Section VII. S.

Wall Watershed Analysis

Fire Hazard and Fuels Treatment
Background, Issues and Recommendations

John Robertson
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The Wall watershed includes some subwatersheds with the potential to support large stand replacement wildfires. Two of the watersheds are currently at high risk for a large fire and also pose particularly difficult situations for management. These are the Swale and Alder/Upper Skookum subwatersheds. Several other subwatersheds also have potential for large fires due to the development of grand fir stands into historically ponderosa pine dominated stands. Still other watersheds need reintroduction of fire to control unwanted vegetation, mainly juniper. Subwatershed identifiers and names can be found on the front cover of this document. Guidelines are included to prioritize these subwatersheds for fuel treatments in order to reduce fire hazard or reintroduce fire into the ecosystem. In developing fuel treatment prescriptions, consideration was given to soil protection and overstory vegetation survival. No ground truthing was completed in the Wall watershed to validate the conditions or assumptions used. All recommendations are based on Plant Association Groupings or simply stated the "potential vegetation without any disturbance." Prior to actual implementation of any recommended treatment, it will be necessary to confirm the actual condition of the stand. A brief discussion of basic fire spread and fire effects is included.

Fire Spread Mechanisms

Ground fire.

A ground fire generally spreads in the duff by smoldering. This type of fire generally occurs where surface fuels are absent or under conditions where they are too moist to burn. Some ground fires have little if any effect on the vegetation. They burn the surface of the duff layer and generally do not impact the soil or vegetation. Where surface fuels are absent and conditions are dry, duff may be totally consumed. In this situation, considerable damage to the plants and the soil can occur. Generally, duff will be completely consumed any time its moisture content is less than 70 percent. Ground fires contribute significantly to air pollution due to low temperature under which combustion occurs. Even those fires considered to be of low intensity can have significant impact of the soil and vegetation.

Surface fire.

Surface fire generally burns in the surface fuels by flaming combustion. Generally fuels smaller than 3 inches in diameter are consumed. Larger fuels are consumed late in the season or any time they are dry. Surface fires may occur even when the duff may be too wet to burn. These conditions are strived for during spring burning (low intensity). If the duff is consumed, damage to the soil or plant roots is likely. If the flames extend high enough (a high intensity fire) in the air, scorching of the overstory plants can occur. Plants can also be damaged by heat applied the cambial layers. This heat can come from either surface or ground fires. Live vegetation can contribute to the fire intensity and act as a ladder to carry fire into the overstory vegetation. Surface fires where the duff is not consumed pollute less than ground fires as they burn at a higher temperature.

Torching.

Torching occurs when the surface fire generates enough heat to ignite the overstory trees or when ladder fuels are present to carry fire into the crowns. Generally if the entire crown is removed the tree will die. Some species have been known to survive torching, examples are ponderosa pine and western larch. Insects may later attack weakened trees causing mortality to occur. These fires are generally considered to be high intensity as the flame length generally exceeds 4 feet in height.

Crown fire spread.

Crown fires have been broken down into three types or phases. The first is torching as described above. The next stage is a dependent crown fire where the surface fire is providing the heat necessary for crowning to occur and the fire to spread. Independent crown fires occur when the fire is being carried by the crowns of the trees and the surface fire results from embers dropped from the burning crowns. Tree survival is rare any time the crown of a tree is consumed. Ladder fuels and tight crown closure contribute to the extent and amount of crowning that occurs. These fires tend to be rather efficient and thus don't pollute as much as surface or ground fires, however, since they are generally large in size and the total amount of fuel (live fuel being a major contributor) consumed is high, they are a major contributor to air pollution.

Spotting.

Spotting is a mechanism of fire spread. It occurs when embers are carried ahead of the fire, land on receptive fuels. New fires are started that appear to make the fire spread much faster. The spots later burn together. As they burn together they interact creating higher intensities which can cause additional spotting to occur. Torching trees are a major contributor to spotting.

Fire History

Since 1970 (through 1994), a total of 302 fires in the Wall watershed have been recorded, equating to 3.2 fires per 10,000 acres per year. Better than half of the fires (161) occurred in the warm grand fir PAG. The largest fire (299 acres) also occurred in the warm grand fir PAG. Ponderosa pine and juniper plant communities are second and third with 38 and 33 fires respectively. Historically, fires have been spread fairly evenly across the watershed. Since some of the land (particularly the northwest and southeast portions) of the watershed are in private ownership, fire records are incomplete. Even though the map does not show fires in these areas, it is very likely that they have occurred but not been reported in the data base. (Figure 1)

Wall Watershed Historical Wildfire Summary
(1970-1994)

Plant Association Grouping	Total Acres Burned	Acres Burned by Fire Size Class: 0-.25 Acre (A)	.25-10 Acres (B)	10-99 Acres (C)	100-299 Acres (D)	Total Number of Fires
Private Land	3.8	1.3	2.5	0	0	14
Cool Grand Fir	4.3	2.6	1.7	0	0	27
Juniper	93.2	2.7	8	83	0	33
Lodgepole	0.6	0.6	0	0	0	6
Meadow	0.3	0	0.3	0	0	1
Ponderosa Pine	38.7	3.1	15.6	20	0	38
Grass Steppe	4.6	1.8	2.8	0	0	20
Warm Grand Fir	360.1	14.0	40.0	0	299.1	161
Rock	3.3	0.3	3.0	0	0	2

