



Rocky Mountain National Park Fire Ecology Annual Report Calendar Year 2004

SUMMARY

Rocky Mountain National Park's fire effects crew kept busy during the 2004 field season with a number of varied tasks. In addition to typical fire effects plot work, the crew spent a substantial amount of time on compliance work associated with mechanical fuels treatments, including pretreatment surveys for rare plants and post-treatment surveys for exotic plant species. The following is a short review of the 2004 field season.

Fire effects plot work

ROMO 1 Install
 0 Post-burn visits
 5 YR01 visits
 5 YR02 visits
 7 YR05 visits

One new fire effects plot was installed in the Front Range Ponderosa Pine monitoring type in anticipation of the South Lateral Moraine Phase 2 prescribed burn (FPIPO1T09 #29). The wettest summer in at least 40 years prevented implementation of 2 planned prescribed burns in the park and as a result, the crew did not conduct any immediate post-burn plot reads during the 2004 field season. Five year-1 plot reads were carried out in Front Range Ponderosa Pine and Ponderosa Savanna types following burning in 2003 (FPIPO1T09 #9, 25, 26, 27; FPIPS1T02 #14). Mechanical treatment monitoring continued in the Emerald Mountain Hazard Fuel Reduction area with 5 year-2 reads in the Eastside Lodgepole Pine – Manual Treatment monitoring type (plots were thinned in 2001/2002, resulting piles were burned during the winter of 2002/2003). Seven year-5 plot visits were conducted in the Front Range Ponderosa Pine, Ponderosa Savanna, and Lower Montane Mixed Conifer monitoring types (FPIPO1T09 #10; FPIPS1T02 #1, 2, 4, 5; FPICM1T08 #2, 3).

FLFO 3 YR02 visits

Three year-2 plot reads were conducted at Florissant Fossil Beds National Monument (FLFO) in the Lower Montane Mixed Conifer – Manual Treatment monitoring type (FPSME1T08 #3, 4, 5).

Plots were thinned in the Boundary Hazard Fuel Reduction project in 2002 and pileburning operations were completed during the winter of 2003/2004.

“Rapid Assessment” protocol development

A new “Rapid Assessment” plot protocol was developed during the 2004 field season to monitor the effects of mechanical fuels treatments. Previously, mechanical projects were monitored using full FMH forest plots. Due to the time required to install and read FMH plots, a very small number of plots could be installed prior to project implementation. This limited the variability of an area which could be sampled in any given project and reduced the statistical validity of the data collected. The new streamlined protocols allow a larger number of plots to be installed in a shorter period of time.

Protocols were adapted from those developed at Yosemite National Park. The design consists of a 7.5 meter radius plot with a 50-ft. Brown’s line originating from the center of the circular plot. Attributes sampled include overstory, pole-sized, and seedling trees, canopy cover, herbaceous and shrub vegetation, and dead surface fuel loading. Plot protocols on file in Fire Effects Office.

A total of 8 monitoring plots were installed in a 90 acre unit along the park boundary near Grand Lake prior to the start of fuels treatment activities. To date, all plots have been thinned and the resulting slash has been piled on site for later burning. An initial analysis of the data has been completed (Appendix A).

Pre-treatment Rare plant surveys

Deer Mountain	640 acres
Emerald Mountain	192 acres
Eagle Cliff	160 acres
Glacier Basin	86 acres

Fire effects crew surveyed over 1075 acres for rare plants along the eastern boundary of Rocky Mountain National Park (ROMO) as required by the 2002 Wildland-Urban Interface Fuels Management Environmental Assessment (WUI EA). No species of concern were found.

Post-treatment Invasives surveys

Deer Mountain	305 acres
Emerald Mountain	135 acres

The fire effects crew completed the first season of invasive plant surveys following pile burning on Deer Mountain and the second year of surveys in the Emerald Mountain hazard fuels treatment area (ROMO). Several bull thistle (*Cirsium vulgare*), Canada thistle (*Breca arvensis*), and woolly mullein (*Verbascum thapsus*) individuals were found in the Emerald Mountain area. All non-native species were pulled. Conservation measures included in 2002 WUI EA call for invasives monitoring annually for the first 3 years following treatment and then every other year for the next six years thereafter. To date the fire effects crew has pulled non-native plants when encountered during surveys and plot work. However, if large populations are found in the future, information regarding species, location, and patch size will be passed on to the exotics crew for treatment.

Fuel moisture monitoring

The crew continued live fuel moisture monitoring on both sides of the park (ROMO). Species monitored throughout the fire season were ponderosa pine (*Pinus ponderosa*), lodgepole pine

(*Pinus contorta*), sagebrush (*Artemisia tridentata* ssp. *vaseyana*), and bitterbrush (*Purshia tridentata*). See graphs of seasonal trends in Appendix B.

