River N.F.	T10S, R86W Sections 15-22, 27-35 T10S, R87W Sections 5-8, 16-36 T10S, R88W Sections 11-14, 24, 25, 36 T11S, R85W Sections 29-34 T11S, R86W Sections 2-11, 14-18, 21-23, 25-27, 34-36 T11S, R87W Sections 1-15 T12S, R85W Sections 3-10, 15-18 T12S, R86W Sections 1-3, 11-13
Pikes Peak Pike N.F.	T11S, R67W-R69W T12S, R67W-R69W T13S, R67W-R69W T14S, R67W-R69W T15S, R67W-R68W
Redfeather-Rustic Roosevelt N.F.	T8N, R72W-R74W T9N, R72W-R74W T10N, R72W-R74-W
Ruedi Reservoir- Fryingpan River White River N.F.	T8S, R83W-R86W
South Platt Pike N.F.	T6S, R72W-R73W T7S, R69W-R73W T8S, R69W-R72W T9S, R68W-R71W T10S, R68W-R71W
Vail White River N.F.	T5S, R80W-R81W T6S, R80W-R81W
Winter Park Arapaho N.F.	T2S, R75W