WALL WATERSHED FIRE/FUELS

WILDFIRE POINT MAP

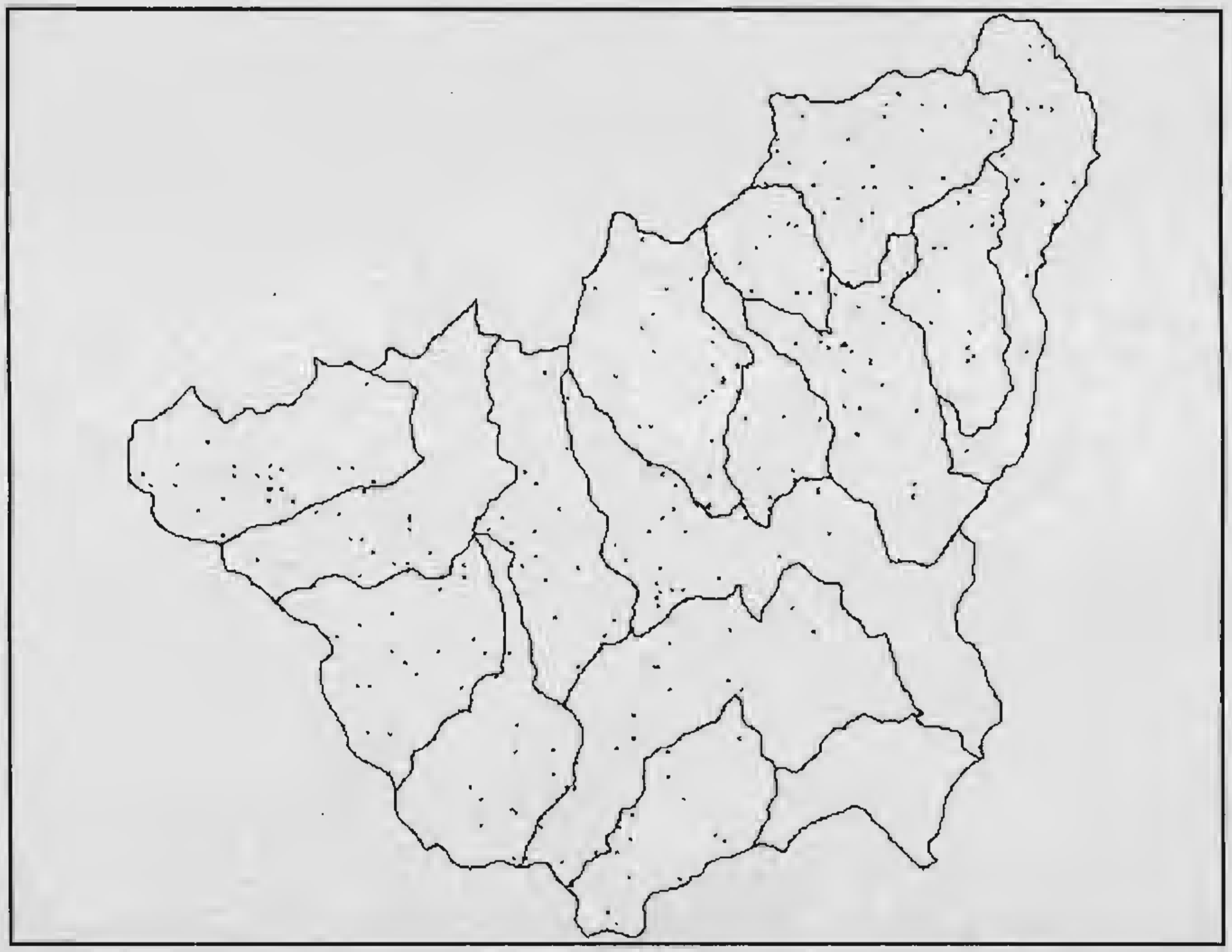


figure1

WALL WATERSHED FIRE/FUELS
PRESCRIBED FIRE HISTORY

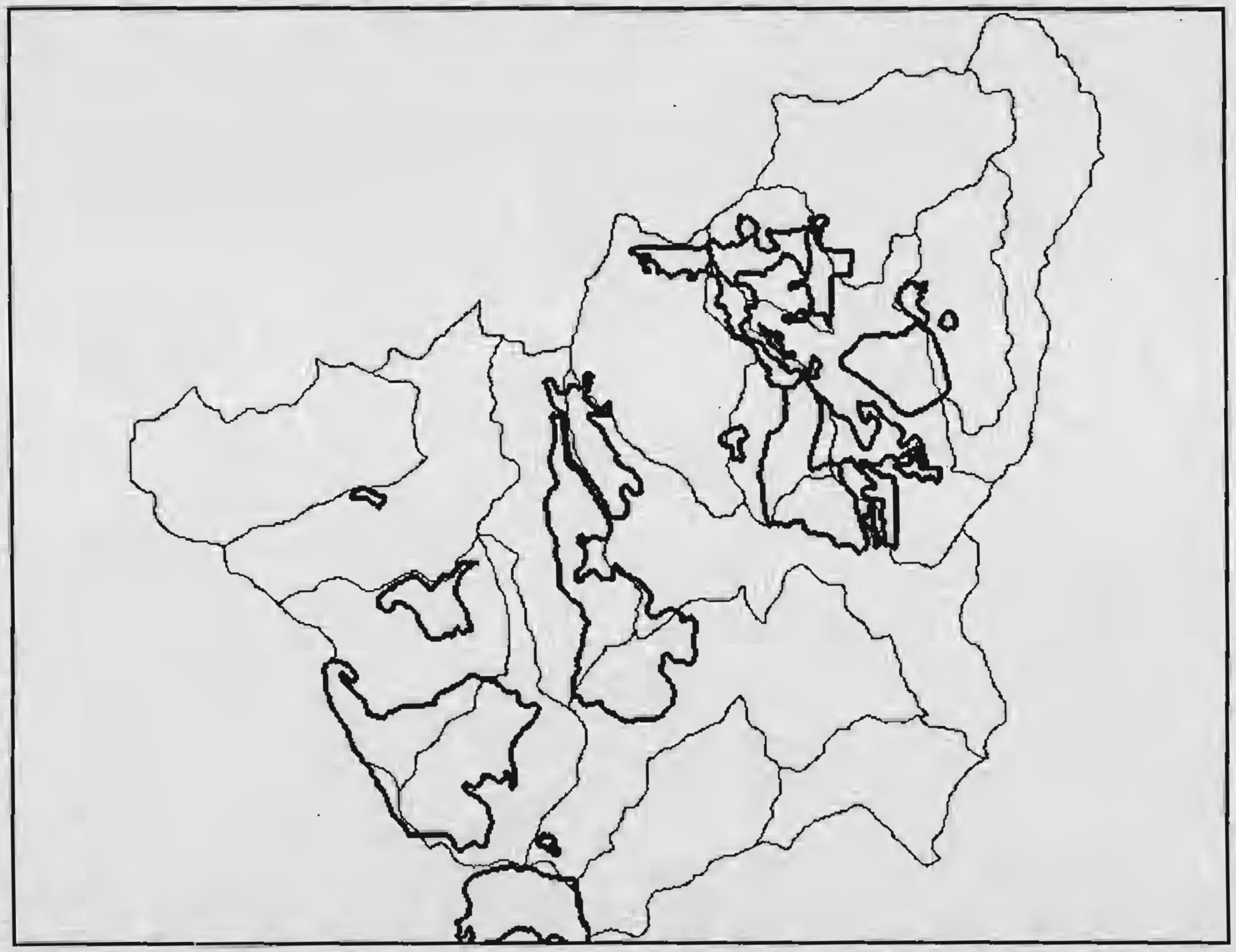
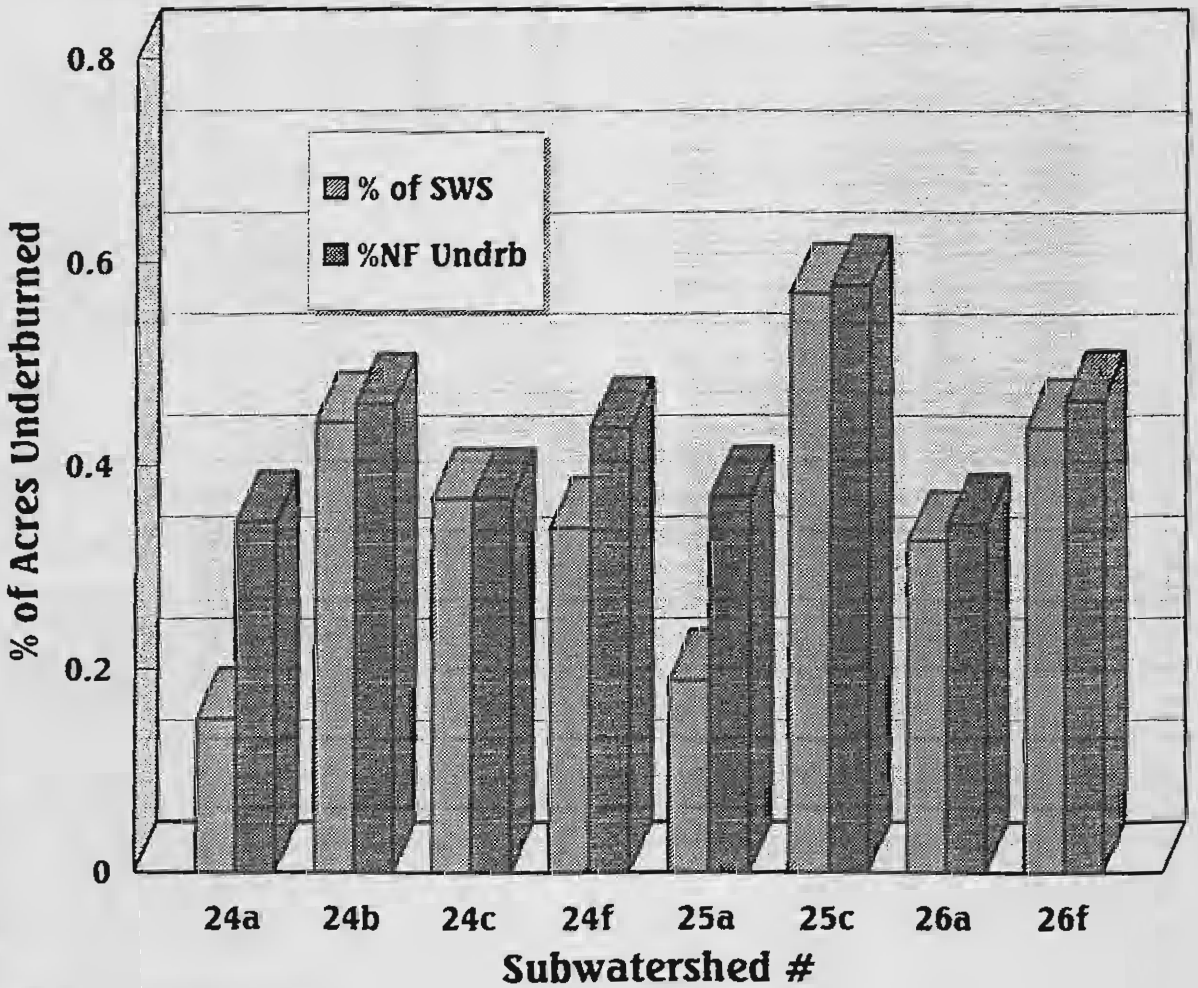