In an effort to address past inconsistencies in 1000-hr fuel sampling, 1000-hr sampling “stations” have been installed at several locations throughout the park. The stations consist of three 6-8” diameter logs elevated off the ground. Material consists of Douglas-fir and lodgepole logs salvaged from ongoing fuels treatment projects in the park. Cookies will be removed and processed every 2 weeks throughout the 2005 fire season. Current sampling locations are: Beaver Meadows Visitor Center (7800’, next to RAWS weather station), Wild Basin Entrance Station (8300’), Willow Park (10,700’), Kawuneeche Visitor Center (8600’), and Moraine Park 2F prescribed fire unit (8200’). Additional stations will be established as needed.

Stream turbidity monitoring

Stream turbidity sampling continued in 4 tributaries of the Colorado River on the west side of the park (ROMO). The original intent of the monitoring was to gather baseline water quality data that could then be compared to measurements following prescribed fire. Data collected is passed on to Karl Cordova (Biologist) who maintains water quality records. The possibility of suspending the turbidity monitoring has been discussed, as prescribed fire is not a permissible management alternative in this area under ROMO’s current fire management plan. However, it was decided to continue turbidity monitoring this season as the time commitment is fairly minimal and sampling can be done at the same time as the west side live fuel moisture sampling. Sampling protocols on file in the Fire Effects Office.

Fire dispatches

Fire effects crew members assisted in several fire suppression, prescribed fire, and fire use assignments out of park in 2004. Kris Whitbeck (crewmember) went on a 14-day assignment as a Firefighter Type 2 with the Alpine Hotshots. Nate Williamson (fire effects specialist) participated in one suppression assignment on the Arapaho-Roosevelt National Forest as well as a prescribed fire assignment on the Pawnee National Grasslands. In addition, Nate went on a 3-week detail with the Yellowstone Fire Use Module in August. During the course of the detail he was assigned to 2 fire use fires at Yellowstone (Promontory and Broken Ankle) and had the opportunity to work on his FEMO and FFT1 taskbooks.

Smoke monitoring

In an effort to monitor smoke output (and potential health impacts) from winter pileburning operations, a DataRAM 2000 particulate monitor was placed on the roof of the Town of Estes Park Municipal Building. Data were collected continuously from 10/9/2003 to 4/3/2004. The DataRAM was configured to monitor airborne particulate matter up to 2.5 micrometers in diameter (PM_{2.5}). PM_{2.5} are small enough to be inhaled deeply into the lungs and can result in adverse health effects, especially in children, the elderly, and those with respiratory or cardiovascular conditions.

PM_{2.5} concentrations (averaged over 24-hour periods) remained below levels deemed “unhealthy” according to EPA’s National Ambient Air Quality Standards regardless of the number or size of piles burned in the park (see Appendix C). An initial comparison of PM_{2.5} concentrations and wind direction/velocity indicates that particulate concentrations are at their highest levels on calm days or days with easterly winds. On days with strong westerly winds, particulate concentrations are at their lowest levels. Given that Rocky Mountain National Park is located west of Estes Park, this suggests that pileburning operations have little impact on particulate levels experienced in town and that the major source of particulates lies to the east of town. This pattern is consistent with other air quality monitoring being conducted in the park that indicates the

majority of air pollution in the park originates at lower elevations along the Front Range. Analysis of this data will continue. No continuous particulate monitoring is planned for this winter; however monitoring will be conducted on an as needed basis.

Table 1. Fire Effects Plot Workload 2004

Park	Monitoring Unit	Type of Plot	Pre-treatment	Immediate Post	Post-treatment (1+ yrs)	Total Plots
Rocky Mountain	Front Range Ponderosa Pine	FMH Forest plot	1		5	15
	Ponderosa Savanna	FMH Forest plot			5	14
	Lodgepole Pine – West Slope	FMH Forest plot				14
	Eastside Lodgepole Pine – Manual Treatment	FMH Forest plot			5	6
		Photo point				73
	Big/Common Sagebrush	FMH Forest plot				8
	Lower Montane - Mixed Conifer	FMH Forest plot			2	13
		Photo point				3
	Grand Lake HFR	Rapid Assessment	8	8		8
Florissant Fossil Beds	Ponderosa Pine	FMH Forest plot				2
	Ponderosa Savanna	FMH Forest plot				3
	Ponderosa Pine - Manual Treatment	FMH Forest plot				3
	Mixed Conifer - Manual Treatment	FMH Forest plot			3	4
	Mixed Conifer - Manual Treatment	Photo point				70
Great Sand Dunes	San Luis Valley - Rabbitbrush Prairie	FMH Forest plot				2
	San Luis Valley - Ponderosa Savanna	FMH Forest plot				6
	Pinyon Flats HFR	Photo point				7
Total			9	8	20	251



