South Platte

Community Wildfire Protection Plan

Deckers Area

August, 2004

Trumbull VFD, North Fork Fire Protection District
Jefferson County, Douglas County
Colorado State Forest Service, USDA Forest Service
FEMA

Prepared by Land Stewardship Associates LLC

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I. COMMUNITY IDENTIFICATION AND DESCRIPTION

The South Platte Community Area is located in the Upper South Platte Watershed approximately 40 miles southwest of the Denver metropolitan area. The area is approximately 45,500 acres in size and ranges in elevation from 6,200 to 8,500 feet. The South Platte River runs through the center of the area and is designated as a Gold Medal Stream by the Colorado Division of Wildlife, which results in significant recreational uses. The following vicinity map identifies communities, several of the fuel treatment locations contained in the *Table 4: Fuel Treatment Table*, other recognizable features within the area, and contains the Wildland-Urban Interface (WUI) Boundary as specified by Federal Register, Volume 66, No.3, page 753.

The area is dominated by highly erosive, decomposed granitic soils. Vegetation is dominated by a ponderosa pine/Douglas-fir montane forest, which is relatively dense and even-aged. The density of the ponderosa pine/Douglas-fir forest is generally dense enough to sustain a substantial crown fire—resulting in a high fire risk.

Two such fires, the Hayman (2002, the largest fire on record in Colorado) and the Schoonover (2002) fires burned portions of the southern third of the area (see *Appendix A: Fuel Treatment Map* for specific locations). The southern edge of the 1996 Buffalo Creek fire serves as the northwest boundary of the area. Much of the forested area within these fires was severely burned.

The area is critical for the water supply to the City of Denver and surrounding metropolitan area. Cheesman Reservoir, located just outside the South Platte Community Area, is the primary storage facility for Denver Water. Water released from Cheesman Reservoir flows through the Community Area via the South Platte River. Strontia Springs dam, a critical holding and distribution reservoir for the Denver Water Department, is located several miles northeast of the area. The previously mentioned wildfires resulted in substantial and costly debris and sediment deposits in both reservoirs.

The South Platte Area can be characterized as a mountain community with permanent and recreational home sites scattered throughout. Landownership patterns are private parcels along the South Platte River, along with scattered private parcels in the upper slopes of the Community Area, all surrounded by Pike National Forest lands. Along the river, private land includes permanent and recreational home sites and vacant land. Denver Water owns land, homes and cabins throughout the Community Plan Area. Deckers, (completely owned by Denver Water) has rental cabins, a store, coffee shop, liquor store, fly shop, a Community Center, and small branch offices for the Sheriff's Department. (See the Fuel Treatment Map for specific locations of the private land).

Colorado State Highway 126 runs through the southern and western portions of the area. County Road 67 runs along the South Platte River and eastern portions of the area. County Road 97 runs along the South Platte River in the northern portion of the Community Plan Area. All are important transportation links through and within the area.

Vicinity Map (Delorme)

The Trumbull Volunteer Fire Department has a Fire Station located at Trumbull, providing coverage to portions of both Jefferson and Douglas Counties. Nearby, but outside the Community Area are the following Fire Agencies:

Table 1: Fire Departments/Agencies Near, But Outside the South Platte WUI Area

Department/Agency	County	Station Location(s)
North Fork Fire Protection District	Jefferson	Pine, SE of Buffalo Creek
Mountain Communities Fire Protection District	Douglas	West Creek
West Douglas Fire Protection District	Douglas	Moon Ridge
US Forest Service	Jefferson	Buffalo Creek
US Forest Service	Douglas	Indian Creek
US Forest Service	Teller	Woodland Park

A public meeting was held April 14-15, 2004, at Deckers, Colorado. Participants included the Trumbull VFD, Colorado State Forest Service, and USDA Forest Service. CSFS represented both their own agency and Denver Water at this meeting. A draft of this plan was developed from recommendations and input received at this meeting. The draft plan was reviewed by representatives from both Jefferson and Douglas County Offices of Emergency Preparedness. Comments and suggestions from the Counties were incorporated into the final plan.

II. COMMUNITY ASSESSMENT

The overall risk to the community from wildland fire is high. This section will discuss the factors considered that led to the overall rating.

Fuel Hazards

Dense ponderosa pine stands cover substantial portions of the planning area. Crown cover densities are well above the forty percent threshold for sustained crown fires. North-facing slopes often contain even thicker stands of Douglas-fir. Ground fuel is characterized by fuel models 2 and 9 in forested areas with openings/meadows normally considered fuel model 1 (see *Appendix E: Primary Fuel and Fire Hazards* for fuel model descriptions). These fuels have high rates of spread under relatively mild weather conditions.

All stands adjacent to structures with crown closures greater than forty percent are problematic. Continuous surface and crown fuel structure, both horizontally and vertically, render this area susceptible to torching, crown fire, and ignition by embers, even under moderate weather conditions. The following *Hazard Assessment* map indicates the majority (78 percent) of the WUI has a fuel hazard assessment of medium-high (class 9) to high (class 12).

Local topography further aggravates fire behavior and control. The South Platte River drainage focuses prevailing winds and funnels them through the communities involved. Slopes range from ten to over fifty percent with most hillsides ranging from twenty to thirty percent.

Fuel Hazards Map (81/2x11 or 11x17)

Risk of Ignition and Wildfire Occurrence

Reconstruction of fire history and forest dynamics in the Cheesman landscape, located south west of the community, reveal (i) an average fire interval of about fifty years during the period 1300-1880, but no major fires between 1880 and 2002; (ii) a mix of non-lethal surface fire and lethal, stand replacing fire in the historic burns (mixed severity fire regime); and (iii) a striking increase in forest density from 1900-2002.

The extent of the high-severity burns in 2002 within and near the Community Area landscape was unprecedented in the last 700 years, in part because of the dense forest conditions that had developed during the twentieth century, and in part because of the extreme drought and fire weather conditions that existed in 2002.

The Hayman Fire of 2002 is the most recent and spectacular of a number of large fires that have burned in the area within the past ten years. Other notable fires along the Front Range include Buffalo Creek (1996), Big Turkey (1998), Hi Meadow (2000), Snaking (2002), Black Mountain (2002) and Schoonover (2002). These fires have burned a total of 669 structures in less than ten years.

Low fuel moistures and relative humidity are common in the area, as are periods of high winds. When dry and windy conditions coincide the stage is set for large, troublesome wildfires. Human population is increasing in the area. All recent large fires, except for the Schoonover Fire, were caused by humans. Numerous fires are ignited each year by lightning. Except for portions of Florida, this area has some of the highest occurrence of lightning in the continental US.

Fires originating in or near communities are the most immediate concern, but fires starting well beyond the boundaries of the planning area can have profound effects upon the communities. Rapid rates of spread and long distance spotting are the norms for fires in the vicinity. Areas classified as high to moderate fuel loading are the most worrisome. *Table 2* gives fire behavior predictions for several fuel models and representative weather conditions.

Table 2: South Platte WUI Area Fire Behavior Predictions

FUEL MODEL	**RATE OF SPREAD** (FT/HR)	**FLAME LENGTH** (FT)	**FIRE SIZE 1 HOUR** (AC)	**FIRE PERIMETER** (FT)	**SAFETY ZONE SIZE** (ACRES)
2	9,095	12	440	20,196	3
8	429	2	1	924	1
9	2,191	6	26	4,884	1
10	1,617	9	14	3,564	2

Based on *Behave Plus 2.0.0* run with relatively dry fuel moistures, 10 mph mid-flame winds and 20% slope.

Community Values at Risk

- **Values** - There are about 13 "neighborhoods" or subdivisions with 211 home sites (not counting Nighthawk Hill) in the South Platte WUI area. *Table 3* gives a summary of the home site and neighborhood wildfire hazard evaluations. Most have heavy fuels nearby and around them. About half of the structures have recognizable defensible space. Many have flammable material near by, on the porch or under decks, increasing their vulnerability. A few of the structures have wooden shingle or shake roofs. The composition and wooden roofs tend to hold pine needles and forest debris allowing accumulations that also increase vulnerability to fire brands. Most of the structures are vulnerable to wildfire damage occurring from firebrand ignition and/or radiation ignition due to the heavy forest fuels within the area. The details of home site and neighborhood hazard evaluations are contained in *Appendices C and D.*

  As previously stated, the South Platte WUI area is a critical watershed supplying water to the Denver Metropolitan area. Substantial costs were incurred in removing debris from the Strontia Springs reservoir following the Buffalo Creek Fire and in attempts to reduce damage at Cheesman Reservoir following the Hayman Fire. Following the Hayman and Schoonover Fires, the South Platte River below Cheesman Canyon has received considerable sedimentation damage at Wigwam and Horse Creeks, Saloon Gulch and other areas.

  The area contains habitat for fish (Gold Medal Stream) and wildlife (birds, big game and numerous smaller species). The area contains critical habitat for the Pawnee montane skipper butterfly, Preble's meadow jumping mouse, and is used by both Bald and Golden eagles.

- **Access** - The primary access routes through the South Platte WUI are Highways 126 and County Roads 67 and 97. Highway 126 and portions of County Roads 67 and 97 are two-lane paved roads. Other portions of County Roads 67 and 97 are maintained on a year-round basis by Douglas County. All provide more than one way into and out of the WUI and communities. A small Douglas County Road & Bridge facility is located north of Trumbull near Dott's Park. Roads within subdivision areas and driveways are often narrow and steep. Turnarounds are marginal or lacking (see *Appendices C and D* for details on access to particular neighborhoods and home sites). Road signs and home and cabin addresses are spotty at best.

- **Risk** - Because of the lack of defensible space around many home sites, natural fuel continuity and steep slopes between some of the neighborhoods, it would be very difficult to protect some home sites from wildfire during periods of high to extreme fire danger.

- **Evacuation** - Evacuation planning is needed to minimize fire emergency confusion and risk to residents who might be asked to evacuate in the event of an emergency. *Appendix G* provides guidelines for developing an evacuation plan.

CSFS RedZone Map (81/2x11 or 11x17)

Table 3: Summary of Wildfire Hazards for Home sites and Neighborhoods

Area Name	County	FPD/VFD	Predominate Homesite Hazard Rating	Neighborhood Hazard Rating	# of Private Structures	# Denver Water Structures	# USFS Summer Homes	Total Structures
Nighthawk	Douglas	TVFD	Extreme	High	12	5	5	22
Scraggy View	Douglas	TVFD	Medium-High	High	23	5	0	28
Oxyoke	Jefferson Douglas	TVFD	Extreme	Moderate	12	7	0	19
Swayback Ranch	Douglas	TVFD	High-Extreme	Moderate	19	0	1	20
Trumbull	Jefferson	TVFD	Medium-High	Moderate	19	17	0	36
Snow Water Springs	Douglas	TVFD	High	Moderate	7	1	0	8
Deckers	Jefferson Douglas	TVFD	Extreme	Moderate	0	9	0	9
Y Camp Road	Douglas	TVFD	Extreme	High	8	0	3	11
Lazy Gulch	Jefferson	TVFD	Extreme	High	1	0	5	6
Highway 126	Jefferson	NFFPD	High	NA	10	0	0	10
Nighthawk Hill	Douglas	WDFPD	Under Development	Under Development	Unknown			
Spring Creek	Jefferson	NFFPD	Medium-High	Moderate	37	0	0	37
Horse Creek	Douglas	TVFD	Medium-High	NA	5	0	0	5
Totals					**153**	**44**	**14**	**211**

Local Preparedness and Protection Capability

Trumbull Volunteer Fire Department has a cadre of six volunteers. Five can respond rapidly to wildland fires on any given day. All six members of the VFD are red carded as basic firefighters. The department has two brush trucks of 400 gallons, one structure engine of 700-1,000 gallons and a 1,000 gallon water tender. ISO rating is 10 everywhere within the WUI area. Mutual aid comes primarily from the North Fork FPD. If needed, other near-by Departments from the surrounding communities can be expected on scene, normally within forty five minutes. Trumbull VFD may be absorbed into the North Fork FPD at some future time.

North Fork Fire Protection District has one Type-1 4x4 engine, one Type-3 tender/engine, one Type-6 4x4 engine, one ambulance and one rescue truck. It has a 30-minute response time to Deckers, and has a contract with Denver Water to provide fire suppression assistance on Denver Water lands. The ISO rating is 9 within a five mile radius of the station and 10 for the rest of the District.

The US Forest Service has four Type-6 engines stationed at Buffalo Creek (2 to 3 in service at any one time), and one Type-4 and two Type-6 engines stationed at Woodland Park, all within about forty five minutes of the community.

Evacuation planning is relatively straightforward with primary evacuation choices being:

- Up or down the South Platte River
- Northwest via Highway 126 towards Buffalo Creek and Pine
- South along Horse Creek towards Woodland Park via CR 67
- Northeast toward Sedalia via Sugar Creek Road (CR67)
- Northeast toward Sedalia via the Pine Creek Road

Safety zones are identified in *Appendix B.*

III. COMMUNITY MITIGATION PLAN

In consultation with interested parties during the April meeting at Deckers, *Table 4: Fuel Treatment Table* was developed. It depicts in detail the strategy for addressing mitigation needs in terms of fuel reduction within South Platte WUI.

The strategy basically addresses fuel treatments and defensible space needs in numerous areas over a several year period. <u>Ninety eight (98) treatment areas on over 20,000 acres, and about 60 miles of shaded fuel breaks along travel-ways have been identified.</u> The areas include private land and Denver Water parcels (identified along with a 100-foot buffer around them), planned and proposed public land (Pike National Forest) parcels between the private parcels, and a series of "shaded fuel breaks" along all primary roads, existing ATV trails and selected strategic ridgelines to break up fuel continuities. In addition, a number of treatment areas on public land have been identified where work can be accomplished through the CSFS by using authorities contained in "Good Neighbor Agreements". Not contained in *Table 4* but included on the fuel treatment map (*Appendix A: Fuel Treatment Map*) are the names and acres of USFS planned treatments for fiscal years 2002, 2003, 2004 and 2005.

Essential to the success of the plan is the involvement of the private landowners. Implicit to the plan is “ownership of the fire problem” by private landowners. While CSFS, Denver Water and the local VFD have worked hard to promote defensible space and land management, private landowners must accept responsibility for completing work on their own lands. Incorporated in the private land treatments is the task of working with individual landowners to improve defensible space in the ignition zone around the buildings.

Identified in *Table 4* are the parcel of land, size, ownership, priority for treatment, time frame, lead agency and general type of treatment.

Fuel Hazard Reduction

Appendix A: Fuel Treatment Map, the fuel treatment map for the South Platte WUI, depicts locations of the suggested treatment areas listed in *Table 4*.

Priorities for reducing fuel hazards were based the following criteria:

- **Priority 1:** Areas around home sites, neighborhoods and roads, including defensible space and forest thinning.
- **Priority 2:** Road corridors and along selected ATV trails.
- **Priority 3:** Interior areas—areas between neighborhoods, roads and trails.