figure 2

WALL ANALYSIS AREA-Underburn

Estimate 30-50% Mortality of small shrubs & trees



Subwatersheds with more than 10 % acres Underburned

figure 3

Prescribed Fire Use

Prescribed fire has been used extensively in this watershed compared to other watersheds on the Forest. However, in comparison to the total number of acres in the watershed, the actual percentage of acres treated is low (see figures 2 and 3). Many of the critical subwatersheds have received little if any treatment by fire. Prescribed fire use has been focused on the ponderosa pine dominated stands and in closely associated juniper plant groupings. Most or all of the burns to date have been conducted in the spring when the duff and soil moisture is high. Under these conditions only, the fine fuels are consumed and only minor damage to the trees and other vegetation occur. These stands generally have not had an excessive fuel loading prior to burning. Fires occurring in areas that have been prescribed burn are usually easier to control. Little if any fire has been used in the cool grand fir and in the ponderosa stands. It is in the cool grand fir and in the warm grand fir that the largest potential for a destructive wildfire presents itself.

Fuels and Fire Hazard Assumptions:

Heavy spruce budworm damaged stands.

In subwatersheds 26c and 26d where spruce budworm has had a significant impact, it is assumed that the fuel loading and risk of fire has increased significantly or is increasing (Figures 5 & 6). This is due to dying grand fir falling to the ground and increasing the existing fuel loading. The opening of the canopy has allowed grass and shrubs to grow that adds additional fuel loading. The open canopy also allows sunlight to dry and warm the surface fuels, increasing the potential for fires to start and spread. Fire spread rates are significantly higher in these stands than they were when the stand had a closed canopy. These stands are also more prone to spread by spotting.

Moderate spruce budworm damaged stands.

These stands show a considerable amount of damage but still contain green trees, and the canopy is still somewhat closed. Fuel loads have not reached critical levels nor are they as dry. In a wildfire situation, torching of the remaining trees is likely. Spread would be dominated by spotting or a surface fire rather than a sustained crown fire (example, Figure 5, level 2 rating).

Light spruce budworm damaged stands. (Level 1 rating)

These stands vary little from a healthy stand based on fire behavior potential. Fires spread primarily by ground or low intensity surface fires but, under extreme conditions, sustained crown fires are likely especially on steep slopes. Spotting is also a mechanism for spread but less likely as the closed canopy helps keep surfaces fuels moist.

Juniper stands.

These stands, once established, are fairly fire resistant except under extreme conditions where fire spread is from tree to tree by torching or more generally spotting from tree to tree. Juniper stands tend to have lesser amounts of fine fuels to carry the fire, especially near the trees themselves.

Ponderosa stands.

These stands traditionally supported frequent light underburns. Fire intensity and spread was low. Fire generally provided the seed bed for the next generation. Fire would later provide a mechanism by which the trees were thinned out. Over time, very resistant stands would develop dominated by older mature pine with scattered areas of poles and seedlings. Many of these stands are now becoming more flammable as firs, shrubs, and fuel loadings increase in the absence of frequent fire. Prescribed fire has been used in several of the subwatersheds in the Wall watershed to help maintain the pine and reduce fire hazard.

Fire Risk by Plant Association Groupings (current situation)

Lodgepole pine stands.

The lodgepole stands are generally of two categories, those that were logged following beetle attacks where fuels were treated and those harvested stands where fuels were not treated or in natural stands where no fuel treat has occurred.
The treated stands are not likely to be a fire problem, as they rarely carry fire to any extent. Fuel loads are generally light. Fire generally behaves as a ground or low intensity surface fire. These stands are generally fire proof. Only under extreme weather conditions is a crown fire likely to occur.