Nate, Kris, Robin, & Kevin @ Rock Cut

Table 2. Fire Ecology Staffing 2004

Monitor	Starting Date	Ending Date	# of Pay Periods	Training and Development
Kevin League	5/10/04	10/14/04	11.5	Refresher
Kristen Whitbeck	5/24/04	10/14/04	10.5	S-130/190; Plants of RMNP
Robin Keith*	7/26/04	10/14/04	6	
Nathan Williamson	N/A	N/A	26	S-211; L-380; Intro to ArcGIS; Vegetation Dynamics Development Tool (VDDT) workshop; FEAT/Statistics workshop; Wilderness workshop

*Robin paid out of fuels project money, not fire effects.



Table 3. Management Objectives and Monitoring Results 2004

Monitoring Unit	Management Objective	Monitoring Results (80% C.I.)	Objective Achieved?
Front Range Ponderosa Pine	40-80% total fuel reduction	38.9% reduction in total fuel load (<i>n</i> =5; 3 burns)	NO , but minimum sample size not achieved
	Limit overstory PIPO mortality to 5% within 5 years post-burn	28.6% reduction in overstory PIPO (<i>n</i> =1; 1 burn)	NO , but minimum sample size not achieved
	generate 5-35% mortality in pole-sized trees within 5 years post-burn	100% reduction in pole-sized trees (<i>n</i> =1; 1 burn)	NO , but minimum sample size not achieved
Ponderosa Savanna	40-80% total fuel reduction	28.2% reduction in total fuel load (<i>n</i> =5; 3 burns)	NO
	Limit overstory PIPO mortality to 5% within 5 years post-burn	5.9% reduction in overstory PIPO (<i>n</i> =4; 2 burns)	NO , but minimum sample size not achieved
	generate 5-30% mortality in pole-sized trees within 5 years post-burn	12.5% reduction in pole-sized trees (<i>n</i> =4; 2 burns)	NO , but minimum sample size not achieved
Lodgepole Forest Westside	40-80% total fuel reduction	54.1% reduction in total fuel load (<i>n</i> =4; 2 burns)	YES , but minimum sample size not achieved
	generate 10-45% mortality in overstory trees within 5 years post-burn	1% increase in overstory trees (<i>n</i> =3; 1 burns)	NO
Eastside Lodgepole Pine Manual Treatment	80-100% woody fuel reduction	24% reduction in woody fuel load (<i>n</i> =5; 1 treatment)	NO , but minimum sample size not achieved (<i>Note: when considering fuels > 1", fuels reduction is 69.2%</i>)
		24.1% reduction in overstory trees (<i>n</i> =5; 1 treatment)	N/A (<i>objectives not specifically tied to overstory density</i>)
		73.3% reduction in pole-sized trees (<i>n</i> =5; 1 treatment)	N/A (<i>objectives not specifically tied to pole-sized tree density</i>)
Lower Montane Mixed Conifer	40-80% total fuel reduction	53.0% reduction in total fuel load (<i>n</i> =2; 1 burn)	YES , but minimum sample size not achieved
	generate 10-25% mortality in overstory trees within 5 years post-burn	42.6% reduction in overstory trees (<i>n</i> =2; 1 burn)	NO , but minimum sample size not achieved
	generate 10-25% mortality in pole-sized trees within 5 years post-burn	30.3% reduction in pole-sized trees (<i>n</i> =2; 1 burn)	NO , but minimum sample size not achieved

Ecologist Accomplishments

- ❖ Collaborated on San Luis Valley ecological model development (using VDDT) for Greater Sand Dunes Interagency Environmental Assessment/Fire Management Plan
- ❖ Wrote/edited/reviewed several chapters/appendices of ROMO's 2004 Fire Management Plan
- ❖ Presented Front Range fire ecology program to YMCA of the Rockies staff
- ❖ Presented Front Range fire ecology program as part of Rocky Mountain National Park Information Officer training
- ❖ Produced fire danger risk assessments throughout fire season
- ❖ Reviewed ROMO's Bark Beetle Management Plan and Environmental Assessment
- ❖ Reviewed ROMO's Biological Assessment for Fuels Management Activities (ongoing)
- ❖ Participated in Rocky Mountain Inventory and Monitoring Network "Vital Signs" monitoring meetings (ongoing)
- ❖ Participated in training of vegetation/fuels mapping field crew (ROMO)
- ❖ Participated in Greater Sand Dunes Interagency Environmental Assessment/Fire Management Plan development process as member of core team (ongoing)
- ❖ Participated in ROMO's Elk-Vegetation EIS planning process as member of ID team (ongoing)
- ❖ Instructed map & compass portion of fire refresher training, gave seasonal outlook presentation to ROMO staff

APPENDIX A.