Because of the generally small size of material to be removed, poor markets and lack of local processing mills, it is anticipated that very little of the treatment products will be able to be used commercially. However, there will be some pockets within treatment areas where commercial use of the material may be feasible. In these cases, efforts will be made to contact mills, operators, etc. to see if commercial utilization would be feasible.

Wildfire Prevention and Fire Loss Mitigation

Prevention strategies focus on education, burning restrictions and closure orders. The coordination of fire restrictions is detailed in County Annual Fire Operating Plans. However, in actual practice, it often is cumbersome and difficult to coordinate. The South Platte River forms the boundaries for Jefferson and Douglas counties. It is not unusual for the Trumbull VFD to be under two very different fire restrictions depending on which side of the river you are on. In addition, restrictions may be in place within counties, but not on USFS lands.

There is a need to improve the process of initiating and coordinating fire restrictions. The best and most favored approach is to develop uniform actions based on the National Fire Danger Rating System adjective ratings. In depth discussions about thresholds for various restrictions can occur during the winter and be automatically triggered when fire hazard warrants without a flurry of last minute phone calls. Prearranged actions take a lot of the hassle out of the implementation of fire restrictions and facilitate communications among cooperators.

While Denver Water and Colorado State Forest Service have been working diligently to improve defensible space within the community, and will continue to do so, much remains to be done.

The Trumbull VFD plans to continue to actively support creation and maintenance of defensible space and FireWise home construction.

Improved Protection Capability

Trumbull VFD is currently recruiting new firefighters with an objective of adding four more people to the department. There is also a movement to consolidate Trumbull with the North Fork Volunteer Fire Department. This is a lengthy process and will require landowners to approve a twelve mill levy. This consolidation will improve communications and fire/EMS response times. Consolidation is at least one year out. In the interim they are acquiring a new structure engine to replace their present one.

Five additional dry hydrants were installed during August, 2004 and will improve access to water for the structural engines. Additional dry hydrant locations have been identified. CSFS and Denver Water are providing the department the adaptors to allow them to connect the structure engine to the existing dry hydrants. Another suggestion is to equip engines with Floto-pumps or portable pumps which will guarantee water availability along the entire length of the South Platte River.

TVFD plans to develop a triage map that shows defendable homes, gas turnoffs, and road/driveway assessments over the next few years.

A separate Communications Plan to address ongoing efforts to inform landowners about steps and measures they can take to reduce their hazards and risks will be developed and updated annually.

Appendix B: Fire Suppression/Pre-Suppression Planning Maps displays location of the existing infrastructure, *i.e.* the firehouse, dry hydrants, existing locations for helispots, staging areas, fire camp and incident command post (ICP). The maps also display needed additional dry hydrants, work on turnouts/turnarounds and fuel breaks or defensible space near the infrastructure. These maps will improve communications during complex fire situations when mutual aid resources are used.

Table 4: Fuel Treatment Table – South Platte Community Wildfire Protection Plan

Treatment Area	Acres	Miles	Owner-ship	Priority	Time Frame	Lead Agency	Treatment Options: Mechan-ical	Treatment Options: Prescribed Fire	Notes
Private Land Treatments	5,444.6								
Eagle Rock (ER)	76.1	NA	Pvt.	3		CSFS	x		Likely inoperable
Twin Cedars (TC)	220.6	NA	Pvt.	2		CSFS	x		
Nighthawk (NH)	52.3	NA	Pvt.	1		CSFS	x		
Scraggy View (SV)	81.8	NA	Pvt.	1		CSFS	x		
Ouzel (OZ)	38.4	NA	Pvt.	Done		CSFS	x		Done
Oxyoke (OX)	272.0	NA	Pvt.	1		CSFS	x		
Swayback Ranch (SR)	315.7	NA	Pvt.	1		CSFS	x		
Trumbull (T)	282.4	NA	Pvt.	Done		CSFS	x		Done (re-entry in one area)
E. Trumbull ET)	43.4	NA	Pvt.	3		CSFS	x		
NW. Trumbull (NWT)	177.7	NA	Pvt.	3		CSFS	x		
Deckers (D)	57.0	NA	Pvt.	Done		CSFS	x		Done
Fletchers Ranch (FR)	255.1	NA	Pvt.	2		CSFS	x		
Y Camp (YC)	143.3	NA	Pvt.	2		CSFS	x		
Grand View (GV)	38.1	NA	Pvt.	2		CSFS	x		
Wigwam (W)	180.2	NA	Pvt.	2		CSFS	x		
Spring Creek (SC)	654.6	NA	Pvt.	1		CSFS	x		In progress
Gunbarrel (G)	292.3	NA	Pvt.	2		CSFS	x		
Sixmile (S)	294.9	NA	Pvt.	2		CSFS	x		
Horse Creek (HC)	80.2	NA	Pvt.	Done		CSFS	x		Done
Nighthawk Hill (NHH)	1,828.8	NA	Pvt.	3		CSFS	x		Do w/ USFS treatments
Mining Claims (MC)	59.7	NA	Pvt.	3		CSFS	x		
USFS Proposed Treatment Units	4,819.5								Does not include 11,040 acres of planned treatment units for 2002-5
P1	41.0	NA	USFS	3	2006	USFS	x	x	
P2	34.4	NA	USFS	3	2006	USFS	x	x	
P3	32.0	NA	USFS	2	2006	USFS	x	x	
P4	119.6	NA	USFS	3	2006	USFS	x	x	
P5	113.2	NA	USFS	1	2006	USFS	x	x	
P6	47.2	NA	USFS	3	2006	USFS	x	x	
P7	148.6	NA	USFS	3	2006	USFS	x	x	
P8	465.0	NA	USFS	2	2006	USFS	x	x	
P9	119.7	NA	USFS	3	2006	USFS	x	x	
P10	112.2	NA	USFS	2	2006	USFS	x	x	
P11	487.9	NA	USFS	3	2006	USFS	x	x	
P12	219.2	NA	USFS	3	2006	USFS	x	x	

NA=Not Applicable Priorities:1=roads & buildings, 2=ATV trails, 3=interior areas Time Frame=fiscal year

Table 4: Fuel Treatment Table -- South Platte Community Wildfire Protection Plan (continued)

Treatment Area	Acres	Miles	Owner-ship	Priority	Time Frame	Lead Agency	Treatment Options: Mechan-ical	Treatment Options: Prescribed Fire	Notes
USFS Proposed Treat-ment Units (cont'd)									
P13	61.1	NA	USFS	3	2006	USFS	x	x	
P14	66.9	NA	USFS	3	2006	USFS	x	x	
P15	68.2	NA	USFS	1	2006	USFS	x	x	
P16	103.2	NA	USFS	1	2006	USFS	x	x	
P17	22.6	NA	USFS	3	2006	USFS	x	x	
P18	95.3	NA	USFS	2	2006	USFS	x	x	
P19	20.9	NA	USFS	3	2006	USFS	x	x	
P20	239.7	NA	USFS	3	2006	USFS	x	x	
P21	34.4	NA	USFS	3	2006	USFS	x	x	
P22	54.7	NA	USFS	2	2006	USFS	x	x	
P23	9.9	NA	USFS	3	2006	USFS	x	x	
P24	253.7	NA	USFS	2	2006	USFS	x	x	
P25	43.3	NA	USFS	3	2006	USFS	x	x	
P26	91.5	NA	USFS	3	2006	USFS	x	x	
P27	87.9	NA	USFS	2	2006	USFS	x	x	
P28	142.1	NA	USFS	3	2006	USFS	x	x	
P29	27.7	NA	USFS	3	2006	USFS	x	x	
P30	107.5	NA	USFS	3	2006	USFS	x	x	
P31	89.0	NA	USFS	3	2006	USFS	x	x	
P32	41.4	NA	USFS	3	2006	USFS	x	x	
P33	643.1	NA	USFS	2	2006	USFS	x	x	
P34	322.6	NA	USFS	2	2006	USFS	x	x	
P35	196.2	NA	USFS	2	2006	USFS	x	x	
P36	27.8	NA	USFS	2	2006	USFS	x	x	
P37	28.5	NA	USFS	3	2006	USFS	x	x	
Shaded Fuel Breaks	NA	60.7							
F	NA	2.2	USFS	3	2007	USFS	x	x	
B	NA	1.7	USFS	3	2007	USFS	x	x	
C	NA	2.6	USFS	3	2007	USFS	x	x	
D	NA	2.0	USFS	3	2007	USFS	x	x	
E	NA	1.6	USFS	3	2007	USFS	x	x	
Road 126 A	NA	9.4	USFS	1		USFS	x	x	Spring Creek south to Hayman
Road 126 B	NA	5.5	USFS/Pvt.	1		USFS	x	x	Wigwam to Deckers
Highway 67 A	NA	2.4	USFS/Pvt.	1		USFS	x	x	Deckers to Sugar Creek

NA=Not Applicable Priorities:1=roads & buildings, 2=ATV trails, 3=interior areas Time Frame=fiscal year

Table 4: Fuel Treatment Table -- South Platte Community Wildfire Protection Plan (continued)

Treatment Area	Acres	Miles	Owner-ship	Priority	Time Frame	Lead Agency	Treatment Options: Mechan-ical	Treatment Options: Prescribed Fire	Notes
Shaded Fuel Breaks (cont'd)									
Highway 67 B	NA	3.2	USFS/Pvt.	1		USFS	x	x	Sugar Creek
Road 97 A	NA	4.6	USFS/Pvt.	1		USFS	x	x	Sugar Crk to Pine Crk
Road 97 B	NA	3.0	USFS/Pvt.	1		USFS	x	x	Pine Crk to Eagle Rock
Pine Creek	NA	3.1	USFS/Pvt.	1		USFS	x	x	
ATV A	NA	9.9	USFS	2		USFS	x	x	
ATV B	NA	5.0	USFS	2		USFS	x	x	
ATV C	NA	4.6	USFS	2		USFS	x	x	
Good Neighbor Agreements	2,552.2								Does not include USFS buffers around pvt parcels
Deckers GNA (G1)	2.3	NA	USFS	Done		CSFS	x		Done
Swayback #1/Scrggy #1 (G2)	120.8	NA	USFS	NA		CSFS	x		
Deckers/Fletcher (G3)	120.4	NA	USFS	2		CSFS	x		
Deckers West TSI (G4)	2.9	NA	USFS	Done		CSFS	x		
Deckers SW (G5)	148.5	NA	USFS	12		CSFS	x		
Ox Yoke #1 (G6)	115.2	NA	USFS	NA		CSFS	x		
Ox Yoke/Ouzel Fuelbreak (G7)	60.8	NA	USFS	3		CSFS	x		
Nighthawk (G8)	212.6	NA	USFS	NA		CSFS	x		USFS
Nighthawk Sum Homes (G9)	--	NA	USFS	4		CSFS	x		
Nighthawk North (G10)	18.0	NA	USFS	NA		CSFS	x		
Lazy Gulch Sum Homes (G11)	32.1	NA	USFS	8		CSFS	x		
Y Camp Sum Homes (G12)	32.8	NA	USFS	10		CSFS	x		
Trumbull Sum Homes (G13)	3.4	NA	USFS	9		CSFS	x		
Trumbull GNA TS (G14)	782.6	NA	USFS	13		CSFS	x		
Trumbull S-Mulch FL (G15)	12.6	NA	USFS	5		CSFS	x		
Trumbull Rest/Fuelbreak (G16)	72.7	NA	USFS	11		CSFS	x		
Trumbull TSI (G17)	7.6	NA	USFS	6		CSFS	x		
Hwy 67 Fuelbreak (G18)	12.0	NA	USFS	7		CSFS	x		
Oxyoke East (G19)	115.2	NA	USFS	14		CSFS	x		
Scraggy View FB (G20)	31.6	NA	USFS	17		CSFS	x		
Grand View (G21)	173.5	NA	USFS	15		CSFS	x		
Y Camp (G22)	12.4	NA	USFS	18		CSFS	x		
Wigwam (G23)	173.5	NA	USFS	16		CSFS	x		
Gunbarrel (G24)	160.8	NA	USFS	19		CSFS	x		
Spring Creek (G25)	127.9	NA	USFS	20		CSFS	x		

NA=Not Applicable Priorities:1=roads & buildings, 2=ATV trails, 3=interior areas Time Frame=fiscal year

IV. IMPLEMENTATION AND MONITORING

Implementation

Table 4 lists all of the 98 mitigation projects identified, their priority rankings and the lead agency for the projects. In addition to the projects in *Table 4*, approximately 150 home sites are rated as high or extreme wildfire hazard and are in critical need of defensible space improvement (see *Appendices C* and *D* for specific needs and *Appendix K* for guidelines when creating defensible space). In total, about 250 small and large projects have been identified.

Table 5: Action Plan for the South Platte Wildfire Protection Plan, identifies the responsibilities and roles (tasks) necessary to finalize the South Platte Community Wildfire Protection Plan and to implement the agreed upon priorities.

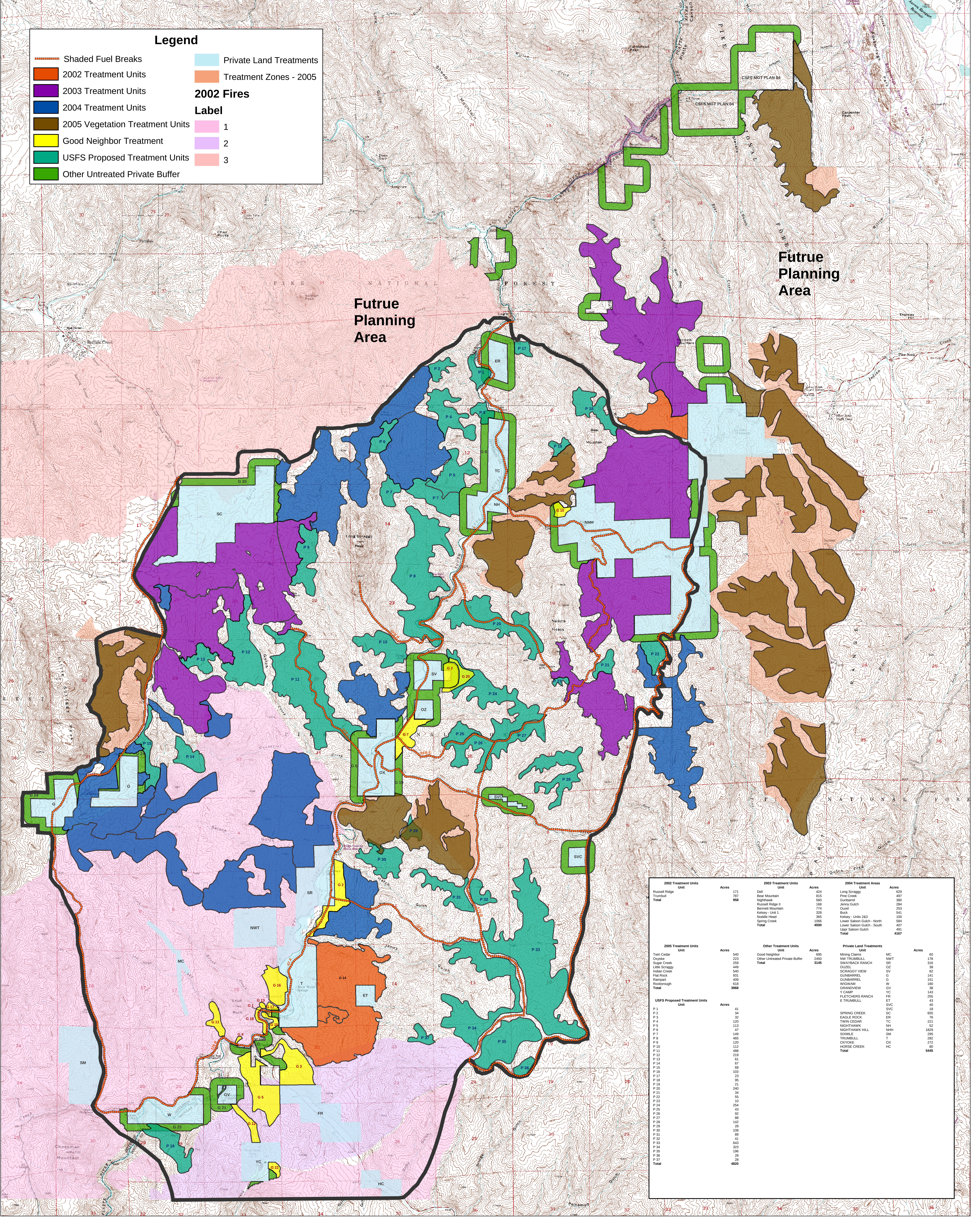
Monitoring

Monitoring is an important part of follow-up to the implementation of projects. HFRA instructs participants to establish, where interest is expressed by the communities, a collaborative multiparty monitoring process. This process should address reporting of accomplishments, need for maintenance of treated areas, tracking of burned areas and the positive and negative ecological and social effects of the projects.