In the harvested but non-fuel treated stands or in the natural stands, the fire potential is much higher. Where the dead trees litter the surface and where fuels left from harvest occur, the potential for large destructive fires is great. Fires will spread by high intensity surface fires and by torching. Generally the canopy is broken up enough that sustained crowning is rare.

Ponderosa Pine stands.

In areas where prescribed fire or some type of harvest activity coupled with fuel treatment has not been used, fir and other fire intolerant species have invaded thus increasing the potential for a large destructive fire. These mixed conifer stands now have the potential for high intensity surface fires with torching and crowning in the closed stands. Mortality in all the species will be considerable once the stands develop multiple layers and tight spacing. (Figure 4)

Warm grand fir stands.

Fuel loading is much higher due to higher stocking levels than occur in the ponderosa pine stands. The fir component has added ladder fuels and have increased crown closure that will allow for fire to carry from the surface into the crowns. Fire spread is primarily by surface fire with a high potential to sustain a crown fire. This is typical of much of the stands that the Tyee Fire burned on the Wenatchee National Forest in 1994. (Figure 5)

Cool grand fir stands.

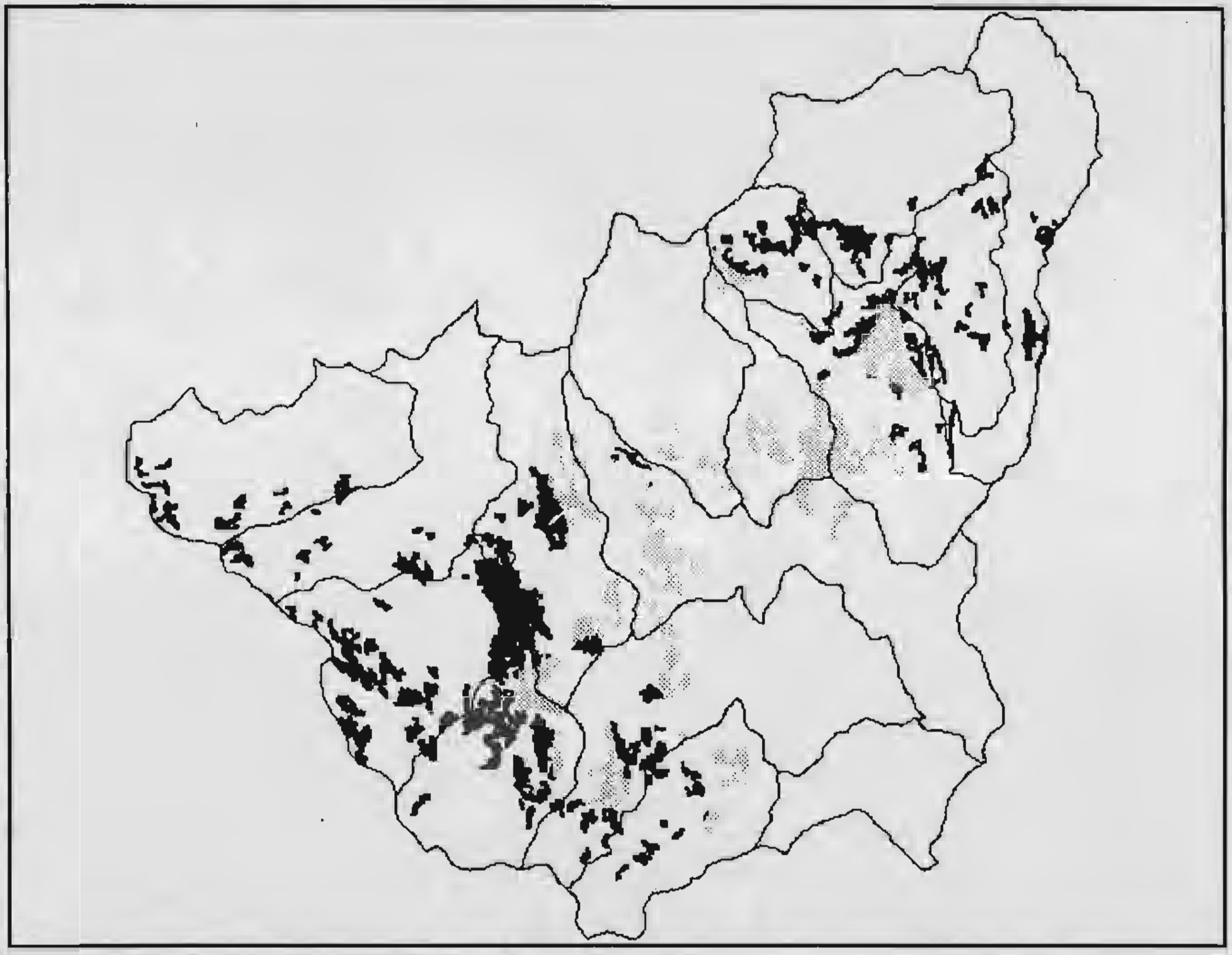
These stands are a true mixed conifer stand. Fuels tend to build up slowly. As a young stand with fairly closed canopy, fire spread is mostly by smoldering ground fire and low intensity surface fire. Fires are generally small in size. As the stand ages, fuels build up and a multi-layered canopy develops. This layering lends itself to carry fire from the surface into the crowns. Due to a higher moisture regime, significant fires are rare except under extremely dry weather when fire generally spread by crown fire. These fires tend to be large in size with high tree and surface vegetation mortality. Rarely are stands completely removed. Generally there will be strips or pockets left undamaged. (Figure 6)

Juniper stands.

Historically, juniper was only found on drier sites that were rarely visited by fire. This was generally restricted to very rocky areas where there was little or no fine fuel to carry the fire to the individual trees. Once juniper becomes established on a site, it is very competitive for water and generally reduces other vegetation except for some annuals like cheat grass. As a stand ages, it becomes almost fire resistant due to the lack of fine fuel on the site. When fire does occur, it is generally carried by spotting from tree to tree. (Figure 7)