Initial Results (Post-treatment) of the Grand Lake Hazardous Fuel Reduction Project at Rocky Mountain National Park

GOALS AND OBJECTIVES

The portion of the Grand Lake Hazardous Fuel Reduction Project discussed in this document is a component of an on-going effort to reduce the threat of catastrophic fire to life and property in the Town of Grand Lake and within the adjacent portions of Rocky Mountain National Park. The goal of the project is to reduce fuel loads and reduce the potential of crown fire by changing the array of live fuels by systematic forest thinning in key areas. The desired outcome is significantly improved public and resident safety by reduction of risk from large fire.

This portion of the project will create a 90 acre shaded fuel break along the western boundary of the park to the west of the Kawuneeche Visitor Center and to the north of Grand Lake. Live and dead fuels will be thinned and either removed or burned on site. In the event of a running crown fire, the increased canopy spacing and decrease in surface fuels will cause the fire to drop to the ground and slow fire spread enough to allow fire personnel to safely and more effectively protect structures and stop fire spread.

Specific objectives include:

- Reduce fuel loading of dead and down woody debris greater than 1-inch diameter by 80%
- Remove 90% of all pole-sized trees growing into overstory crowns
- Establish average overstory canopy spacing of a minimum of 5-7 feet
- Limb all trees to 5 feet above ground level

VEGETATION TYPES

The primary vegetation within the project area is dense, even-aged lodgepole pine. Other overstory species include Douglas-fir and aspen. Predicted fuel loading ranges from 10-50 tons/acre. Canopy cover ranges from 75-100%. The fuel models most nearly represented are 8, 10, and 11 (Anderson 1982).

MONITORING METHODS

A new "Rapid Assessment" plot protocol was developed during the 2004 field season to monitor the effects of mechanical fuels treatments. Protocols were adapted from those developed at Yosemite National Park (Paintner and Buhler 2002). The design consists of a 7.5 meter radius plot with a 50-ft. Brown's line originating from the center of the circular plot. Attributes sampled include overstory, pole-sized, and seedling trees, canopy cover, herbaceous and shrub vegetation, and dead surface fuel loading. Plot protocols on file in Fire Effects Office.

A total of 8 monitoring plots were installed prior to the start of fuels treatment activities. To date, all plots have been thinned and the resulting slash has been piled on site for later burning.

Dead and down fuels data were processed using methods developed by Brown (1974). Data were analyzed using the Fire and Fuels Extension to the Forest Vegetation Simulator (Reinhardt and Crookston 2003).

RESULTS

Dead and Downed Fuel Loading

Dead and downed fuels inventories were not completed during the post-treatment plot visits due to the presence of piled material on site. In order to assess the effects of treatment on subsequent fire behavior, initial loadings of fuels > 1 inch diameter were reduced by 80% (Table 1). This reduction comes directly from the treatment specifications. Initial loadings for fuels < 1 inch diameter were doubled for post-treatment fire behavior analysis. An increase in 1- and 10-hr fuels has been documented in previous mechanical treatment monitoring and would be expected given the levels of activity occurring during treatment operations (smaller branches are likely to break off as trees are felled, bucked, and piled). No adjustments were made to litter loading values for post-treatment analysis. Litter would be expected to

increase in much the same manner as 1- and 10-hr fuels however litter may be compacted during treatment operations and previous data has been inconclusive. All plots will be surveyed for dead and downed fuels loadings following the completion of pile burning operations and data will be reanalyzed.

Table 1. Actual pre-treatment and estimated post-treatment fuel loading (all plots)

	Pre-treatment	Post-treatment (estimated)	
Fuel Type	Loading (tons/acre)	Loading (tons/acre)	Percent change
1-hr	0.16	0.32	100%
10-hr	1.07	2.14	100%
100-hr	0.91	0.18	-80%
1000-hr	5.74	1.15	-80%
Litter	14.10	14.10	0%
Duff	10.20	10.20	0%
TOTAL	32.2	28.1	-13%

Stand Structure

Stand structure data were collected for all plots (Tables 2, 3). Initial results indicate reductions of 55% for live seedlings (< 1-inch diameter), 37% for live poles ($\geq$ 1-inch < 6-inch diameter), and 11% for live overstory trees ($\geq$ 6-inch diameter). Total basal area was reduced from 116 ft.²/acre to 96 ft.²/acre (a reduction of 17%). Standing dead stems were reduced almost 80% across all plots (83% reduction in standing dead poles, 52% reduction in standing dead overstory trees).