Monitoring in the South Platte Community Wildfire Protection Plan calls for an annual field review by the partners (participants) of accomplishments and need for maintenance. Based on this review, it calls for needed adjustments in the next years plan, as appropriate. Thirdly, it calls for a determination of interest and meeting by the partners for monitoring the ecological and social effects of projects. These tasks are identified in *Table 5*.

Table 5: Action Plan for the South Platte Community Wildfire Protection Plan

Task	Lead Agency	Date	Partners -- Participants					
			CSFS	USFS	Fire Depts	Counties (Includes DWB)	Neighbor-hoods	FEMA
Community Wildfire Protection Plan								
Finalize Plan								
Review Draft Plan	CSFS	8/04		x	x	x	x	x
Finalize Fuel Treatment Map and Attribute Table	USFS	8/04	x		x			
Gain public understand, acceptance and support	All	ongoing						
Develop Communications Plan	CSFS	10/15/04	x	x	x	x		
Hold public open house—explain, ask input, train	Fire Depts	11/04	x	x	x	x	x	x
Sign Plan	All	12/04	x	x	x	x	x	x
Defensible Space Improvement								
Coordinate efforts to develop Defensible Space	CSFS	2X per Year	x		x		x	
Mailing and Visit Homeowners	Fire Depts	3/05	x				x	
Provide Assistance in Preparing Cost Share Grant Requests	CSFS	Yearly			x	x	x	
Technical Assist to Landowners (maybe through contractors)	CSFS &Fire Departments	Ongoing						
Marking trees	CSFS	Ongoing		x			x	
Tree/debris removal	CSFS	Ongoing		x			x	
Good Neighbor Projects								
Complete NEPA on Projects—TES clearance	USFS	Ongoing	x					
Coordinate project with adjacent landowners	CSFS	Ongoing		x			x	
Annual Project Planning (complete by Sept each year)								
Estimate costs and schedule for next years work—PNF	USFS	9/04	x		x	x	x	
Estimate costs, schedule and grants for next years work—Private & Denver Water Land	CSFS	9/04	x		x	x	x	
Estimate costs and schedule for next years work—Landowners	Pvt Landowners	9/04	x				x	
Estimate costs and schedule for next years work	Fire Depts	9/04	x	x		x		x
Annual Monitoring								
Annual Meeting of Partners (field review of accomplishments)	CSFS	11/04	x	x	x	x	x	x
Update CWPP per review by partners	CSFS	11/04	x	x	x	x	x	x
Mtg to determine interest/extent of ecological/social monitoring	CSFS	2/05	x	x	x	x	x	x



2002 Treatment Units

Unit	Acres
Russell Ridge	171
Trumbull	787
Total	**958**

2003 Treatment Units

Unit	Acres
Dell	424
Bear Mountain	815
Nighthawk	560
Russell Ridge II	168
Bennett Mountain	774
Kelsey - Unit 1	328
Noddle Head	365
Spring Creek	1066
Total	**4500**

2004 Treatment Areas

Unit	Acres
Long Scraggy	629
Pine Creek	497
Gunbarrel	380
Jenny Gulch	284
Ouzel	253
Buck	541
Kelsey - Units 2&3	100
Lower Saloon Gulch - North	584
Lower Saloon Gulch - South	407
Uppr Saloon Gulch	491
Total	**4167**

2005 Treatment Units

Unit	Acres
Twin Cedar	540
Oxyoke	223
Sugar Creek	259
Little Scraggy	449
Indian Creek	540
Flat Rock	931
Rampart	409
Roxborough	618
Total	**3968**

Other Treatment Units

Unit	Acres
Good Neighbor	695
Other Untreated Private Buffer	2450
Total	**3145**

Private Land Treatments

Unit		Acres
Mining Claims	MC	60
NW TRUMBULL	NWT	178
SWAYBACK RANCH	SR	316
OUZEL	OZ	38
SCRAGGY VIEW	SV	82
GUNBARREL	G	141
GUNBARREL	G	151
WIGWAM	W	180
GRANDVIEW	GV	38
Y CAMP	YC	143
FLETCHERS RANCH	FR	255
E TRUMBULL	ET	43
	SVC	40
	SVC	18
SPRING CREEK	SC	655
EAGLE ROCK	ER	76
TWIN CEDAR	TC	221
NIGHTHAWK	NH	52
NIGHTHAWK HILL	NHH	1829
SIXMILE	SM	295
TRUMBULL	T	282
OXYOKE	OX	272
HORSE CREEK	HC	80
Total		**5445**

USFS Proposed Treatment Units

Unit	Acres
P 1	41
P 2	34
P 3	32
P 4	120
P 5	113
P 6	47
P 7	149
P 8	465
P 9	120
P 10	112
P 11	488
P 12	219
P 13	61
P 14	67
P 15	68
P 16	103
P 17	23
P 18	95
P 19	21
P 20	240
P 21	34
P 22	55
P 23	10
P 24	254
P 25	43
P 26	92
P 27	88
P 28	142
P 29	28
P 30	108
P 31	89
P 32	41
P 33	643
P 34	323
P 35	196
P 36	28
P 37	28
Total	**4820**

SAN LUIS VALLEY AUTHORITY
The San Luis Valley GIS/GPS Authority
419 San Juan Ave
Alamosa, CO 81101
719-587-0286

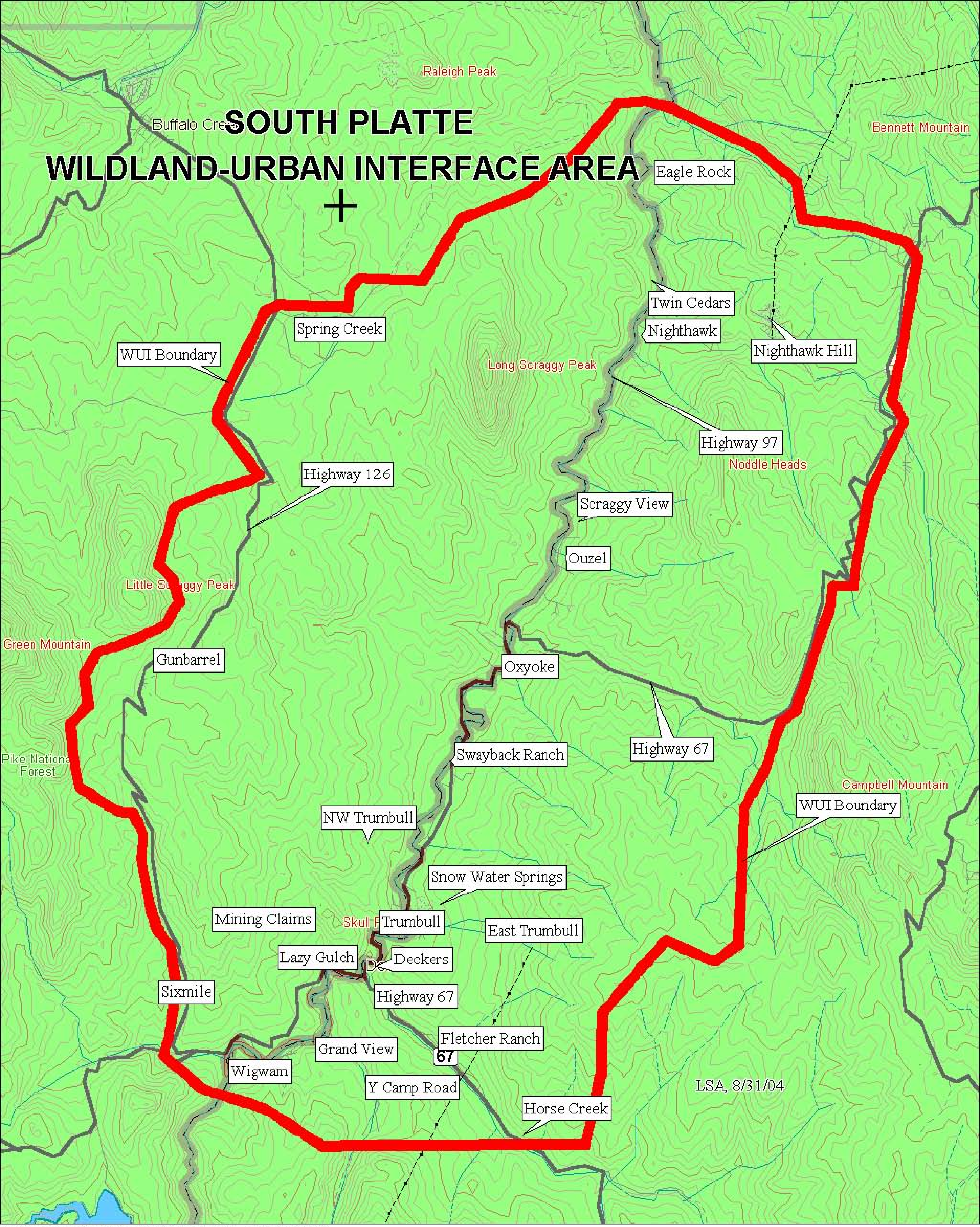
1:24,000

0 1 2 4 6 8 Miles

Vegetation Treatment Areas - 2002-2005

Upper South Platte Watershed
Protection and Restoration Project

LSA
Manager
PO Box 27944
Denver, CO 80227
Phone: 1-866-721-0704 (Toll Free)



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096

2500 ft Scale: 1 : 87,500 Detail: 10-6 Datum: WGS84

APPENDIX E – Primary Fuel and Fire Hazards

The primary fuels within the South Platte WUI area are forested land with some shrub areas between the forested areas. Fuel Models 8, 9, and 10 probably best depict the forested areas depending on the amount of dead and down material intermingled, the canopy closure and age (size) class of the timber. Fuel Model 8 depicts the aspen stands in the summer while Fuel Model 9 is more indicative of fall burning conditions in aspen. Fuel Model 2 best depicts shrub lands.

Fuel Model 2
Fire spread is primarily through the fine herbaceous fuels, either curing or dead. These are surface fires where the herbaceous material, in addition to litter and open sagebrush contribute to the fire intensity. Open shrub lands that cover one-third to two thirds of the area may generally fit this model; such stands may include clumps of brush that generate higher intensities and that may produce firebrands.

Fuel Model 8
Slow-burning ground fires with low flame lengths are generally the case, although the fire may encounter an occasional "jackpot" or heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures and low humidity's, and high winds do the fuels pose high hazards. The thinned and cleaned up stands represent this model.

Fuel Model 9
Fires run through the surface litter faster than model 8 and have longer flame height. Concentrations of dead-down woody material will contribute to possible torching out of trees, spotting and crowning. The pure stands of aspen represent this model. In the fall, after the associated grass and forbs have cured, this fuel will burn more intensely and is temporarily more of a threat.

Fuel Model 10
The fires burn in the surface and ground fuels with greater fire intensity than the models 8 and 9. Dead-down fuels include greater quantities of 3-inch or larger limb wood resulting from over maturity or natural events such as mountain pine beetle that create a large load of dead material on the forest floor. Crowning out, spotting, and torching of individual trees is more frequent in this fuel situation, leading to potential fire control difficulties. Within these types in most places there is dead material caused from blow down and insect mortality

APPENDIX F – Fuel Hazard Reduction Guidelines

TREE SPACING – RULE OF THUMB
Strive to reduce crown density to 40% or less.

Ponderosa Pine/Douglas Fir: Convert stem diameter from inches to feet and add 7 more feet.

> **Example:** A Ponderosa Pine 8" in diameter at dbh will have a spacing of 8 feet plus 7 feet for a total of 15 feet to the next tree.

The spacing does not need to be even. In fact the fuel treatment area will look more natural if the spacing varies and small clearings are intermingled with small stands of trees. The important focus should be on breaking up fuel continuity – horizontal and vertical.

Staging the thinning work over a long enough time to allow the standing trees to develop their wind firmness. Thinning when trees are small helps prevent this blow down vulnerability. Thinning in patches and designing the thinning to minimize wind effect can be done depending on location. All of these can be used but can best be accomplished with the assistance of an experienced forester.

An important part of fuel hazard reduction is removal of the ladder fuels; particularly when adequate thinning cannot be accomplished. Therefore, the following is important to do within a timber canopy.

- **Prune trees up to 6 or 8 feet depending on slope, leaving 1/3 live tree cover**
- **Remove under story reproduction**
- **Remove sagebrush, oak or any other flammable brush**
- **Remove all dead forest debris**
- **Remove trees recently killed by mountain pine beetle or any other disturbance**

**Note: All slash disposal procedures should be implemented to avoid attracting Mountain Pine bark beetle to the project area.

APPENDIX G – Evacuation Planning Guidelines

Background

The growth of urban development in forested wildland areas in recent years has resulted in a potentially hazardous situation. People are attracted to forested areas seeking solitude and to escape the pressures of everyday life. Large land holdings have been subdivided into small affordable acreages for cabin sites or remote homes. At the same time wildfires have been aggressively suppressed allowing young trees to establish in high densities and dead fuels to accumulate to alarming levels. These ladder fuels provide a "leg up" for a wildfire to burn into the crowns and move rapidly under windy conditions. The new generation of small lot landowners value individual trees and have built their cabins under the cover of these overstocked forests. Cabins are constructed on prominent points or ridge tops for the view or they are tucked into the forest canopy seeking solitude. In order to minimize the impact of their presence on the land driveways are often narrow with inadequate opportunities to turn around at the building site. Little attention has been paid to the potential destructive capacity of an uncontrolled wildfire.