WALL WATERSHED FIRE/FUELS

PONDEROSA PINE PLANT ASSOCIATION GROUPING



WITH BUDWORM DAMAGE   WITHOUT BUDWORM DAMAGE

figure 4

WALL WATERSHED FIRE/FUELS EMPHASIS
WARM GRAND FIR WITH BUDWORM DAMAGE

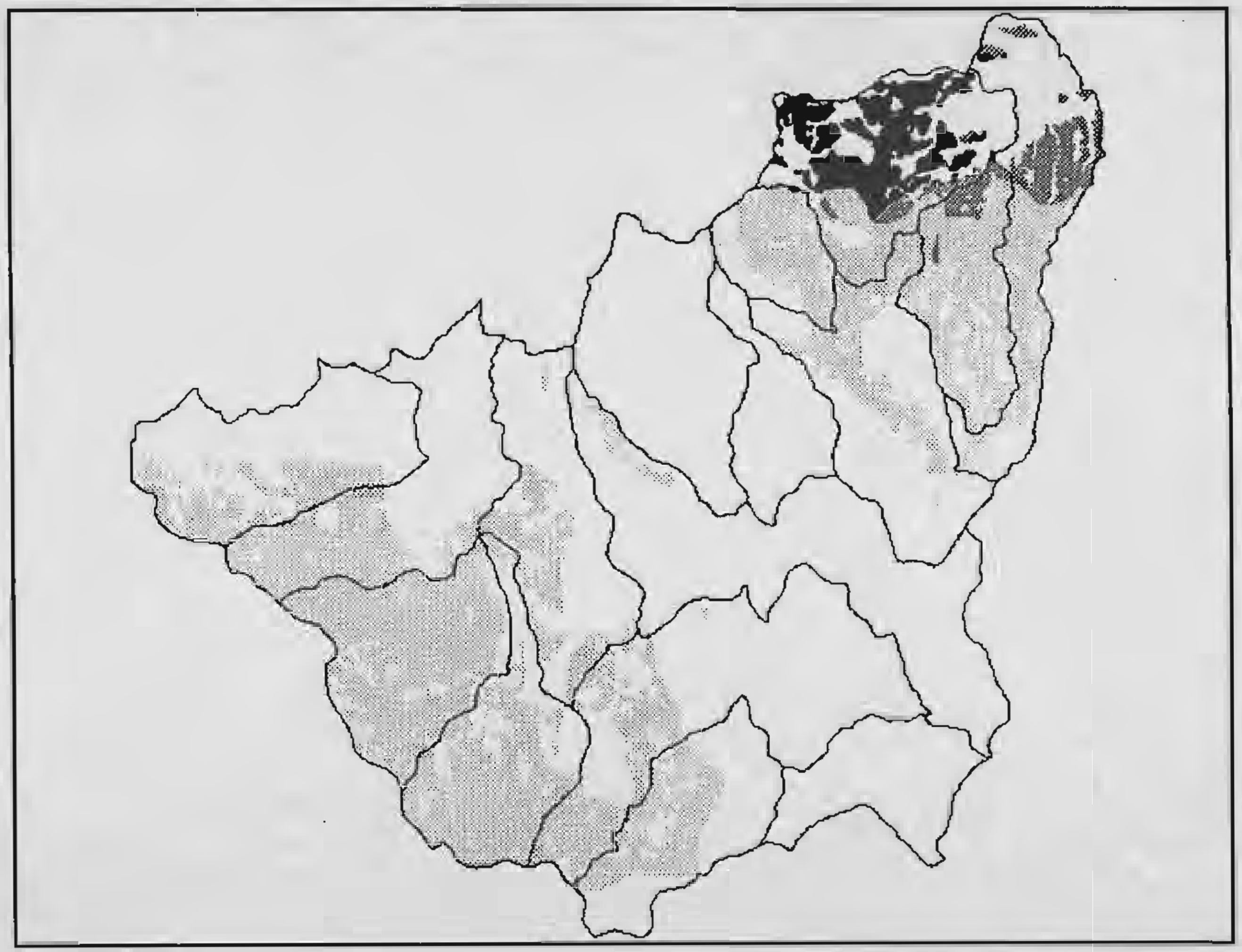
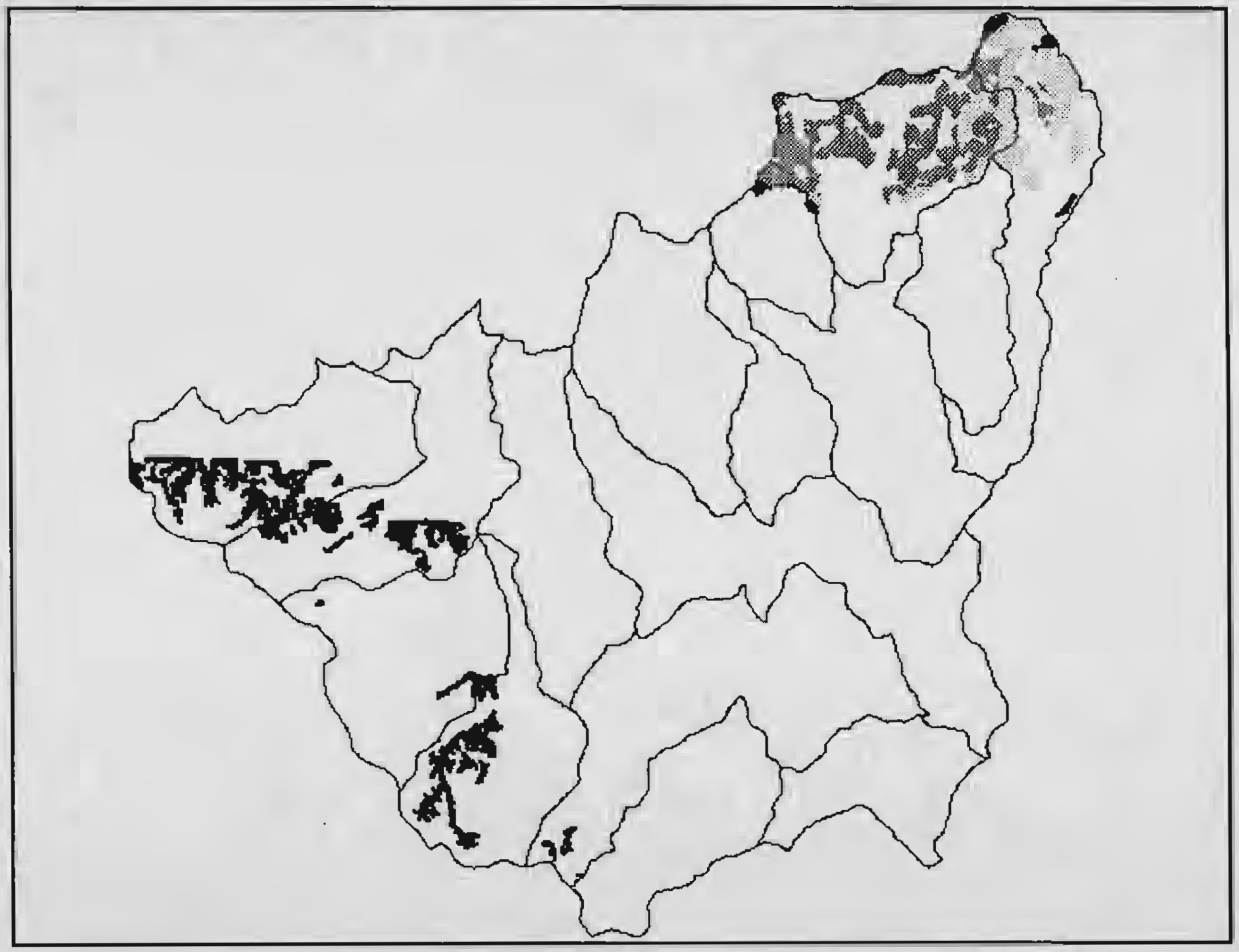