Table 2. Live tree size class distribution pre- and post treatment (all plots)

	Pre-treatment (live stems/acre)	Post-treatment (live stems/acre)	Percent change
Seedlings	20	9	-55%
Poles	193	121	-37%
Overstory	184	164	-11%
TOTAL	397	294	-26%

Table 3. Standing dead tree size class distribution pre- and post treatment (all plots)

	Pre-treatment (dead stems/acre)	Post-treatment (dead stems/acre)	Percent change
Seedlings	0	0	N/A
Poles	210	35	-83%
Overstory	29	14	-52%
TOTAL	239	49	-79%

Canopy base height was raised from an average of 22.5 ft. for all stands to a post-treatment average of 24.6 ft. (Table 4). For the purposes of this analysis, canopy base height is defined as the lowest height above the ground at which there is sufficient canopy fuel to propagate fire vertically through the canopy. Current research suggests this threshold to be at least 0.011 kg/m³ (30 lbs/acre/ft.) (Scott and Reinhardt 2001). Canopy bulk density (mass of available canopy fuel per unit canopy volume) was reduced an average of 18% for all stands. Canopy cover and crown competition factor were also reduced an average of 18% for all stands.

Table 4. Canopy characteristics pre- and post treatment (all plots)

	Pre-treatment	Post-treatment	Percent change
Canopy base height (ft.)	22.5	24.6	9%
Canopy bulk density (kg/m³)	0.104	0.085	-18%
Canopy cover (%)	67.9	55.8	-18%
Crown Competition Factor	118	97	-18%

Treatment Effects on Potential Fire Behavior

Treatment effects on potential fire behavior were determined for all plots under both “moderate” and “severe” burning conditions (Table 5). Treatment had little effect on predicted fire behavior for either set of environmental conditions (Table 6). In all cases, predicted fire type remained a surface fire and flame lengths remained essentially unchanged following treatment. Treatment resulted in raising the 20-ft. windspeed necessary to initiate active crown fire spread (Crowning Index) under severe burning conditions by just under 8 mph. However, windspeeds necessary to initiate passive crowning (Torching Index) remained essentially unchanged. Potential mortality (expressed as a predicted percentage of basal area killed due to fire) also remained the same following treatment under both sets of conditions.

Table 5. Simulated burning conditions

Fire Condition	20 ft.Wind (mph)	Temp (°F)	Fuel moisture by size class/type (%)					
			1-hr	10-hr	100-hr	1000-hr	Duff	Live
Severe	20.0	70	4	4	5	10	15	70
Moderate	6.0	70	8	10	12	16	125	120

Table 6. Predicted characteristics of simulated fires

	Flame length (ft.)		Fire type		Torching index - severe (mph)	Crowning index - severe (mph)	Potential Mortality - severe (%BA)	Potential Mortality - moderate (%BA)
	Severe	Moderate	Severe	Moderate				
pre-treatment	4.4	2.1	Surface	Surface	81.9	23.8	69.6	65.5
post-treatment	4.6	2.0	Surface	Surface	81.5	31.5	69.6	65.5

DISCUSSION

Treatment has reduced densities of all size class trees both living and dead: 26% reduction in live stems, 79% reduction in standing dead stems. However, the 37% reduction in pole-sized trees falls well short of the 90% reduction called for in the project specifications. Although the current analysis can not determine post-treatment crown spacing, treatment has resulted in a reduction of both canopy cover and crown competition indicating an opening of the stand. Treatments have had little impact on potential fire behavior under either “moderate” or “severe” burning conditions.