In an emergency wildfire situation that threatens the lives and property of residents in the area, the Trumbull Volunteer Fire Department and the North Fork Fire Protection District, in consultation with the fire suppression team and land managing agencies, have the responsibility and authority to evacuate residents to a safe area. Prior evacuation planning is essential to implement this action effectively.

By definition, evacuation is a protective action—moving people from a place of danger to a place of relative safety. As a phenomenon, it is a temporary mass movement of people that collectively emerges in coping with a threat to park visitors.

An Evacuation Plan will facilitate this orderly evacuation during an emergency wildfire situation that threatens residents and facilities. Step by step actions provide critical information and guidance for fire suppression, and law enforcement personnel during an emergency situation. Each subdivision, home site development area or land owner association should be strongly encouraged to develop an evacuation plan for their area that identifies potential evacuation routes and critical information (locked gates, inadequate bridges, etc) for a variety of wildfire threat scenarios.

Critical Contacts

Routt County Sheriff	xxx-xxx-xxxx
Routt County Fire Warden	
Colorado State Patrol	
Colorado State Forest Service	
Colorado Division of Wildlife	
Medicine Bow Routt National Forest, Ranger District	
Bureau of Land Management Little Snake Field Office	
Interagency Fire Center/Fire Dispatch Center	
Federal Emergency Management Agency	
Routt County Emergency Preparedness Director	
Local News Media	
Red Cross	
Local Towing Service	
Others_________________	
________________________	
________________________	
________________________	

Check List When Potential For Evacuation Exists

1) Close back country roads and trails at the trail heads
2) Post on bulletin boards information regarding fire danger.
3) Set up a local Information Center where residents and visitors can access up to date information and status regarding wildfire that pose a threat to the area.
4) Provide routine updates on wildfire conditions for local radio and television stations as the threat increases.
5) When the fire suppression team and land managing agencies (probably US Forest Service) believe evacuation may become necessary, notify the Jefferson and/or Douglas County Sheriffs and Fire Wardens.
6) Fire suppression team and land managing agency manager should meet with the Sheriff to decide if an evacuation is necessary. The decision to evacuate should be made and implemented well before the evacuation needs to be complete. Local conditions and the fire's rate of advance will dictate.
7) Sheriff in consultation with the land managing agency makes the decision to evacuate the threatened area and implements the actual evacuation
8) Notify residents and visitors of the Order to Evacuate
   - Siren to alert visitors in the back country
   - Law enforcement patrol vehicles with public address systems announce evacuation order
   - House to house verification that threatened home site development is completely evacuated
   - Law enforcement vehicles and ATVs drive back country roads and trails to assure evacuation
   - Use one color flagging to mark secondary roads/trails at their junction with the primary road (evacuation route) when notification is in progress then change to another color when verification is complete on that road/trail.
9) Drive evacuation routes installing free standing traffic control signs at key road intersections and opening locked gates or cutting fences to allow exit.
10) Notify Federal Emergency Management Agency (FEMA)
11) Notify Colorado State Patrol
12) Assign law enforcement to direct traffic at critical road junctions

The officer in charge of the evacuation will make the decision regarding which evacuation route to use at the time. Depending on the situation the decision may be to use any or all of the routes to evacuate the threatened area.

Emergency Evacuation Routes

Primary emergency evacuation routes are suggested but should be validated with landowners and land managing agencies involved prior to the onset of an emergency need for evacuation. These primary evacuation routes should provide multiple opportunities for evacuating traffic to exit the area. Hazardous fuel concentrations should be treated along primary evacuation routes to reduce canopy cover to 40 percent or less and remove slash and combustible debris within 150 to 200 feet of the road. Tributary roads should be identified in local developments and treated similarly to facilitate a safe and orderly evacuation.

Estimated Time To Implement An Evacuation

The decision to evacuate a threatened area must be made well in advance of the time the fire is expected to threaten residents, visitors and facilities.

Fire Behavior and Evacuation Timing

Spread Component (SC) is the key fire danger component to monitor. The spread component is a numerical value derived from a mathematical model that integrates the effects of wind and slope with fuel bed and fuel particle properties to compute the forward rate of spread at the head of the fire. Output is in units of feet per minute. A spread Component of 31 indicates a worst-case, forward rate of spread of approximately 31 feet per minute.

The inputs required in to calculate the SC are wind, slope, fine fuel moisture (including the effects of green herbaceous plants), and the moisture content of the foliage and twigs of living, woody plants.

Since characteristics through which the fire is burning are so basic in determining the forward rate of spread of the fire front, a unique SC table is required for each fuel type.

When considering spotting, the rich diversity of fuel types scattered throughout the County, and the likelihood of wind, it may be prudent, when fire danger is Very High, to start an evacuation process when wind brings a fire to within 2 miles of a subdivision or home site development area (urban interface area). Knowing the SC for the most prevalent fuel type between where the fire is and where the home site developments are can best refine this judgment call. With a SC of 44 a fire will cover 2 miles or more within 4 hours. If the SC is 22 the fire will cover at least one mile within 4 hours and 2 miles within 8 hours. If the SC is 11 the fire will cover two miles within 16 hours. If the SC is 5 the fire can cover two miles within 32 hours.

Timing

Evacuation planning needs to take into account how long it will take to notify residents that an evacuation is necessary, how long it will take for them to get ready and start driving out of the area and then how long it takes to actually drive to a safe area. This determination should be made locally for each development area or subdivision and then validated before it is used during an emergency.

Every situation will be different but it is reasonable to estimate the minimum time required to be no less than 4 hours to complete the process. As much as three hours may be required to notify residents and visitors and get them started moving and another hour to get everyone out of the area. Residents and visitors closest to the advancing threat should be notified first. Once they are driving out of the area it will take them up to an hour in most cases to exit the area if traffic is flowing at a rate of 10 to 20 miles per hour.

Driving time should be measured on each of the potential evacuation routes by driving at a conservative speed depending on road conditions and how many people are expected to be evacuated to approximate how long it would take to drive the route during an evacuation providing traffic was moving at about that rate. The following table displays the type of information that needs to be incorporated in the Evacuation Plan.

Travel Time for Evacuation Routes

Beginning Point	Ending Point	Time Required	Miles Traveled	Average Speed

This table provides GPS coordinate locations for critical points referred to.

GPS Locations for Critical Features and Facilities

Feature	GPS Location

Recommendations

- Negotiate agreements with neighboring private land owners and land managing agencies to allow evacuation across their property on their roads and through their locked gates.
- Negotiate an agreement to thin fuels along the evacuation route between the subdivision or home development area and safe areas.
- Upgrade roads on evacuation routes by widening curves, providing water bars to prevent erosion and thinning fuels along these emergency exits.
- Construct and store freestanding “Fire Exit Directional Signs” or “Evacuation Route” for use in marking evacuation routes.
- Develop a specific evacuation procedure and assign responsibilities to Routt County staff.

APPENDIX H – Fire Effects for Vegetative Types

Douglas Fir: Pseudotsuga menziesii var. glauca

(for complete list of references by author visit
http://www.fs.fed.us/database/feis/plants/tree/psemeng/references.html#227)

Fire adaptations: In the pole and sapling stages Rocky Mountain Douglas-fir is susceptible to fire damage as bark is thin, photosynthetic, and resin-filled. Trees develop fire-resistant bark in about 40 years on moist sites in the northern Rockies. The thickness of the bark layers is about 12% to 13% of bole diameter in the northern Rockies. Mature trees can survive moderately severe surface fires because the lower bole is covered by thick, corky bark that insulates the cambium from heat damage. Fire scars are characterized by resin deposits that may increase the size of the scar in subsequent fires. Rocky Mountain Douglas-fir usually forms obvious fire scars and can survive several centuries after injury, making the history of understory fire easily studied. Rocky Mountain Douglas-fir is killed by crown damage; fine twigs and buds are particularly susceptible. Fire resistance offered by thick bark is often offset by low-growing branches which may be retained even when shaded out and no longer green. Trees that host Douglas-fir dwarf mistletoe (*Arceuthobium douglasii*) often accumulate dense brooms that increase likelihood of charring of the bole or torching.

Mature Rocky Mountain Douglas-fir is generally more fire resistant than spruces, true firs, lodgepole pine, western hemlock, western redcedar, and western white pine and slightly less fire resistant than ponderosa pine and western larch. Rocky Mountain Douglas-fir is, however, slower growing and much less fire resistant than ponderosa pine or western larch in sapling and pole stages. High fire frequency reduces the dominance of Rocky Mountain Douglas-fir relative to western larch and ponderosa pine because of the species' differential rates of growth and susceptibility to fire. During pre-settlement times frequent fire often maintained ponderosa pine rather than Rocky Mountain Douglas-fir on drier sites, as Rocky Mountain Douglas-fir did not reach fire resistant size before the next fire. On more mesic sites western larch was dominant as its bark is more fire resistant than ponderosa pine's and its deciduous habit allows it to recover from crown scorch more easily. On moist sites Rocky Mountain Douglas-fir growth is rapid enough that some reach fire-resistant size before the next fire, allowing open stands to develop. In some grasslands and savannas, fire restricted Rocky Mountain Douglas-fir to rocky microsites with sparse herbaceous fuels. Fire suppression has allowed Rocky Mountain Douglas-fir to spread from these fire-safe sites and form extensive pole-sized stands in mountain grasslands.

Rocky Mountain Douglas-fir relies on wind-dispersed seeds to colonize burned areas where trees have been killed. Mineral soil exposed by burning provides a good seedbed. Seedling establishment begins a few years after fire and is restricted to within a few hundred yards of seed trees adjacent to the fire or relatively undamaged by the fire. On xeric sites, Rocky Mountain Douglas-fir establishment is more successful in shade. On wet sites with thick litter layers, fire can aid establishment by reducing litter layer thickness. Oswald and others observed that prescribed fire (in October) favored Rocky Mountain Douglas-fir establishment on a western redcedar/queencup beadlily habitat type by reducing the thickness of litter layers. Means are presented below. Different letters indicate means significantly different at $p<0.05$:

Treatment and litter depth	Germination (%)	Mean survival (%, 1 year)	Mean height (3 yr, cm)	Mean diameter (3 yr, cm)
Burned 0-1 cm	59.3a	35.5a	7.6a	0.38b
Unburned 0-1 cm	44.9b	32.8a	4.8b	0.32c
Burned 2-4 cm	41.9b	18.9b	6.9a	0.40b
Unburned 2-4 cm	6.4d	3.4c	4.9b	0.49a
Burned >4 cm	23.1c	8.1c	5.5b	0.41b
Unburned >4 cm	9.5d	3.8c	3.6b	0.31c

Fire regimes: Fire regimes in moist Rocky Mountain Douglas-fir habitat types are mixed, ranging from low to moderate severity surface fires at relatively frequent intervals (7 to 20 years) to severe crown fires at long intervals (50 to 400 years). In some areas, large fires burn at several intensities, changing with shifts in stand structure, fuel loads, topography, and weather. The result is a mosaic of burn patterns. Intense crown fires or repeat fires generally favor seral associates such as quaking aspen or Rocky Mountain lodgepole pine. In the Bob Marshall Wilderness in Montana, Rocky Mountain Douglas-fir-dominated sites were converted to Rocky Mountain lodgepole pine by 3 fires at 30- to 40-year intervals. Another site in the same area was converted from a Rocky Mountain Douglas-fir-western larch forest to a forest dominated by Rocky Mountain lodgepole pine as a result of a single severe fire.

Central Rocky Mountains: Fire was not as frequent as in the southern Rockies and because of this it sometimes resulted in patchy stand replacement fire in and a mixed fire regime (with mean intervals of 50 years of longer). Variable forest structure was also created by postfire regeneration in the crown fire areas. Postfire regeneration was episodic and controlled primarily by climatic factors (i. e. several age groups were in a single crown fire area). Logging has reduced the variability in ages. In central Colorado there is no evidence of high frequency surface fires as is seen in the interior ponderosa pine/bunchgrass types of the southern part of the range. Fire suppression has allowed the development of dense, Rocky Mountain Douglas-fir sapling thickets and increased risk of stand replacement fire. Frequent fire prevented Rocky Mountain Douglas-fir and white fir from replacing ponderosa pine. Surface fires have been excluded for about 60 to 90 years in these stands, increasing the likelihood of stand-replacing fire.

Colorado: Fire regimes in Rocky Mountain Douglas-fir/interior ponderosa forest types below 8,200 feet (2,500 m) were historically likely "mixed and variable" with fires historically larger than 3.6 square miles (10 km^2) occurring 50 to 60 years apart; stands were not even-aged on a landscape scale. "Passive" crown fire (where crown fire occurs in a stand but does not spread to adjacent ones) was more common than "active" crown fire (where crown fire occurs and spreads from a stand) which, if it occurred, was usually very localized and confined to younger stands. When crown fire occurred it created openings. Tree recruitment thereafter was episodic and influenced by moisture. Kaufman and others modeled stand conditions prior to fire exclusion in the mid-elevation forests of Cheesman Lake: interior ponderosa pine (pure) patches were 35-50% of area (not as much on north slopes), interior ponderosa pine/Rocky Mountain Douglas-fir (>10% Douglas-fir canopy cover, 20% of trees are Douglas-fir) patches were 20-30% of the area, and 25% were very open (<10% canopy cover). The fire regime and tree recruitment patterns that create this variable forest structure were:

Process	Mean interval (years with standard errors)	Range (years)
Fires >5 km^2 in 35 km^2 landscape between 1496 and 1880	42.7 (12.7)	27-65
Fires in 0.5 to 2 km^2 areas, 1496 to 1880	50.0 (17.2)	29-83
Tree recruitment, 1588 to 1885	45.3 (23.5)	18-82

Immediate effect on plant: Fire mortality in Rocky Mountain Douglas-fir can occur via cambial damage, root damage, or crown scorch. These damage indices may be highly variable across the landscape, and root damage is difficult to quantify. Thus causal determination is limited because, by necessity, most mortality predictions or studies are based on aboveground characteristics. In addition, postfire insect infestation of individual trees is correlated with bark and crown damage parameters. An investigation of fire caused mortality in eastern Idaho and Yellowstone National Park encountered extensive variability in mortality and damage parameters: statistically, crown scorch was the best predictor of postfire mortality, but it explained very little variation ($r=-.028$, $p<0.01$) . Agee states that in Montana, Wyoming, and Idaho Rocky Mountain Douglas-fir is most commonly killed by crown destruction in fire and mortality is a function of both crown scorch and postfire insect damage. Generally Rocky Mountain Douglas fir with greater than 60% crown scorch do not survive. However, on Lubrecht Experimental Forest, mortality of Rocky Mountain Douglas-fir 8 years after a "light" surface fire in a Rocky Mountain Douglas-fir stand was best predicted by the number of quadrants of the bole with dead cambium. Secondarily, crown volume scorch was a better predictor than height of lethal scorch. Shallow lateral roots can be damaged if the organic layer burns, but this type of damage is seldom quantified or included in mortality models.