figure 5

WALL WATERSHED FIRE/FUELS

COOL GRAND FIR PLANT ASSOCIATION GROUPING



LOW BUDWORM DAMAGE

MODERATE BUDWORM DAMAGE

HIGH BUDWORM DAMAGE

figure 6

WALL WATERSHED FIRE/FUELS

JUNIPER/STEPPE PLANT ASSOCIATION GROUPINGS

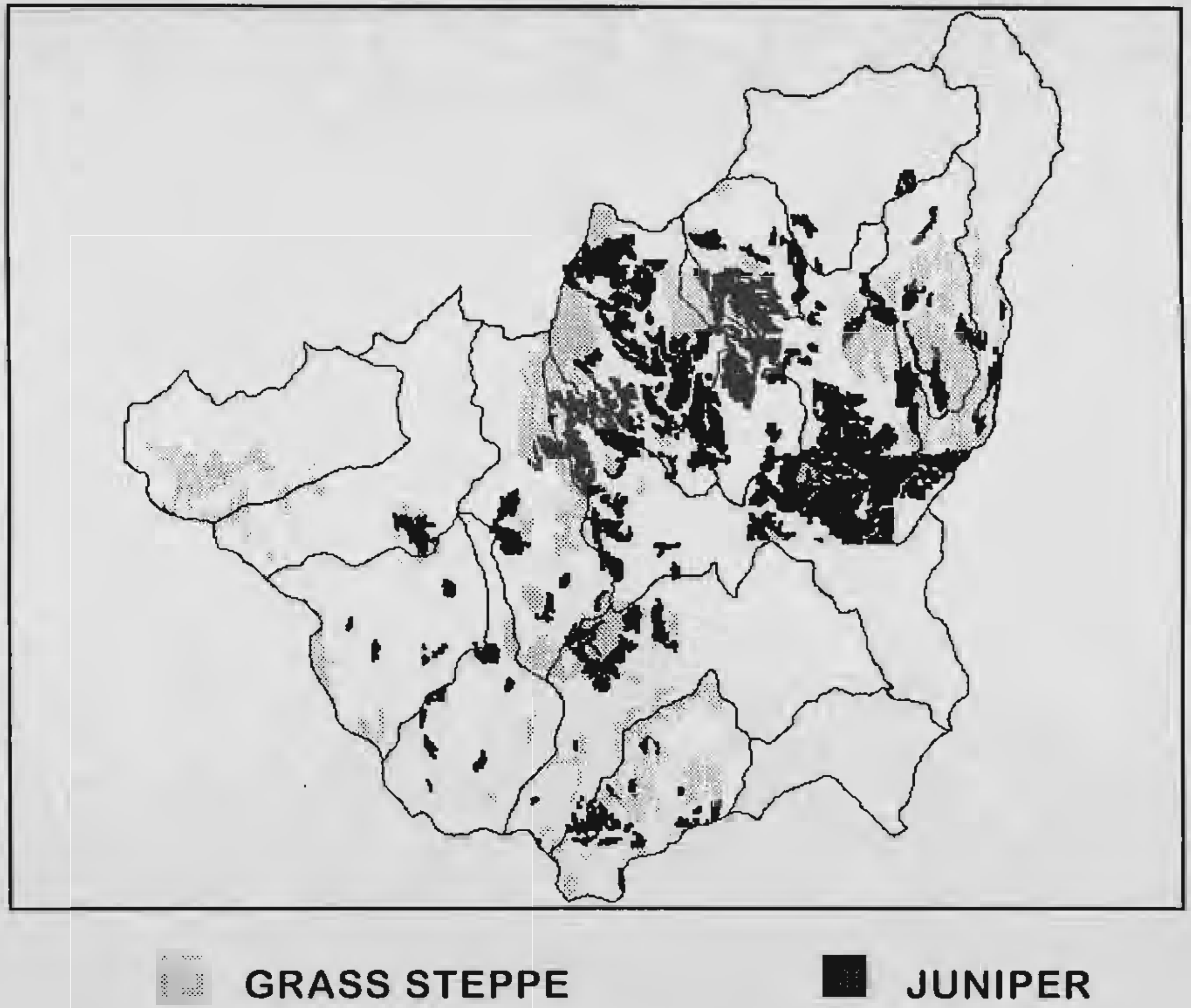


figure 7

Riparian areas (buffers).

Fire generally avoids these areas because of the moist nature of the fuels. Under normal fire season conditions, fires will spread into these areas in a mosaic fashion with little or no overall impact on the stream or vegetation. Under extreme conditions when fuels are dry, fire can kill all of the live vegetation and consume most of the down and dead material. Riparian zones can also provide a network for fire to move from the lower watershed to the upper watershed. All types of fire spread is possible but it is generally limited to ground or surface fires except under extreme conditions when crowning can occur. When duff and soil moisture are also low, mortality can occur even with low intensity fires (less than 2 to 4-foot flame length).

Wall Watershed Fire Hazard Reduction Priorities

Each subwatershed in the Wall Watershed Analysis Area was evaluated and placed in a ranking of high, moderate, or low as a priority for fuel treatment needs. This was accomplished by estimating the number of acres in each fuel treatment priority divided by the number of acres of Forest Service managed lands in the each subwatershed. The number of acres treated by prescribed fire was also considered in developing the ranking. Table 1 contains information on the distribution acres by treatment priority and subwatershed and is summarized below.

The following subwatersheds are considered to have a high need for fuel treatment in order to mitigate large fire potential.

- 26C (Alder/Upper Skookum) Seventy-five percent priority 1 acres, sixteen percent priority 2 acres.
- 26D (Swale) Thirty-nine percent priority 1 acres, thirty-three percent priority 2 acres.
- 24B (Middle Big Wall) Twenty-one percent priority 1 and sixty-seven percent priority 2 acres. Forty-six percent of the area has been underburned.

The following subwatersheds are considered to have a moderate need for fuel treatment and or reintroduction of fire.

- 24C (Upper Big Wall) Sixteen percent priority 1 and seventy-eight percent priority 2 acres. Thirty-seven percent of the area has been underburned.
- 26B (Bear) Fourteen percent priority 1 and sixty percent priority 2 acres. No prescribed fire use.
- 26F (Hog) Thirteen percent priority 1 and seventy-seven percent priority 2 acres. Forty-six percent of the area has been underburned.
- 24E (Upper Wilson) Seven percent priority 1 and seventy-one percent priority 2 acres.

- 24A (Lower Big Wall) Seven percent priority 1 and seventy-six percent priority 2 acres. Thirty-four percent of the area has been underburned.
- 25B (Upper Little Wall) Eighty-two percent of the area is priority 2 and only six percent has been underburned.
- 26A (Lower Skookum) Six percent priority 1 and eighty percent priority 2 acres. Thirty-four percent of the area has been underburned.