CONCLUSION

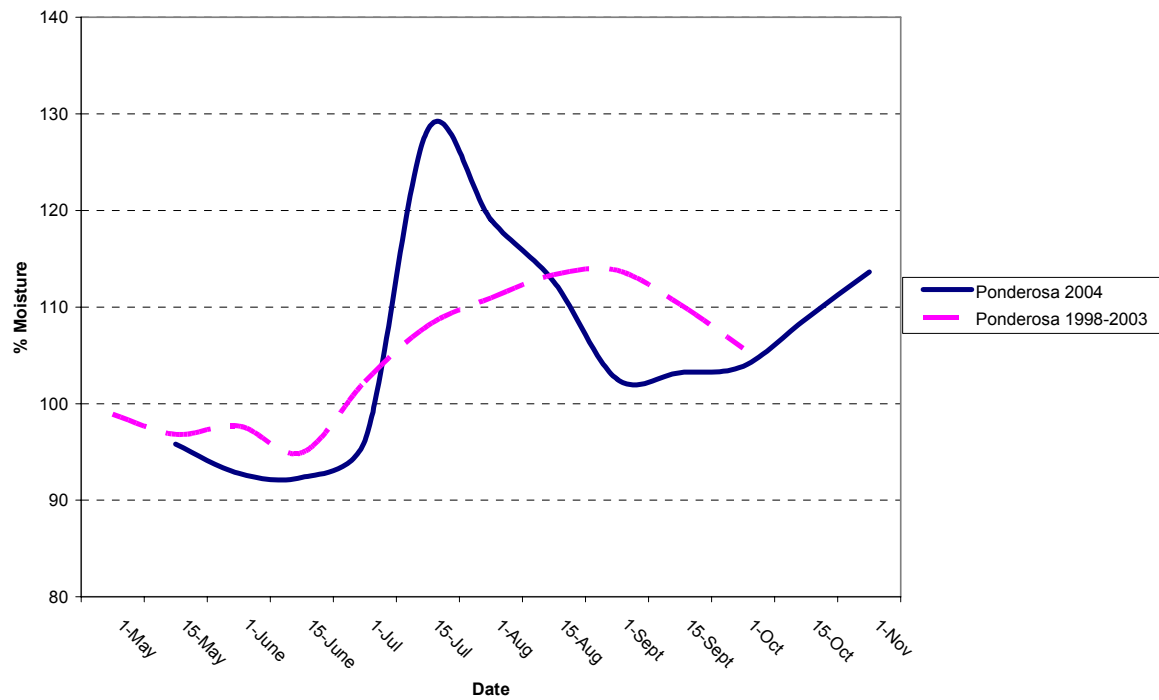
Although this analysis is based on estimated surface fuel loadings, initial results indicate that the treatment is having essentially no effect on potential fire behavior despite the resulting changes in stand structure. Winds required to initiate crown fire behavior (Torching Index) were in excess of 80 mph prior to treatment and remain unchanged following treatment. Analysis will continue following pile burning and actual post-treatment surface fuel loading data is collected.

REFERENCES

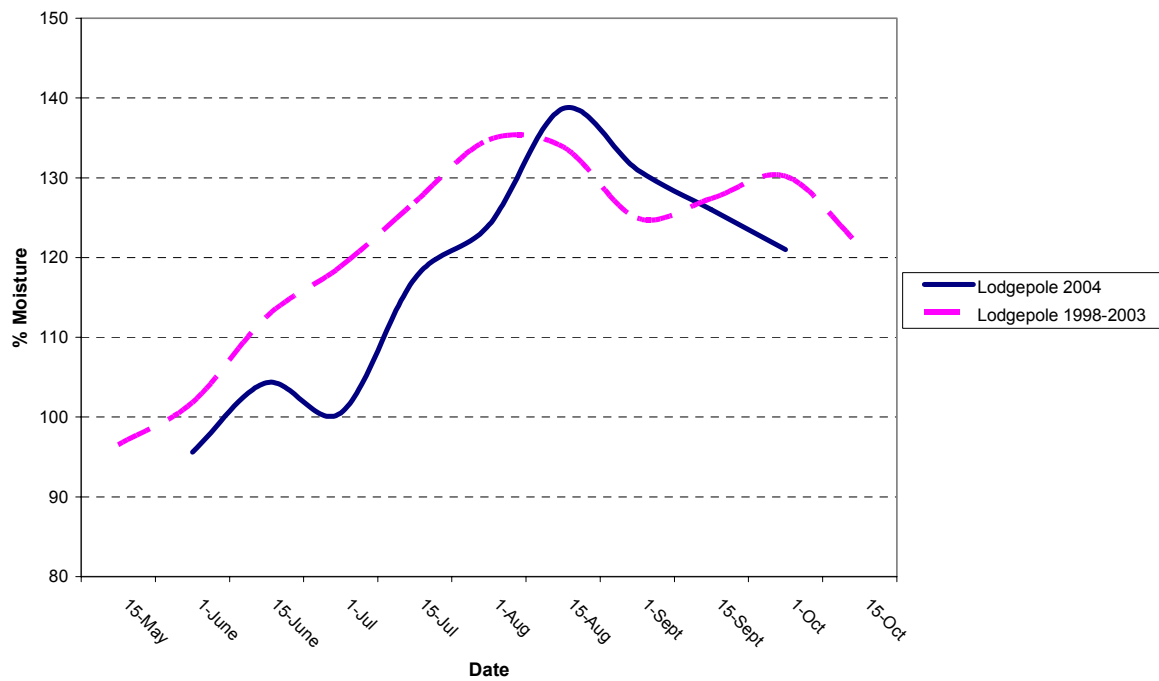
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- Scott, J.H. and E.D. Reinhardt. 2001. Assessing crown fire potential by linking models of surface and crown fire behavior. USDA Forest Service, Research Paper RMRS-29.