The effects of fire on Rocky Mountain Douglas-fir vary with fire severity and tree size. Seedlings are most susceptible to fire damage but can live through 122 degrees Fahrenheit (50 °C) for 1 hour, 140 degrees Fahrenheit (60 °C) for 1 minute, and 158 degrees Fahrenheit (70 °C) for 1 second. Saplings are often killed by surface fires because their thin bark offers little protection from damage. Photosynthetically active bark, resin blisters, closely spaced flammable needles, and thin twigs and bud scales are additional characteristics that make saplings more vulnerable to all fires. Surface fires intense enough to kill saplings by girdling them often also scorch the entire crown.

Chance of survival generally increases with tree size. Because larger trees have thicker bark and larger crowns, they can withstand proportionally greater bole and crown damage than small trees. Following a low- to moderate-severity surface fire in an open mixed-conifer stand in Colorado, 64 out of 103 Rocky Mountain Douglas-fir trees died within 2 years. Live trees averaged 9.5 inches (24 cm) in diameter and 32 feet (9.8 m) in height, while fire-killed trees averaged 5.6 inches (14.3 cm) in diameter and 22.6 feet (6.9 m) in height. Fire resistant bark develops by about age 40, but branching habit and stand density can offset this fire resistance. If branches grow (or are dead and retained) along the entire bole, as is common when the tree is open-grown, fire can climb into the crown. If regeneration is dense and crowns overlap, the potential for canopy fire is even greater. In the Yellowstone fires of 1988 Rocky Mountain Douglas-fir types had little stand replacing fire even though many fires started. Most fires started prior to curing of surface fuels: the fuel arrangement did not allow crown fire to start but carried surface fire in adjacent stands.

Fuel type and arrangement, and related fire behavior, vary greatly in dry Douglas-fir habitat types. Where surface fuels are discontinuous, many trees survive burning. If there are heavy fuel accumulations around bases of trees, severe cambial damage can occur from surface fires that otherwise burn primarily in the litter. Trees infested with Douglas-fir dwarf mistletoe, rust fungi (*Chrysomyxa* or *Melampsorella*), and/or needle cast fungus (*Elytroderma deformans*) commonly have suppressed growth and large accumulations of dead, fallen "brooms" around their base. The branches of the brooms have a higher than normal proportion of compression wood, decreasing their susceptibility to decay and increasing the length of time that they are a fire hazard. When ignited, this fine debris burns hot, girdling the bole and/or providing a fuel ladder to torch the crown. Trees with brooms may increase fire spotting.

Discussion and qualification of fire effect: There have been a number of models to predict succession, fuel consumption, or mortality in forests that include Rocky Mountain Douglas-fir; these include CLIMACS, NONAME, and FIRESUM. A model of mortality was developed by Ryan for Rocky Mountain Douglas-fir and Pacific ponderosa pine on Lolo National Forest, Montana. Peterson and Ryan modeled fire mortality in Rocky Mountain Douglas-fir for the northern Rocky Mountains for trees 15.5 m tall with diameter of 20 cm; time to cambial kill was 3.2 minutes in late summer. For a 40 cm diameter, 24.4 m tall tree, critical time to cambial kill was 13.4 minutes for the same conditions. The critical time for seedling mortality at any temperature has been modeled with the following equation (where T is temperature C°, and t is time in minutes): $T= 59.44- 2.291 \log_e t$. The FIRESUM (FIRE SUccession Model) was applied to a Rocky Mountain Douglas-fir/ninebark habitat type of western Montana. With a 10-year fire return interval, predicted fireline intensities were approximately 50 to 100 kW/m; with a 20 year return interval, predicted fireline intensities were 80 to 150 kW/m; predicted fireline intensities with a 50 year return interval were 300 to 1,200 kW/m. Cambial and root damage or postfire insect damage may be partial causes of the inability of crown scorch-based models to consistently accurately predict mortality.

Plant response to fire: Indirect postfire mortality: Douglas-fir beetle, wood borers, Douglas-fir tussock moth and western spruce budworm cause significant postfire mortality, particularly as some insect populations have increased as a result of fire suppression. Small-scale outbreaks of Douglas-fir engraver beetles sometimes occur after "light ground fires," and root rot interacting with fire damage may also cause mortality. On sites surveyed in Yellowstone National Park after 1988, postfire mortality was 31.7%: 18.5% from fire, 12.6% from interaction of fire, bark beetle, and wood borer, and 0.6% unidentified. Postfire bark beetle infestation occurs when the phloem is not too damaged (hardened or scorched) as this condition inhibits feeding. Thus the highest probability of significant postfire outbreak is in stands where most vegetation is scorched but few trunks are blackened. Bark beetles must utilize injured trees before the phloem becomes too dry for feeding. Bark beetles usually used larger fire-injured trees. After the Yellowstone fires of 1988 Douglas-fir beetle infestation was highest in the trees where the percentage of basal circumference killed by fire was highest; 77% of Rocky Mountain Douglas-fir with bark beetle infestations were at least 50% girdled by fire. Infestation was also more common in trees with "ample green phloem and less than 75% crown scorch". After a large stand-replacement fire on Shoshone National Forest, Wyoming Pasek and others noted that most areas of large-diameter Douglas-fir adjacent to burned areas "likely were infested" by Douglas-fir beetle in 1990. In another postfire study in Yellowstone 83% of dead Rocky Mountain Douglas-fir were infested with wood borers and Douglas-fir beetles; 34% of living trees were infested. Bark beetle populations in fire-injured trees in Yellowstone caused increased infestation of residual trees that were not fire-injured. The most severely damaged trees were generally utilized in the 1st year; in following years trees with less severe damage were utilized. Cumulative percentages of insect infestation and mortality for 4 postfire years (n=125):

	Year			
	1989	1990	1991	1992
Infested	24%	62%	76%	79%
Dead	12%	37%	52%	77%

Postfire growth: Though thinning via fire can increase growth of residual trees, radial growth can be greatly reduced for up to 4 years following fire. At Lubrecht Experimental Forest, western Montana, in a Rocky Mountain Douglas-fir/big huckleberry habitat type, Rocky Mountain Douglas-fir had similar growth on sites that had prescribed understory fire and those that did not. On sites on the Salmon-Challis National Forest of central Idaho, Bitterroot National Forest, and Yellowstone National Park, 75% of Rocky Mountain Douglas-fir trees showed a decline in mean basal area increment over the 1st 4 postfire years (wildfires with no description given). In Rocky Mountain lodgepole pine/Rocky Mountain Douglas-fir mixed stands, postfire growth always declined when crown scorch exceeded 50% in Rocky Mountain Douglas-fir. At these sites surviving burned Rocky Mountain Douglas-fir had the following characteristics (n=135):

	Mean	Standard deviation	Minimum	Maximum
Diameter (cm)	35.9	15.1	13.9	109.0
Height (m)	18.1	15.1	9.0	47.0
Bark thickness (cm)	1.9	0.8	0.3	4.7
Scorch height (m)	9.7	4.8	2.5	23.0
Crown scorch (%)	40.1	26.8	0	100
Basal scorch (%)	84.0	27.5	0	100
Bark char (cm) upslope	1.00	0.78	0	5.40
Bark char (cm) downslope	0.60	0.60	0	2.10
Bark char ratio	0.45	0.31	0	1.50

Rocky Mountain Douglas-fir seedling establishment following fire is dependent on the spacing and number of surviving seed trees. Following large, stand-replacing fires, Rocky Mountain Douglas-fir seedling establishment is slow. Seedlings are restricted to the burn edge or near surviving trees within the main burn. Germination of artificially sown seed was about 60% on burned seedbeds but only 10% on unburned duff. On logged sites Rocky Mountain Douglas-fir establishes after slash burning, particularly where Douglas-fir is a seral species, such as in grand fir or subalpine fir habitat types, on north- and east-facing slopes. On dry, south- and west-facing slopes some shade is often needed for seedlings to survive. Many tree associates are more dependent on mineral soil for seedling establishment than Douglas-fir is. Thus burning may increase the percentage of associates such as Pacific ponderosa pine, Rocky Mountain lodgepole pine, and western larch.

Fire management considerations: Prescribed burning: Prescribed fire can be used for reducing fuel loadings, understory conifer reduction, or when thinning is impractical or in conflict with other uses. The likelihood of ladder fuels allowing ponderosa pine mortality raises concerns about wildlife habitat and biodiversity. Fire management can increase the variety of stand types and densities and reduce risk of severe fire. Prescribed burning has been used to limit invasion of Rocky Mountain Douglas-fir in bunchgrass habitat types, and for site preparation, fuel reduction, and habitat improvement in increasingly crowded forests of the Intermountain West. Low-severity surface fires generally lessen fuel loading, stimulate shrub and herbaceous growth, kill saplings, and increase plant-available nutrients in soil.

A first step to reducing Rocky Mountain Douglas-fir cover on sites that were historically open savannas often is a "low thinning" treatment. This process mechanically removes some understory Rocky Mountain Douglas-fir as well as suppressed members of the overstory and thus reduces the likelihood of canopy fire destroying desired overstory trees. When burning understory in ponderosa pine-western larch-grand fir forests, Rocky Mountain Douglas-fir leave trees should be larger than 16 inches (40 cm) in diameter when fuels exceed 30 tons/acre (73 t/ha). Heavy fuels within 6 feet (1.8 m) of the base of leave trees should be removed. Damage to desired Pacific ponderosa pine, western larch, or Rocky Mountain Douglas-fir can be minimized by moving fuel from bases of trees or prescribing fire under moist conditions. Late summer and fall fires damage Rocky Mountain Douglas-fir foliage less than spring fires; accordingly, fires designed to eliminate encroaching saplings are often prescribed in the spring, weather permitting. Predicted mortality, fuel reduction, and smoke production in a Pacific ponderosa pine-Douglas-fir stand in the Bitterroot National Forest, Montana during hypothetical low-severity prescribed fire and severe wildfire are as follows:

Fuel consumption (tons per acre)	Prescribed understory fire	Wildfire
Duff	2.0	5.1
Small woody (0-3" diameter)	3.5	3.5
Large woody (3"+)	3.7	4.1
Canopy fuels	1.0	5.4
Particulate matter (less than 10 microns) emission (pounds per acre)	271	450
Tree mortality (%) all species by diameter		
0-4"	91	96
4.1-8"	63	96
8.1-12"	40	79
12.1-16"	27	88
16.1"	23	80

Fuel reduction: In ponderosa pine/Rocky Mountain Douglas-fir stands, fire severity can be controlled by selecting burn conditions/days that eliminate most fine fuels but do not burn large fuels or all duff. Complete duff consumption can allow excessive erosion and is thus usually avoided. Robichaud and others burned a mixed western hemlock, grand fir, western white pine, western larch, and Rocky Mountain Douglas-fir stand with relatively moist conditions in late April. This reduced fuel loading and fire hazard and improved regeneration conditions by removing 50% of litter and only 22% of humus while protecting mineral soil from erosion. An experimental burn in the Bitterroot National Forest provides an example of conditions that allow fuel reduction while protecting soil from erosion: fine fuel moisture was 9%, duff moisture was 50%, large woody fuel moisture was 90%; 65% of litter and "small woody fuels" was consumed and duff was reduced 20%. In western larch-Rocky Mountain Douglas-fir forests in western Montana, broadcast burning in clearcuts or in standing timber can be controlled and practical when small diameter fuel (less than 4 inches (10 cm)) moisture content is between 10 and 17%. Norum offers "when to burn" guidelines that include the combined effects of moisture content and dead fuel loading for minimizing crown fire risk in western larch Rocky Mountain Douglas-fir stands. Fresh, cured coniferous logging slash is generally very flammable because of its loose arrangement and high percentage of needles and twigs. Flammability decreases with time, particularly as needles are compacted by winter snow. In experimental burns with 32.5 tons of slash per acre (80 t/ha) and relative humidities of 52 to 70%, the rate of fireline spread in fresh, cured Rocky Mountain Douglas-fir logging slash was 20.7 seconds/foot, while the rate of spread in 1-year-old slash was 70 seconds/foot.

Insect outbreaks: The duration and intensity, but not the frequency, of western spruce budworm epidemics have increased since 1910. Douglas-fir beetle populations and Douglas-fir dwarf mistletoe infestation have also increased. Insect epidemics, though "naturally occurring," have been exacerbated by the presence of other insect or disease outbreaks, past high-grading timber extraction, and fire exclusion. Low thinning and surface fire prescriptions that favor ponderosa pine will likely reduce the frequency and/or duration of insect outbreaks. Douglas-fir dwarf mistletoe is controlled by fire. Alexander and Hawksworth state that high-severity fire controls Douglas-fir dwarf mistletoe because canopy elimination "sanitizes" the areas and trees recolonize burned sites faster than the parasite.

Invasion of grasslands and fire: To control Rocky Mountain Douglas-fir invasion of sagebrush-bunchgrass communities, spring fires are best to kill young Rocky Mountain Douglas-fir; the primary disadvantage to spring burning is that sometimes fuels do not dry sufficiently during this short period. Gruell and others provide much information on prescription specifics for sagebrush-grasslands at different degrees of Rocky Mountain Douglas-fir invasion. Grazing can reduce fire danger by reducing fuels, and this decrease in fire frequency is in part responsible for Rocky Mountain Douglas-fir's invasion of these communities. Fire and grazing history greatly influence the fuel buildup. In northern Idaho, Rocky Mountain Douglas-fir was more susceptible to fire damage in stands subjected to years of livestock grazing than in ungrazed stands. Ungrazed stands remained open and parklike, and had a nearly continuous distribution of small fuels that carried fire well. Prescribed fires had flame lengths up to 36 inches (91 cm), but spread rapidly and only scorched the lower crowns of large trees. On grazed sites open stands were converted to dense pole stands with sparse understories and numerous sapling thickets. These stands had a greater accumulation of duff and large woody fuels that contributed little to fire spread. This resulted in a less intense but slow-spreading fire that was more damaging to trees, probably because of the long residence time. Heavy grazing, however, can have the opposite effect in some cases; if unpalatable species become more dominant, probability of fire increases. Published guides outline prescribed burning objectives and techniques for killing invading Rocky Mountain Douglas-fir in bunchgrass habitat types.

Soils: Effects of fire on soil nitrogen are variable. Use of "cool" prescribed fire in moist conditions in a 250-year-old Rocky Mountain Douglas-fir, western larch, subalpine fir, Engelmann spruce stand resulted in a temporary increase in available nitrogen. In 1976, Debyle found that soil nitrogen decreased after prescribed fire in a clearcut Rocky Mountain Douglas-fir-western larch site; Jurgensen and others stated that this was the result of the fire's high severity and surface fuel consumption. It is important to note that even where available nitrogen decreases, nitrogen fixation and other inputs compensate for this over the development of the stand. Harvey and others found that broadcast burning of slash (rather than "intensive removal") significantly ($p<0.05$) reduced the number of active ectomycorrhizal tips per tree. They suggest that when site preparation is used for natural or planted regeneration, organic layers that are less disturbed benefit the ectomycorrhizal symbiosis and nutrient uptake.