The following subwatersheds are considered to have lower priority for treatment than the previous areas, however, if opportunities arise fuel treatment is still very desirable.

- 24F (Lower Wilson) Twelve percent of the area is priority 1 and fifty-eight percent is priority 2. Forty-four percent has been underburned.
- 25A (Lower Little Wall) Eighty-six percent of the area is priority 2 and thirty-seven percent has been underburned.
- 24D (Porter) Seven percent is priority 1 and forty-three percent is priority 2.
- 24G (Indian) Four percent in priority 1 and eighty-five percent is in priority 2. In this subwatershed the grand fir has not encroached into the pine as much as in other subwatersheds.
- 25C (Bacon) Ninety-two percent is priority 2 and fifty-eight percent has been underburned.
- 23C (Fern) All private land. Little if any opportunity for fire hazard reduction.

Wall Watershed Fire/Fuels Analysis
Table 1

SWS #	Rx Use	% Acres	PRIORITY 1							PRIORITY 2				
			WGF HBWD	% Acres	CGF HBWD	% Acres	PP BD	% Acres	Total % Acres	WGF LBWD	% Acres	PP LBWD	% Acres	Juniper
24A	2066	34%	0	0%		0%	430	7%	7%	3471	58%	337	6%	734
24B	3263	46%		0%		0%	1467	21%	21%	4239	60%	266	4%	241
24C	3009	37%		0%		0%	1321	16%	16%	6250	76%	0	0%	123
24D	0	0%		0%		0%	277	7%	7%	1662	42%		0%	11
24E	96	2%		0%		0%	296	7%	7%	2937	66%		0%	218
24F	2799	44%		0%		0%	757	12%	12%	2976	47%	172	3%	548
24G	26	0%		0%		0%	235	4%	4%	3830	67%	541	9%	459
25A	2581	37%		0%		0%	33	0%	0%	3492	50%	149	2%	2374
25B	531	6%		0%		0%		0%	0%	4482	51%		0%	2694
25C	2327	58%		0%		0%		0%	0%	1982	49%	611	15%	1124
26A	2949	34%		0%		0%	512	6%	6%	2966	34%	773	9%	3165
26B	0	0%	355	7%	3	0%	401	7%	14%	2638	49%	6	0%	559
26C	174	2%	3239	37%	3030	35%	309	4%	75%	1246	14%		0%	153
26D	1	0%	1188	15%	1566	20%	254	3%	39%	2043	26%	148	2%	367
26F	1448	46%	16	1%	5	0%	394	13%	13%	1828	59%		0%	572
23C	0	0%		0%		0%		0%	0%		0%		0%	

SWS# Sub watershed ID number
WGF HBWD Warm Grand Fir High Budworm Damage
CGF HBWD Cool Grand Fir High Budworm Damage
PP BD Ponderosa Pine with Budworm Damage
WGF LBWD Warm Grand Fir Low Budworm Damage
PP LBWD Ponderosa Pine without Budworm Damage
Rx Use Prescribed Fire Use (Underburning)

Wall Watershed Fire/Fuels Analysis

Table 1

		SWS #	PRIORITY 3												
	Total													Total	
% Acres	% Acres		CGF LBWD	% Acres	Lodgepole	% Acres	Steppe	% Acres	Meadows	% Acres	Riverine	% Acres	% Acres	NF Acres
12%	76%	24A	68	1%	8	0%	786	13%		0%		0%	14%	5990
3%	67%	24B	679	10%		0%	168	2%		0%		0%	12%	7080
2%	78%	24C	108	1%		0%	339	4%		0%		0%	5%	8185
0%	43%	24D	1214	31%		0%	702	18%	30	1%		0%	50%	3930
5%	71%	24E	765	17%		0%	192	4%		0%		0%	22%	4440
9%	58%	24F		0%		0%	1189	19%	4	0%		0%	19%	6400
8%	85%	24G		0%	9	0%	983	17%		0%		0%	17%	5695
34%	86%	25A		0%		0%	396	6%		0%		0%	6%	6990
31%	82%	25B		0%		0%	1323	15%	27	0%		0%	15%	8750
28%	92%	25C		0%		0%	298	7%	6	0%		0%	8%	4035
37%	80%	26A		0%		0%	608	7%	39	0%		0%	8%	8610
10%	60%	26B		0%	88	2%	1288	24%	6	0%		0%	26%	5381
2%	16%	26C	78	1%	692	8%		0%	37	0%		0%	9%	8770
5%	33%	26D	204	3%	1074	14%	809	10%		0%	153	2%	29%	7735
18%	77%	26F	21	1%		0%	133	4%		0%		0%	5%	3120
	0%	23C		0%		0%		0%		0%		0%		0.001

CGF LBWD Low Budworm Damage

Steppe Grass Steppe

% Acres Percentage of the acres within a sub watershed

General Recommendations

Budworm damaged stands

Traditional timber harvest and fuel treatment methods will provide a very limited benefit to the Alder/Upper Skookum and the Swale subwatersheds. In these watersheds, spruce budworm damage is very extensive. Small harvest units will do little to reduce the potential for fire spread except in those areas that are actually treated. Fires can easily spread around or go beyond treated areas by spotting. There will also be an increased risk of prescribed fire escapes in the harvest units due to the high fuel loading outside the harvest areas. If the units are not large and are not treated effectively, fire will undoubtedly spread around the treated areas anyway. The concept of a fuel break system is not likely to be effective unless the fuels breaks are very wide (in excess of 500 feet). A patchwork of large (greater than 40 ac.) units tied in with natural breaks and/or previous harvest areas could be designed. There will , of course, be an increased risk of fire resulting from the prescribed fire use. Larger units can help to reduce the perimeter requiring holding and thus reduce the potential for escape (if the same number of acres are treated). The lodgepole pine grouping is less extensive (except in the upper northeast corner) and can be treated much like the cool grand fir in this area.

Riparian Buffers

Riparian areas and buffers pose a difficult problem for the management of fire and fuels. Generally these areas are very productive sites and generate higher fuel loadings than areas adjoining them. They are also more moist so generally do not support frequent light underburning. They pose a problem not unlike the cool grand fir PAG in that they tend to burn less frequently and more intensely. This happens during dryer than normal fire seasons. When this occurs, the impact to the riparian zone can be significant. These areas also provide a network that connects many of the other plant associations and as such can be the wick that carries fire even through otherwise treated areas. This is especially true in the Wall watershed where many of the drainage's are oriented with the prevailing wind.

It is important to incorporate the treatment of these areas into any watershed plan. If treatments are not used, the risk of damaging a significant portion of riparian zone could occur. Obviously, riparian zones perform a critical function in maintaining water temperature and controlling water yields so it is critical that we develop plans that will maintain them over time.

There are a couple of options that can be used. First, is to plan for light harvesting in small areas limited to one side of the stream or the other in an alternating fashion. Units should be kept small for the purpose of providing breaks in otherwise continuous fuels. Removal of the fuels less than 3 inches in diameter should be the focus as well as some reduction in crown closure to reduce the potential for crown fire.