APPENDIX B.

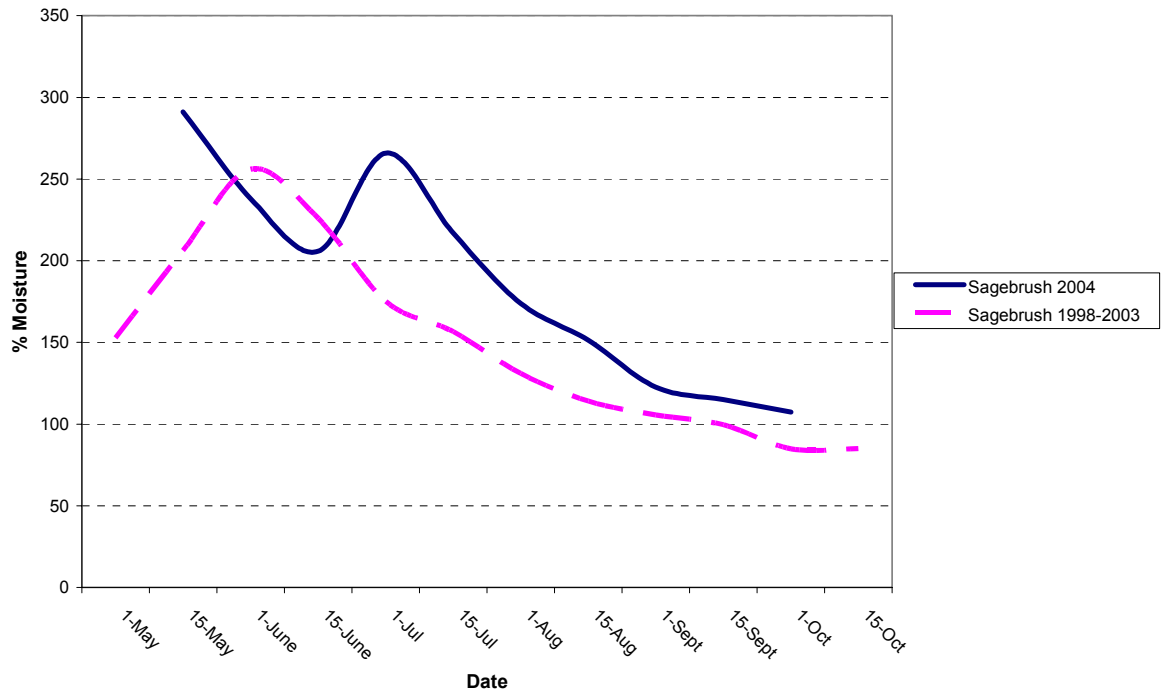
Live Fuel Moisture Trends - Ponderosa Pine



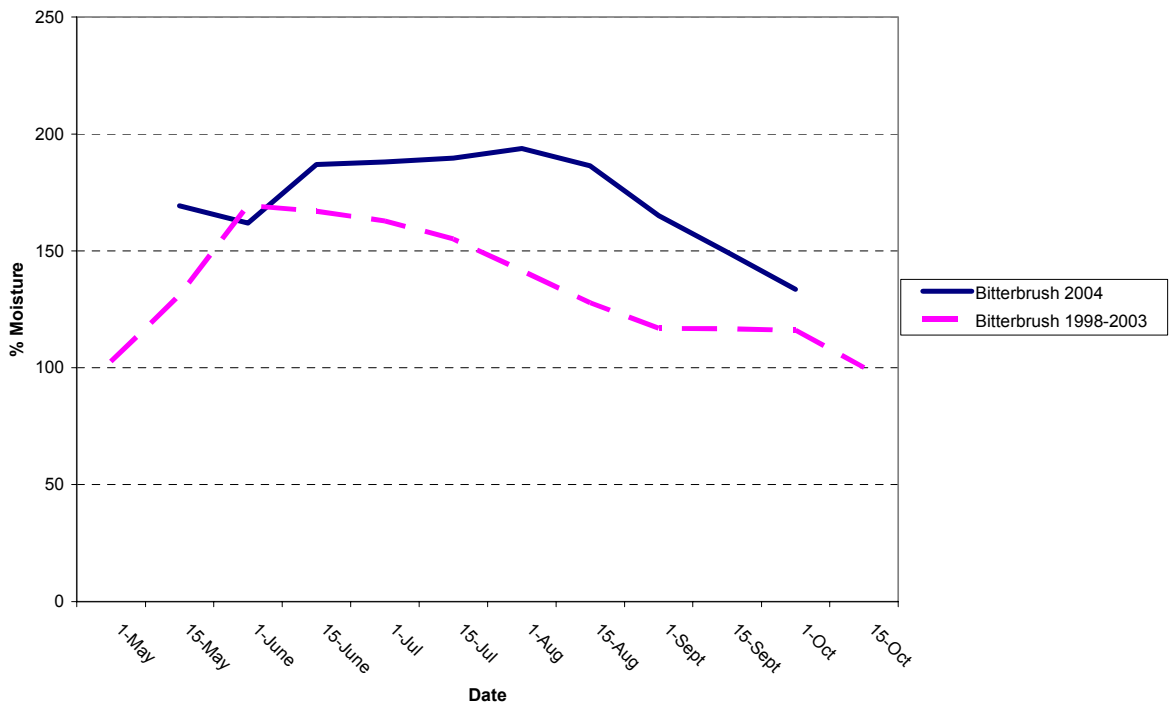
Live Fuel Moisture Trends - Lodgepole Pine