Ponderosa Pine: Pinus ponderosa var. scopulorum

(for complete list of references by author visit
http://www.fs.fed.us/database/feis/plants/tree/pinpons/references.html#227)

Fire adaptations: Interior ponderosa pine is rated "very resistant" to fire. No other conifer within its range is better adapted to survive surface fires, which often char but usually do not kill mature trees. Adaptations to survive surface fires include open crowns; self-pruning branches; thick, insulative, relatively unflammable bark; thick bud scales; tight needle bunches that enclose and protect meristems, then open into a loose arrangement that does not favor combustion or propagation of flames; high foliar moisture; and a deep rooting habit. Trees in widely spaced stands are typically better equipped to survive surface fire than trees in denser stands because they develop thicker bark. Ponderosa pine cannot survive crown fire, but mature trees can survive a considerable amount of scorching.

Surface fire often kills interior ponderosa pine seedlings and saplings; however, the effect is dependent upon fire severity and stand structure. Young trees in open canopies acquire fire-resistant traits rapidly, and 6-year-old saplings often survive low-severity surface fire. Fire is especially damaging in overcrowded young stands: the relatively denser foliage and thinner bark of trees in thick stands reduce resistance to surface fire. Such stands are also prone to crown fire.

Fire prepares a favorable seedbed for interior ponderosa pine regeneration. Periodic surface fire removes the heavy litter and duff that accumulate in ponderosa pine forests. Wind-borne seeds falling from the crowns of surviving or fire-killed trees land on a nutrient-enriched mineral seedbed under an open canopy that favors germination and seedling establishment. Seedling-water relations may be enhanced when fire removes competing vegetation.

Fire regimes: Interior ponderosa pine evolved under a regime of frequent surface fires and infrequent mixed-severity and stand-replacement fires. Presettlement fires in lower-elevation (<7920 feet (2400 m)) ponderosa pine communities were mostly low- to moderate-severity surface fires that maintained open-grown, parklike stands. Prior to the 1900s interior ponderosa pine was perpetuated by surface fires that recurred every 5 to 30 years. Fire return intervals tended to be shorter in the warm, dry forests of the Southwest than in the cool, dry forests of the central Rocky Mountains or the cool, relatively moist forests east of the northern Rocky Mountains. For example, Dieterich and Swetnam report a 2-year mean fire return interval for presettlement interior ponderosa pine on the Fort Valley Experimental Forest near Flagstaff; Laven and others report a 45.8-year mean fire return interval (range=20.9-66.0 years) for the Front Range of Colorado; and Brown and Sieg report an average fire return interval of 22 years for presettlement interior ponderosa pine forests of South Dakota. Gruell provides an annotated record of wildfires that occurred throughout interior ponderosa pine's range during the settlement period (1776-1900). Historic fire regimes are summarized by state and region in the ending paragraphs of this section.

Fire history studies show mixed-severity fire regimes for some interior ponderosa pine forests. Many forests experienced infrequent, large stand-replacement fires prior to the European-American settlement period. For example, Laven and others reported a range of 3 to 161 years (mean (m)=45.8) for the central Colorado Front Range. Small fires occurred on average every 20.9 years; large fire occurrence averaged 41.7 years. Higher-elevation (>7920 feet (2400 m)), relatively mesic mixed-conifer forests with interior ponderosa pine, Rocky Mountain Douglas-fir, and Rocky Mountain lodgepole pine tend to have more mixed-severity fires than lower-elevation interior ponderosa pine forests. This is probably because herbaceous species recover from fire more quickly, and dry out earlier in the season, at low elevations. In the northern Colorado Front Range, mean fire interval for widespread (≥ 10 trees scarred), mixed-severity fire in higher-elevation forests during 1650 to 1920 ranged from 34 to 43 years; mean fire interval for widespread, mixed-severity fire in lower-elevation interior ponderosa pine forest was 14 to 24 years. During the same period, mean fire interval for localized (2-9 trees scarred) fires in higher- and lower-elevation ponderosa pine forest was 17 to 22 years and 8 to 18 years, respectively. Interior ponderosa pine at 5,633 to 5,919 feet (1707-1804 m) in the Chiricahua Mountains experienced an historical fire return interval ranging from 1 to 15 years (m=6.17 years) compared to a range of 1 to 31 years (m=7.96 years) in higher-elevation (6,801-7,002 feet (2073-2134 m)) mixed-conifer forest in the Chiricahua Mountains. Some higher-elevation mixed-conifer forests show an historical fire regime similar to lower-elevation ponderosa pine, however. Swetnam and Basian suggest that mixed-conifer forests on dry, steep slopes, where fire can easily ignite and spread upslope from many directions, are most likely to experience frequent surface fire.

Native American burning influenced fire regimes in ponderosa pine ecosystems prior to and during European-American settlement, mostly by increasing fire frequency. For example, in studying fire history in the Chiricahua Mountains of southeastern Arizona, Seklecki and others found that southwestern ponderosa pine showed a shorter fire return interval (mean=3.0 years, range=1.0-16.0 years) between 1700 and 1900, when Chiricahua Apaches inhabited the area, than in earlier periods when Apaches did not reside there. Dormant-season (spring) fires were also more frequent during that time period in southwestern ponderosa pine sites of the Chiricahua Mountains compared to southwestern ponderosa pine sites near the Mexican border, which were used as travel corridors but mostly unoccupied at that time. Near the border, most fires occurred in the late May to early June growing season. Fire frequency increased to 1 per year (an uncommonly low number for southwestern ponderosa pine) during the

Spanish-Apache wars of 1760 to 1780, when Apaches probably used fire as a method of warfare. Fire occurrence terminated abruptly in the late 1880s, coincident with Apache resettlement to reservations (Geronimo surrendered in 1886) and increased livestock grazing by European-Americans.

Fire regimes in interior ponderosa pine also affect regimes of adjacent communities. In many cases, fire frequency has been reduced in adjacent communities because ignitions in interior ponderosa pine are suppressed and fire does not spread into adjacent communities. For example, stand structure of a shrub live oak-hairy mountain-mahogany (*Quercus turbinella-Cercocarpus montanus* var. *paucidentatus*) community on the Prescott National Forest of Arizona was historically a fire-maintained mosaic of different-aged chaparral. Mean fire frequency in the adjacent interior ponderosa pine/Arizona white oak (*Q. arizonica*) stand was 2 years. After over 100 years of fire exclusion, the chaparral stand is even-aged and senescent, with heavy accumulations of dead material. Interior ponderosa pine is encroaching into the chaparral.

Climate and fire frequency: Long-term fire history studies on the northern Colorado Front Range show that interannual variability in soil moisture is more conducive to widespread fire than drought alone. Fire occurrence, especially widespread fire, tends to increase 1 to 4 years after above-average moisture availability in spring-summer. Similarly, fire occurrence tends to increase 2 to 3 years after above-average precipitation in winter-spring. Climatic variation that produces widespread, stand-replacing fire has been associated with southern oscillation events. El Nino is associated with greater soil moisture and herbaceous fuel production in spring, with fire occurrence peaking several years after El Nino events. La Nina events are associated with dry springs, with fire occurrence peaking in the same year. A decline in fire frequency in interior ponderosa pine forests of the Southwest coincided with reduced El Nino-La Nina events between 1780 and 1830. Alternating wet and dry years resulting from El Nino-La Nina events in the mid- to late 1800s increased fire frequency.

Fire exclusion: The ecological changes that have occurred in ponderosa pine forests over the last century have been well documented by a number of researchers. Frequent, mostly light-severity surface fires thinned small trees, especially the less fire-resistant Rocky Mountain Douglas-fir and firs. The combined effects of 60 to 80 years of fire exclusion, logging that removed many overstory pines, heavy livestock grazing, and climate change have created closed-canopy stands with dense understories and ladder fuels. These changes have been documented throughout interior ponderosa pine's range, and have also occurred in interior ponderosa pine/Douglas-fir and mixed-conifer types. A fire history study of interior ponderosa pine stands near Flagstaff, Arizona, documented changes in stand structure over a 116-year period.

Stand structure in 1876 (reconstructed) and in 1992:

	Trees/acre	
Dbh class (inches)	1876	1992
0-3.9	0.3	945
4-7.9	0.7	243
8-11.9	1.0	46
12-15.9	1.4	6.7
16-19.9	1.7	1.6
20-23.9	2.1	2.5
24-27.9	2.4	2.4
28-31.9	2.8	4.1
32-35.9	3.1	1.7
36-39.9	3.5	0.3
40-43.9	3.8	0.2
Total	22.8	1,253.5

When wildfire burns these dense interior ponderosa pine stands under dry conditions, the abundant fuel quickly allows it to develop a high intensity and to spread into tree crowns. Severe, stand-replacing fires were infrequent in interior ponderosa pine forests in the past; now they are common. Abundant litter and living and dead woody fuels feed explosive wildfires of intensities and sizes that have not occurred for many centuries, if ever. The increasingly frequent occurrence of large, crowning wildfires in interior ponderosa pine may indicate a shift to a fire regime characterized by very large (> 100 000-acre (4000 ha)) crown fires. Data in Sackett and others show a great increase in the number of acres burned by wildfire in Arizona and New Mexico since 1970. Over 100,000 acres (40 000 ha) burned from 1915 to 1990, with 70% of the fires occurring after 1970. Before 1970, total acreage burned per year never exceeded 130,000 acres (52 000 ha). After 1970 there were 8 years in which total acreage burned exceeded 119,000 acres (47 600 ha), with nearly 500,000 acres (200 000 ha) burning in 1989. On the Mexican side of the international border, where there is a lack of effective fire suppression, frequent, widespread surface fires have persisted in southwestern ponderosa pine and mixed-conifer forests.

Besides unprecedented, large-acreage severe fires, other ecological consequences of fire suppression in interior ponderosa pine ecosystems include:

- decreases in soil moisture and nutrient availability
- decreases in spring and stream flows
- decreases in animal productivity
- increased concentrations of potentially allelopathic terpenes in pine litter
- decreases in productivity and diversity of herbaceous and woody understory species
- decreases in tree vigor, especially the oldest age class of pines, and
- increased mortality in the oldest age classes of trees

Organisms within interior ponderosa pine ecosystems have evolved with fire, and frequent fires are probably required to maintain ecosystem health. Some researchers have questioned whether ponderosa pine ecosystems are sustainable under current conditions.

Fuels: Even within the same provenance, fuel loadings in ponderosa pine stands may vary greatly depending upon age class, stand structure, and understory composition. Prediction equations for fuel loads in ponderosa pine are available. Mean fuel loadings (tons/acre, 0-1 inch and > 1-inch fuels) have been calculated for ponderosa pine stands on 3 Reservations, 2 National Parks, and 8 National Forests of Arizona and New Mexico. The study involved 62 sites: mean forest floor loading for the entire 62 stands was 12.5 tons/acre (4.1 t/ha).

Absence of fire in interior ponderosa pine and mixed-conifer forests has led to uncharacteristically large accumulations of surface and ground fuels. Structurally, fire exclusion has led to vertical continuity, with Douglas-fir, firs, and other shade-tolerant, less fire-resistant species in the understory. These late-successional species become ladder fuels that encourage crown fires in interior ponderosa pine and mixed-conifer forests. In the dry southwestern climate, the natural accumulation of pine needles and woody fuels is exacerbated by slow decomposition.

State and regional fire regime studies

Black Hills and interior Northwest: Fire season on the interior ponderosa pine-grassland savannas of eastern Montana and the Dakotas peaks in July and August, when the majority (73%) of lightning-strike ignitions occur. Wildfire season generally extends from April to September. Frequent surface fires historically burned litter and killed young interior ponderosa pine and other non-sprouting woody species encroaching into grasslands. Interior ponderosa pine in the Black Hills was historically characterized by 2 communities: interior forest and savanna. These treed landscapes were described as "islands" surrounded by plains grasslands. Brown and Sieg found that in interior forest sites at Jewel Cave National Monument, South Dakota, fire return intervals from the 1500s to the late 1800s averaged 20 to 24 years, with a range of 1 to 93 years. Fire return intervals at savanna sites in Wind Cave National Park, South Dakota, averaged 10 to 12 years, with a range of 2 to 23 years. The fire return interval of interior ponderosa pine savannas is the shortest documented for northern interior ponderosa pine ecosystems, and is similar to the short-return intervals of interior ponderosa pine forests in the Southwest.

Invasion of interior ponderosa pine onto grasslands, and increased tree density in formerly open savanna, is thought to be largely attributable to reduced fire frequency, although grazing has probably contributed to increased interior ponderosa pine density on forest and grassland margins. A little less than one-half of interior ponderosa pine in the Black Hills are single-storied, even-aged stands that developed after crown fires or mountain pine beetle epidemics. "Dog-hair" interior ponderosa pine thickets are common on many sites.

Brown and others report the following measures of fire frequency on interior ponderosa pine sites less than 50 acres (20 ha) in size:

Site	Period of Analysis	No. of Intervals	Median Fire Interval (years)	Range of Intervals (years)	Years Since Last Fire
Black Hills, SD	1580-1887	9	23	11-74	110 (1887-1997)
Black Hills, SD	1668-1890	7	22	13-72	107 (1890-1997)
Medicine Bow NF, WY	1436-1911	15	26	8-74	86 (1911-1997)
Medicine Bow NF, WY	1460-1909	12	33.5	8-82	88 (1909-1997)
Arapahoe-Roosevelt NF, WY	1568-1861	4	80.5	10-122	136 (1861-1997)
Arapahoe-Roosevelt NF, WY	1568-1887	3	117	80-122	110 (1887-1997)
Rio Grande NF, CO	1528-1896	26	9.5	2-41	101 (1896-1997)

Colorado: A fire history study of a 10,000-acre (4000 ha) interior ponderosa pine-Rocky Mountain Douglas-fir site in central Colorado showed a pattern of frequent surface fires from 1197 to 1851. Large stand-replacement fires were rare, but several landscape-level fires are documented. Intervals between fire years ranged from 1 to 128 years at the landscape scale and from 1 to 58 years for individual stands. Fires occurred throughout the growing season. Fire size varied across time; for example, numerous small fires occurred in the 1500s, while landscape-level fires occurred in 1631, 1696, and 1723. After 1723, there were few fires until 1851; that fire was a stand-replacement, mixed crown and severe surface fire that covered most of the landscape. There have been no extensive fires in the study area since 1851, and most stands have not experienced fire for nearly 100 years.

There are many western plant communities and ecosystems in which interior ponderosa pine is either dominant, an important component of the vegetation, or an invader. Historic fire return intervals for these communities and ecosystems are summarized below. Please refer to the Fire Effects Information System report on the dominant species listed here for further information on fire regimes in these communities and ecosystems.

Community or Ecosystem	Dominant Species	Fire Return Interval Range (years)
Nebraska sandhills prairie	*Andropogon gerardii* var. *paucipilus*-*Schizachyrium scoparium*	< 10
sagebrush steppe	*Artemisia tridentata/Pseudoroegneria spicata*	20-70
mountain big sagebrush	*A. t.* var. *vaseyana*	20-60
Wyoming big sagebrush	*A. t.* var. *wyomingensis*	10-70 (40**)
plains grasslands	*Bouteloua* spp.	< 35
blue grama-needle-and-thread grass-western wheatgrass	*B. gracilis-Hesperostipa comata-Pascopyrum smithii*	< 35
blue grama-buffalo grass	*B. g.-Buchloe dactyloides*	< 35

grama-galleta steppe	*B. g.-Pleuraphis jamesii*	< 35 to < 100
curlleaf mountain-mahogany*	*Cercocarpus ledifolius*	13-1000
mountain-mahogany-Gambel oak scrub	*C. l.-Quercus gambelii*	< 35 to < 100
Rocky Mountain juniper	*Juniperus scopulorum*	< 35
wheatgrass plains grasslands	*Pascopyrum smithii*	< 35
Engelmann spruce-subalpine fir	*Picea engelmannii-Abies lasiocarpa*	35 to > 200
pinyon-juniper	*Pinus-Juniperus* spp.	< 35
Rocky Mountain lodgepole pine*	*Pinus contorta* var. *latifolia*	25-300+
Colorado pinyon	*P. edulis*	10-49
interior ponderosa pine*	*P. ponderosa* var. *scopulorum*	2-46
Arizona pine*	*P. p.* var. *arizonica*	2-10
quaking aspen (west of the Great Plains)*	*Populus tremuloides*	7-120
mountain grasslands	*Pseudoroegneria spicata*	3-40 (10**)
Rocky Mountain Douglas-fir*	*Pseudotsuga menziesii* var. *glauca*	25-100
bur oak	*Quercus macrocarpa*	< 10
oak savanna	*Q. m./Andropogon gerardii-Schizachyrium scoparium*	2-14

*fire return interval varies widely; trends in variation are noted in the species report
**mean

Immediate effect on plant: The effect of fire is related to tree size, fire severity, and stand density. Low-severity surface fires usually kill trees less than 3 to 5 years of age or less than 6 inches (15 cm) dbh, and mortality in the 6- to 30-inch (15-76 cm) dbh class is not unusual. Researchers in Zion National Park, Utah, found surviving 10-year-old interior ponderosa pine seedlings that were scarred from low-severity surface fire. Trees in dense stands and trees infected with southwestern dwarf-mistletoe are most susceptible to mortality, particularly in the smaller size classes. Pole-sized and larger trees are resistant to low-severity surface fires. Thick bark affords protection against cambial damage, and foliage and buds are usually elevated away from the flame zone. However, intense radiant heat produced by moderate-severity fire, or flames that reach buds, can damage or kill mature trees. Severe surface or crown fires generally kill interior ponderosa pine of all size classes, although some sawtimber-sized trees may survive severe surface fire. Heavy accumulations of litter at the base of trees increase the duration and intensity of fire, making trees more susceptible to scarring. Resin deposits around an old "cat-face" may increase bark flammability and promote further injury.

On the Coconino National Forest, a mixed-severity wildfire on 7-9 May 1972 killed about 1/4th of the standing interior ponderosa pine where surface fire severity was moderate. Mortality was greatest in the smaller diameter classes: 90% of "pulpwood" and 7% of "sawtimber" were killed by moderate-severity fire. Approximately 2/3rds of the trees were killed where severe surface or crown fire occurred. Ninety percent of pulpwood and 50% of sawtimber were killed where fire was severe. The summer after the fire, basal area was 211 ft^2/acre (47.5 m^2/ha) on an adjacent unburned area; 103 ft^2/acre (23 m^2/ha) on the moderate burn; and 40 ft^2/acre (9 m^2/ha) on the severe burn.

Discussion and qualification of fire effect: With its high foliar moisture content, interior ponderosa pine can withstand extensive scorching as long as bud and twigs, which tolerate higher temperatures than needles, are not badly scorched. Ponderosa pine may recover from as much as 90% scorching as long as 50% of buds and twigs survive to maintain shoot growth on defoliated branches. Extensive scorching of ponderosa pine crowns may cause mortality within 3 postfire years. Generally, ponderosa pine recovery is best after dormant-season scorching; trees scorched in the growing season show poorer survivorship. After a growing-season (July) wildfire in northern Arizona, Herman noted at least 65% survival for trees greater than 8 inches (20 cm) dbh that had less than 60% crown scorch, while Dieterich observed 89% recovery of 6 to 14-inch (15-36 cm) dbh trees that had been up to 90%

scorched by dormant-season (November) wildfire on the Coconino National Forest. Studies of postfire survivorship after scorching show mixed results, however. Davis and others reported that more than 75% of ponderosa pines (5- to 11-inch (13-28 cm) dbh class) scorched more than 67% died within 2 years following a dormant-season (October) prescribed fire on the Coconino National Forest.

Dormant-season studies indicate that bud kill, which is related to fire season, is more important than foliage kill in determining chances of ponderosa pine survival after burning. Wagener and Harrington found the minimum requirement for ponderosa pine survival was 90% or less scorch with 50% or more of bud and twigs remaining. Five years after prescribed burning on the San Juan National Forest of Colorado, Harrington found significant (p=0.05) differences in mortality of scorched interior ponderosa pine, depending upon season of burning. Mortality was lowest for fall-scorched trees (5%), and spring-scorched trees showed less mortality than summer-scorched trees (17 vs. 21%, respectively). Ninety percent of fire-damaged interior ponderosa pine that died had done so by postfire year 4. Most trees greater than 7.2 inches (18 cm) diameter survived fall burning even with 90% scorching. With spring and summer burning, trees less than 4 inches (10 cm) diameter died with greater than 50% scorching, while at least 90% scorching was required before trees larger than 4 inches (10 cm) in diameter were killed by spring or summer fire.

Mortality models: McHugh and Kolb found a model using total crown damage by fire (scorch + consumption) and bole char severity as independent variables gave the best 2-way variable model for predicting individual tree mortality for prescribed and wildfires in northern Arizona. A study on the Colorado Front Range found that crown scorch, expressed as a percentage of the prefire live crown length, was the best determinant of postfire mortality of interior ponderosa pine. Wyant and Zimmerman found that degree of crown scorch and tree size was the most effective predictors of postfire survival potential after September prescribed burning in Colorado. They provide a model for estimating mortality based upon percent crown scorch and dbh.

Mortality studies: Harrington and Hawksworth conducted prescribed burning treatments to interior ponderosa pine on the South Rim of Grand Canyon National Park, Arizona. They found that mortality generally increased with decreasing tree size and increasing crown scorch, bole char, and southwestern dwarf-mistletoe infection. Trees with greater than 87% crown scorch experienced 100% mortality, even in the 30- to 36-inch (76-92 cm) size class. Severe bole char resulted in 67% mortality.

On the Coconino National Forest, the general effect of a 3 October prescribed fire was a thinning from below and a 70% reduction in duff. No interior ponderosa pine less than 4.5 inches (10 cm) tall survived the fall fire. Mortality was less in pole-sized and larger trees. Severely damaged trees died within 2 years. Percent damage and postfire mortality of interior ponderosa pine by size class* and fire severity are given below.

	Saplings		Poles		Sawtimber		All trees	
	Site A	Site B	Site A	Site B	Site A	Site B	Site A	Site B
Crown damage:								
none	0	0	8	10	8	8	7	12
light	20	16	20	37	22	72	22	50
moderate	10	16	20	16	35	11	18	18
severe	70	68	52	37	35	9	53	30
Dead after 2 years:								
none	0	0	0	0	0	0	0	0
light	0	0	0	0	0	0	0	0
moderate	0	5	0	6	0	0	0	10

severe	60	68	42	30	25	6	43	20

*saplings are < 5 in. dbh, poles are 5-11 in. dbh, sawtimber is > 11 in. dbh

Plant response to fire: Fire prepares a mineral soil seedbed favorable to interior ponderosa pine regeneration. Germinants require mineral soil so the emerging root radicle immediately contacts soil moisture. On the Fort Valley Experimental Forest near Flagstaff, moisture in the upper 2 inches (5 cm) of soil was consistently greater on burned sites than on unburned sites. Plots were seeded to interior ponderosa pine 4 weeks after a November prescribed fire. The 1st postfire growing season was droughty, and although overall seedling establishment was poor, it was significantly greater ($p=0.05$) on burned than on unburned plots. Of 62 surviving seedlings, 95% (59 seedlings) were on burned plots, and 5% (3 seedlings) were on unburned plots. A study on the Coconino National Forest showed a frequency of 90% for natural regeneration the year following moderate-severity prescribed surface fire. At postfire year 12, frequency of interior ponderosa pine regeneration had dropped to 25% on burned plots. Adjacent unburned plots showed no seedling establishment during the 12 years of the study.

Mature interior ponderosa pine may show increased growth following low-severity surface fires. Following prescribed fall burning on the Front Range of Colorado, mean fascicle lengths and bud sizes (length and diameter) were significantly greater ($p < 0.01$) on trees that received burning treatment than on trees on unburned control sites. Sutherland and others present a linear regression model to predict postfire radial growth of southwestern ponderosa pine after prescribed fire.

Discussion and qualification of plant response: The open canopy created by frequent fire produces physiological and morphological changes that significantly increased interior ponderosa pine's resistance to bark beetles and foliar insects, increased nutrient uptake, and promoted growth on a northern Arizona site. These changes occur even in old growth. A year following thinning and prescribed burning near Flagstaff, resin flow was higher in presettlement trees (established before 1876) on burned plots compared to presettlement trees on untreated control plots, with flows of 12.2 mL/24 h and 3.6 mL/24 h, respectively. Foliar toughness, which increases resistance to pine sawflies, was greater on burned compared to control plots (76 vs. 69.8 g tension). Trees on burned plots also had greater leaf nitrogen content (1.59 vs. 1.44 g/m^2) and showed more basal area growth (20.7 vs. 14.3 cm^2) on burned than on control plots. Thinning without burning produced similar changes in tree physiology and morphology, except that with a mean resin flow of 4.3 milliliters per day, presettlement trees on plots that were thinned but not burned developed less resistance to bark beetles than trees on thinned and burned plots.

Fire management considerations: Current fire return intervals are greater than the historical range of variability for ponderosa pine forests. Magnitude of fire decline is greater at lower than higher elevations, which may aid managers in determining where management actions to reduce fuels and restore more natural fire regimes might be of highest priority. Millions of acres of forest burns in the western United States during fire years. Roughly half of those acres are in ponderosa pine. The expense of excluding fire from ponderosa pine forests in an active fire year can easily exceed a billion dollars, and these costly attempts at fire suppression are not always successful. In comparison, treatments to restore ponderosa pine structure and ecological processes are modest in cost.

Thinning to remove small-diameter trees, accompanied by prescribed fire, has been suggested as a means of restoring structure and function to degraded ponderosa pine ecosystems. Frequent low-severity surface fires restore ecosystem function by thinning dense stands and reducing woody debris and other organic matter on the forest floor. This can result in increased soil moisture, increased soil temperature (with accompanying rates of increased litter decomposition, soil nutrient cycling, and fine root growth), increased productivity of understory herbs and shrubs, increased basal diameter growth of overstory ponderosa pine, and favorable seedbeds. Fire-pruning of lower pine branches opens the canopy, aiding production of wildlife shrubs such as snowberry and chokecherry. Frequent prescribed fires reduce fire hazard without damaging overstory ponderosa pine. Biswell listed several ways in which prescribed burning reduces wildfire hazard in interior ponderosa pine:

- reduces the volume of dead fuel
- thins dense thickets of saplings and pole-sized stands
- keeps shade-tolerant trees out of the understory, thus destroying ladder fuels
- raises the height of green foliage level by needle scorching, making crown fires less likely to occur

- allows pine needles to fall to the ground, where they compact more closely than when draped over understory vegetation and debris that keep them off the ground

If several fire cycles have been missed, thinning presettlement trees and manually removing heavy fuels from the base of large trees may be necessary to in order to protect old growth from severe scorching or death. Harrington recommends growing-season (spring or summer) burning in interior ponderosa pine forests if the management objective is thinning from below, and fall prescribed burning if stand losses must be minimized. Weather parameters for prescribed burning in southwestern ponderosa pine, and a logistic regression model predicting probability of interior ponderosa pine mortality by tree size, scorch class, and season of injury are available.

Allen and others provide ecologically based recommendations for restoring southwestern ponderosa pine. They stress that restoration programs should include natural variability in southwestern ponderosa pine stands and the reestablishment of natural processes. Managers are encouraged to fully review their recommendations. A synopsis of their principles for restoration follows:

- Reduce the threat of crown fire
- Prioritize and strategically target treatment areas
- Develop site-specific reference (historical) conditions
- Implement multiple, conservative treatments
- Utilize and incorporate existing forest structure
- Restore ecosystem composition
- Retain trees of significant size or age
- Consider demographic processes (regeneration pulses)
- Integrate ecological processes and stand structure
- Control and avoid using exotic species
- Foster regional heterogeneity
- Protect sensitive species
- Assess cumulative effects
- Protect from overgrazing
- Establish monitoring and research programs
- Implement long-term, adaptive management

Swetnam and Dieterich recommend allowing large (> 3000 acres (1200 ha)) prescribed natural surface fires in southwestern ponderosa pine in wilderness areas such as the Gila Wilderness. Based upon their fire history research, which showed evidence of mostly extensive but also small fires, they also recommend allowing small and patchy mixed-severity fires in approved areas, subject to the limitations of wilderness boundaries, visitor safety, and management and suppression capabilities.

Mixed and stand-replacing fire: High-elevation interior ponderosa pine forests were historically denser, with lower fire frequencies and greater severities, than lower-elevation forests. Even at low elevations, north-facing slopes and mesic ravines probably supported dense forests that experienced occasional mixed and stand-replacing fires. Evidence of a mixed regime of frequent surface fires and occasional mixed or stand-replacement fires suggests that a single prescription cannot capture historical variability of fire regimes in interior ponderosa pine types.

Historical occurrence of large, widespread prehistoric fires in interior ponderosa pine demonstrates the potential for large portions of montane zones to burn during a single year. Interannual climatic variability, particularly El Nino-La Nina events, can greatly increase fine fuels. Fuels management through thinning and prescribed burning reduces the probability of widespread wildfire in most years, but it is uncertain that low to moderate levels of fuels management will reduce fire hazard enough to prevent stand-replacing fire during years when the weather is exceptionally conducive to rapid fire spread. It may be helpful for public education programs on fire hazard reduction to emphasize that although frequent surface fires were most common in interior ponderosa pine stands, mixed and stand-replacement fires did occur in prehistoric times, and that during years of high fire hazard, stand-replacement fires may occur again despite fuels reduction programs.