Live Fuel Moisture Trends - Sagebrush

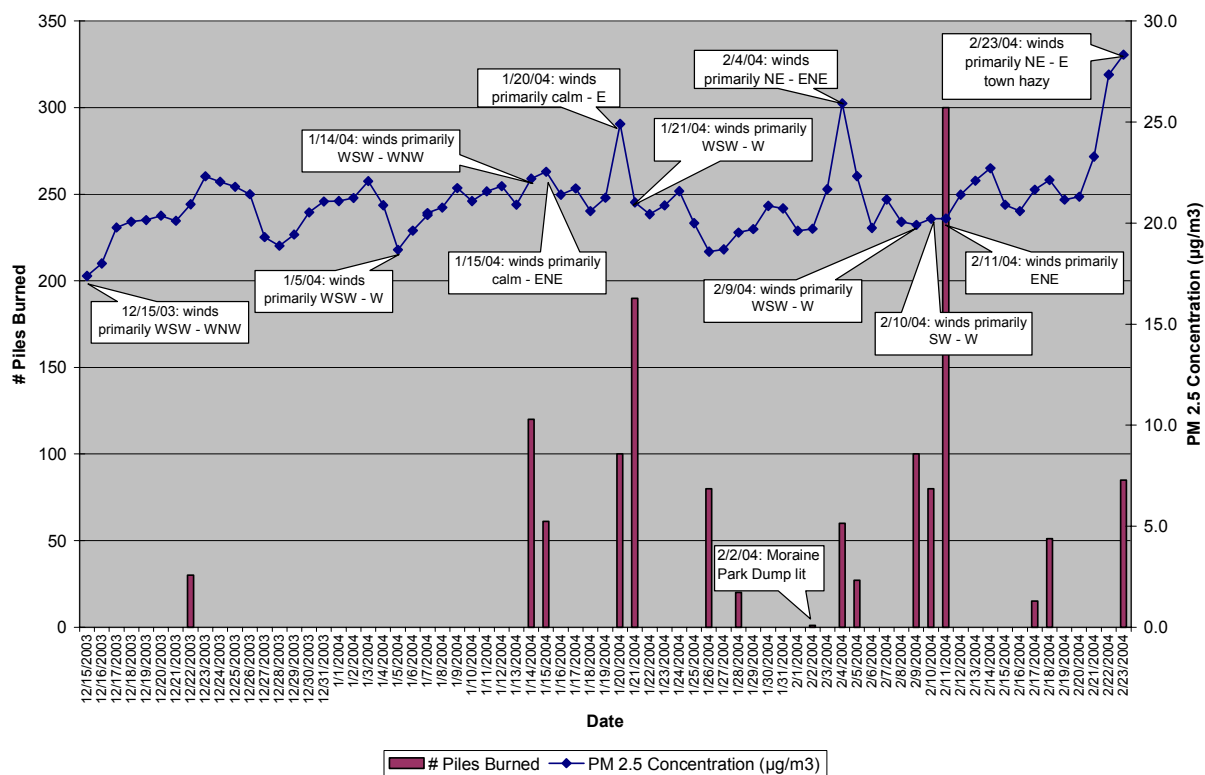


Live Fuel Moisture Trends - Bitterbrush



APPENDIX C.

Piles Burned vs. PM 2.5 Concentration (EP Municipal Building)



PM2.5 Concentration (EP Municipal Building 2/8-14/04)