Fuels: Fuel loads in pole-sized thickets of interior ponderosa pine can be high. Ponderosa pine's long needles form a loose litter layer that burns readily . Near Flagstaff, fuels averaged 28.3 tons per acre (63.4 t/ha), 21.3 tons (19.2 t) of which was duff. Eakle and Wagle provide a model, developed on the Fort Apache Reservation, for estimating fine fuels in southwestern ponderosa pine stands. Harrington presents a model for estimating forest floor consumption in southwestern ponderosa pine forest based upon moisture content of the H surface soil layer.

Beaufait found that backfires in ponderosa pine needles spread more slowly and had less flame depth, longer residence time, and a higher rate of energy release than headfires.

Boldt provides prescriptions for thinning pole-sized "dog-hair" thickets of interior ponderosa pine using sequential treatments. Additional information on thinning "dog-hair" stands is found in Sackett and others.

Range: Prescribed fire can enhance understory forage production by reducing forest floor depth, tree density, and allelopathic toxins, and by increasing nutrient availability . On the Fort Apache Reservation in Arizona, Gambel oak had reached mid-story in an interior ponderosa pine forest. Prescribed surface fires at 5- to 7-year intervals reduced Gambel oak to an understory shrub that was readily available to browsing animals. Coverage of the dominant grass, mountain muhly, increased under the prescribed burning regime.

Pearson and others reported that on the Wild Bill Range of Arizona, an area of interior ponderosa pine that had been thinned to 20 square feet basal area per acre (4.5 m^2/ha) did not show a significant reduction in density following a wildfire. The fire crowned and killed the trees in an adjacent unthinned stand, however. Forage production increased as much as 578 pounds per acre (650 kg/ha) from prefire levels on sites were stand-replacement fire occurred, while pre- and postfire forage production were similar on thinned and burned sites.

Wild ungulate foraging, especially that of bighorn sheep, increased after late April prescribed fire in a interior ponderosa pine/sedge-bluegrass (*Carex-Poa* spp.) community in Custer State Park, South Dakota. Grass production did not increase after the fire, but forb production was significantly increased ($p < 0.01$) on burned compared to unburned sites.

October prescribed burning brought a 2-fold increase in nitrogen content of Arizona fescue and associated grasses on an interior ponderosa pine/Arizona fescue community on the Fort Valley Experimental Forest near Flagstaff. Concentrations of potassium, phosphorus, calcium, and magnesium were also generally greater in forb and grass species on burned plots than in herbs on unburned control plots. Understory biomass was significantly ($p < 0.05$) greater on burned plots. The 1st fall after burning, understory yield was twice as great on burned plots compared to unburned plots.

Overgrazing can greatly reduce fire frequency by removing understory fuels. Fire history studies of southwestern ponderosa pine document the near-cessation of fire in the mid-1800s due to livestock grazing in Arizona and New Mexico.

Exclusion of the recurrent fires that once swept the interior ponderosa pine-plains grasslands interface has resulted in interior ponderosa pine invasion into the grassland. Expansion is likely to continue without application of prescribed fire.

Since fire kills interior ponderosa pine seedlings and some saplings, prescribed fire can be used to reduce the density of encroaching pines. Late-April fire in little bluestem-hairy grama-sideoats grama in the Black Hills of South Dakota caused 79% mortality of pine seedlings. Mean density of interior ponderosa pine seedlings was 8,132 per acre (3251/ha) before the fire and 1,669 per acre (4173/ha) in late summer, after burning. The fire reduced ground fuels by 32%.

Wildlife: Fire benefits the majority of wildlife species inhabiting interior ponderosa pine ecosystems. Among bird species, fires in interior ponderosa pine tend to increase guilds that use open stands and snags. On the Prescott National Forest in Arizona, a stand-replacement burn in interior ponderosa pine attracted relatively more granivores, aerial insectivores such as flycatchers, and bark-feeding insectivores such as woodpeckers, while unburned areas attracted more ground and foliage insectivores. A 20-year wildlife study on 4 stand-replacement burns near Flagstaff had similar findings for birds. Most rodent species, except chipmunks, also increased on burned interior ponderosa pine sites relative to adjacent unburned control sites. Wild ungulate use increased greatly on burned sites compared to unburned sites. Mule deer use of burned sites declined at postfire year 1, but increased to 2.5 times that of unburned sites for the next 19 years. Elk use also dropped at postfire year 1 relative to unburned sites, but increased to 3 times that of controls until postfire year 20, when use of burned and unburned sites was nearly equal. Elk use of the burns peaked at postfire year 7.

Availability of interior ponderosa pines as nesting sites for cavity-nesters, particularly secondary cavity-nesters, is limited due to the scarcity of large, old-growth trees. Brawn and Balda reported that violet-green swallow, pygmy nuthatch, and western bluebird populations increased after artificial nest boxes were placed in open and thinned plots, but not on untreated (dense) plots. Prescribed underburning that leaves large trees may encourage nesting. Prescribed fire in interior ponderosa pine of Wind Cave National Park, South Dakota, significantly ($p < 0.05$) increased the number of breeding bird pairs and deer mice on burned sites compared to unburned control sites. Creating small openings with prescribed fire may also promote nesting. Aulenbach and O'Shea-Stone noted differential songbird use of burned sites created by a small, crowning wildfire compared to adjacent unburned sites in interior ponderosa pine on the Front Range of Colorado. Several species including red-breasted nuthatch, chipping sparrow, yellow-rumped warbler, and northern flicker occurred only on the burn. American robin, Steller's jay, and dark-eyed junco preferred the burn but used the control, while pygmy nuthatch, downy woodpecker, white-breasted nuthatch, and mountain chickadee occurred only on the unburned site.

Standing time of interior ponderosa pine snags is somewhat predictable. Harrington found that 75% of fire-killed interior ponderosa pine snags on the San Juan National Forest of southwestern Colorado fell within 10 postfire years. Fall rates were not significantly different ($p=0.1$) among trees 2 to 16 inches (5-41 cm) dbh, but large trees that died quickly after 80% or greater crown scorch were likely to fall more quickly, while large trees that survived 2 or 3 postfire years before succumbing were likely to remain standing for longer periods of time.

APPENDIX I – Definition of Terms

Appropriate Management Response (AMR) - Specific actions taken in response to a wildland fire to implement protection and fire use objectives identified by appropriate government agency. AMR allows for a full range of strategies to be applied, from an intense full suppression response to wildland fire use. The first response decision to be made is whether to have a suppression oriented response or to allow the fire to burn for predetermined benefits.

Confinement Response- The suppression-orientated strategy employed in appropriate management response where a fire perimeter is managed by a combination of direct and indirect actions and use of natural topographic features, fuels, and weather factors. These strategies and tactics could include perimeter control.

Defensible Space- Area around a structure where fuels and vegetation are treated, cleared or reduced to slow the spread of wildfire towards the structure. It also reduces the chance of a structure fire moving from the building to surrounding forest. Defensible space provides room for firefighters to do their jobs.

Disturbance- A discrete event, either natural or human induced, that causes a change in the existing condition of an ecological system.

Energy Release Component (ERC)- An index developed through the National Fire Danger Rating System. ERC then is an indicator of dryness in the fuel, is a fuel loading based rate that predicts how much energy f fire will produce both from its consumption of available fuel and through its residence time. ERC, and 1000hr. time lag fuel moisture has been used in dry climates to track seasonal drying trends.

Escape Fire Situation Analysis (EFSA)- If a wildfire has escaped initial attack EFSA is the process the agency administrator or acting uses to determine the best suppression strategy for achieving appropriate suppression that best meets resource objectives.

Fire Management Plan (FMP)- A strategic plan that defines a program to manage wildland and prescribed fires. The plan could be supplemented by operational plans, prescribed fire plans, hazardous fuels reduction, and prevention plans.

Fire Use- The combination of wildland fire use and prescribed fire application to meet specific resource and landowner objectives.

Fuel Treatment- Programmed and contracted to reduce or change fuel loading or type on a site. Can be accomplished by mechanical, chemical, or fire use.

Full Response- A suppression response action that can include: control lines surrounding the entire perimeter, (hot spot and cold trail may be considered completed line) including any spot fires, protection of interior islands, burn-out of fuels adjacent to control lines and mop-up to a standard adequate to hold under high fire intensity conditions. Full response objectives are based on safe yet aggressive approach to achieve containment of the fire by the beginning of the next burn period. Fire behavior may dictate, at least temporarily, the utilization of natural barriers or indirect strategies. These strategies and tactics would include direct control.

Haines Index- Lower atmosphere stability index (LASI) developed by Donald Haines. The index relies on two variables: dryness and stability/instability. On a scale of six, three points are given to dryness and three to the stability or instability of the atmosphere. Both these variables have a pronounced affect on extreme fire behavior. In the scaling, a 6 is extreme. 5 are high and, 4 are moderate, while 3 to 1 are low.

Initial Attack- An aggressive suppression action consistent with firefighter and public safety and values to be protected.

Initial Management Area (IMA)- The size of an IMA may be adjusted based on fire behavior predictions, weather forecasts, site analysis and risk assessment. The IMA becomes fixed as an MMA once a wildland fire is placed under a stage III implementation plan.

Insurance Services Office (ISO) Rating- An overall fire services rating developed for use in determining insurance premiums for residential and commercial property. Factors such as fire alarm systems, equipment, training, availability of water (hydrants), etc. are used to develop the rating. The rating is on a scale of class 1 to class 10, with 1 providing the best public protection and 10 providing the lowest public protection. See www..iso.com for more details.

Maximum Management Area (MMA)- The firm limits of management capability to accommodate the social, political, and resource impacts of a wildland fire. Once an approved Wildland Fire Use plan is established the MMA is fixed and not subject to change. If MMA determination is exceeded, the fire will follow the Wildland Fire Situation Analysis (WFSA) process.

Mitigation Actions- Those on-the-ground activities that will serve to increase the defensibility of the Maximum Manageable Area (MMA); check, direct, or delay the spread of fire, and minimize threats to life, property, and resources. Mitigation actions may include mechanical and physical non-fire tasks, specific fire applications, and limited suppression actions. These actions will be used to construct fire lines, reduce excessive fuel concentrations, reduce vertical fuel, and create black lines.

POL – Stands for "Products Other than Logs" thinning to harvest poles and posts and firewood.

Polygon- A planning sub-unit within a fire planning area that represents similar resource values and landowners objectives, fuel conditions with associated fire behavior, Social/Political concerns and economic considerations. Polygons are categorized as A, B, C, and D areas.

Preparedness- Activities that lead to a safe, efficient, and cost-effective fire management program in support of land and owners management objectives through appropriate planning and coordination.

Prescribed Fire- Any fire ignited by management actions to meet specific objectives. A written, approved prescribed fire plan must exist prior to ignition.

Prescribed Fire Plan- A plan required for each fire application ignited by management. It must be prepared by qualified personnel and approved by the appropriate agency administrator prior to implementation. Each plan will follow specific direction and must include critical elements and how to mitigate each element.

Prescription Guidelines- guidelines used to show upper and lower reaches of a prescription.

Spread Component (SC)- An index developed through the National Fire Danger Rating System. The index provides predicted rate of spread of a fire (in chains per hour) from inputted information on the fuel complex and weather information collected from a local Remote Automated Weather System (RAWS) site.

Suppression Constraints- A limitation placed on suppression forces to minimize adverse affects to the environment due to fire suppression activities. An example would be restricting the use of heavy equipment in certain areas.

Suppression oriented response- A range of responses to a wildland fire, which range from full response to confinement of the fire. It may also include periodically checking fire status and fire behavior.

TSI – Stands for "Timber Stand Improvement" thinning to stimulate growth and improve residual tree health

Wildfire- An unwanted wildland fire.

Wildland Fire- Any nonstructural fire, other than prescribed fire, that occurs in the wildland. This term encompasses fires previously called both wildfires and prescribed natural fires.

Wildland Fire Implementation Plan (WFIP)- A progressively developed assessment and operational management plan that documents the analysis and selection of strategies and describes the appropriate management response for a wildland fire being managed for resource benefit.

Wildland Fire Situation Analysis (WFSA)- A decision-making process that evaluates alternative management strategies against selected safety, environmental, social, economic, political, and resource management objectives**.**

FUEL TREATMENT PLANNING
for
Community Wildfire Protection Plans (HFRA)
April 14-15, 2004, Deckers, Colorado
Agenda

Wednesday, April 14 – Anderson, Facilitator

10:00 am – Introduction

- Welcome, introductions, sign up sheet, housekeeping, agenda review

10:10 am – Background – Chuck Dennis

- HFRA, Community Wildfire Protection Plans, Cost-share opportunities, Good Neighbor approach

10:30 am – Objectives

- Define/develop a "Community Wildfire Protection Area Map" for the Deckers Area (Schoonover Fire/Fletcher Ranch north to Nighthawk).
- Locate on maps (paper and electronic formats) and list strategic fuels treatments needed to protect the communities (one map showing treatments irregardless of ownership, one map showing treatments by ownership).
- Identify roles and responsibilities of partners in accomplishing needed treatments.

10:45 am – Review Accomplishments and Plans

- Colorado State Forest Service
  - Denver Water
  - Private lands
  - Good Neighbor Projects

11:30 am – Review Accomplishments and Plans (continued)

- USDA, Forest Service

12:15 pm – Lunch (Provided)

1:00 pm – Review Accomplishments and Plans (continued)

- Local Fire Departments
  - Trumbull VFD
  - North Fork FPD
  - Mountain Communities FPD

1:45 pm – Group Discussion of Accomplishments and Plans

- Discuss any issues and concerns
- Resolve concerns

2:15 pm – Break

<u>Wednesday, April 14</u> (continued)

2:30 pm – Group Develop, Agree and Map the Final Fuel Treatment Areas

- Map Final CWP area boundary and communities and within the area
- Identify potential fuel treatment areas and priorities for treatment

3:50 pm – Critique of Day

4:00 pm – Adjourn

<u>Thursday, April 15</u> – Schmidt, Facilitator

8:00 am – Group Develop, Agree and Map the Final Fuel Treatment Areas (cont.)

10:00 am – Break

10:15 am – Group Develop and Map Additional Information

- Incorporate fire control and other features on maps: staging areas; helibase/helispots; helicopter dipping locations; hydrant drafting locations (including dry); initial attack/expended attack ICP locations; potential locations for project fire camps and ICP; fire stations; evacuation centers and routes; residue storage/chipping areas; infrastructure improvement needs, signing, etc.

Noon – Lunch

1:00 pm – Identify Roles and Responsibilities of Partners

- CSFS, USFS, Fire Departments, Emergency Management—group agreement

2:00 pm – Break

2:15 pm – Finalize Any Items, e.g. roles and responsibilities and mapping

- Group

3:00 pm – Wrap-up

- Gather work products, e.g. maps, roles and responsibilities, notes, etc.
- Summarize agreements and any follow-up assignments

3:30 pm – Critique of Session

- Focus on how to improve this work session
- Where to from here?

4:00 pm – Go Home — Safely

PARTICIPANTS

(FUEL TREATMENT PLANING, April 14-15, 2004, Deckers, Colorado)

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