If light harvests and treatments are not possible, an other alternative is to allow fire to play a more natural role in these systems as part of activities on the uplands. For example, while treating a harvest unit near a riparian zone, a buffer fire could be allowed to burn back from the harvested area into riparian buffer. This minimizes the need for control lines paralleling the stream and could allow for a mosaic to develop in the buffer along the stream. Low intensity fires generally cause minimal damage to live vegetation, especially those conducted in the spring when the soil and duff is still damp. During the spring generally only the 3-inch or smaller fuels should be available for burning, which should leave large logs and other debris within the buffers. Since we are developing a mosaic, it is important that enough of the riparian area is treated so that fire will have difficulty moving up or down the stream. A prescription should call for flame lengths less than 4 feet in height and those less than 2 feet would be preferable.

Private lands

In developing specific plans for fire hazard reduction, it is important to account for areas that adjoin private lands. Treating areas with a high fire behavior potential near private lands could help prevent fires spreading from the National Forest to private lands. At the same time it is important to consider potential problems that might exist off of the National Forest that presents a threat. Since the actual fuel loadings were not known at the time of the analysis, it is important that the user evaluate fuels near boundaries when developing plans.

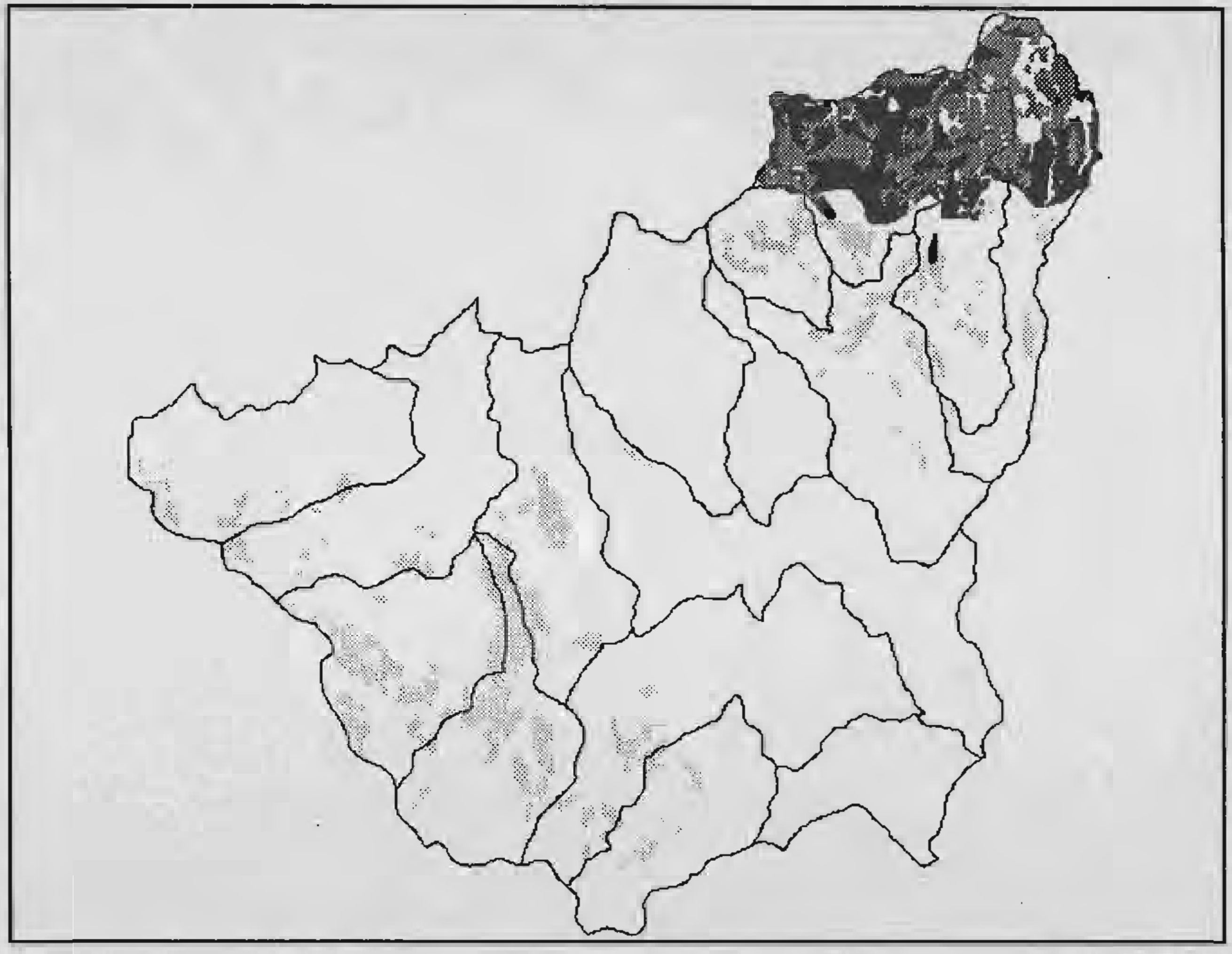
Specific Priorities for Fuel Treatment:

<u>Priority 1</u> Fire Hazard Reduction Areas: (Figure 8)

In developing priorities for treatment, the plant groupings and the budworm damage level was used. The stands with the highest need of treatment to reduce fire hazard are stands which have sustained high budworm rating regardless of plant association. These stands show the highest potential for large stand replacement wildfires and will remain in that condition until they burn or are treated. These areas are the most prone to fires that could significantly impact vegetation, soils and watershed conditions. Treatments must be sensitive to the soils. Treatment should include reduction of some dead and downed material as well as stocking level control. With the existing high fuel loading, significant damage could occur to the soil if burning prescriptions are not well planned and implemented. A preferred method would be to use some utilization scheme to reduce fuel loading prior to treatment by fire. Planting of the native shrub and tree species would speed the re-establishment.

WALL WATERSHED FIRE/FUELS

PRIORITY 1 FIRE HAZARD REDUCTION AREAS



WARM GRAND FIR HIGH BUDWORM DAMAGE

COOL GRAND FIR HIGH BUDWORM DAMAGE

PONDEROSA PINE WITH BUDWORM DAMAGE

figure 8

Areas classed in the ponderosa pine PAG that show some level of budworm damage: These are stands of ponderosa pine with an existing component of grand fir. These areas historically had frequent low intensity fires. The potential for frequent high intensity fire now exists. Treat by using fire after timber utilization where practical and economic. The fire intolerant species will be damaged or reduced in stocking by the use of fire, however, the surviving ponderosa pine should provide for a seed source for regeneration. This will help develop a multi-aged stand while reducing the risk of destructive fire. Periodic burning on a 15-year cycle will help maintain the stand.

Priority 2 Fire Hazard Reduction Areas: (Figure 9)

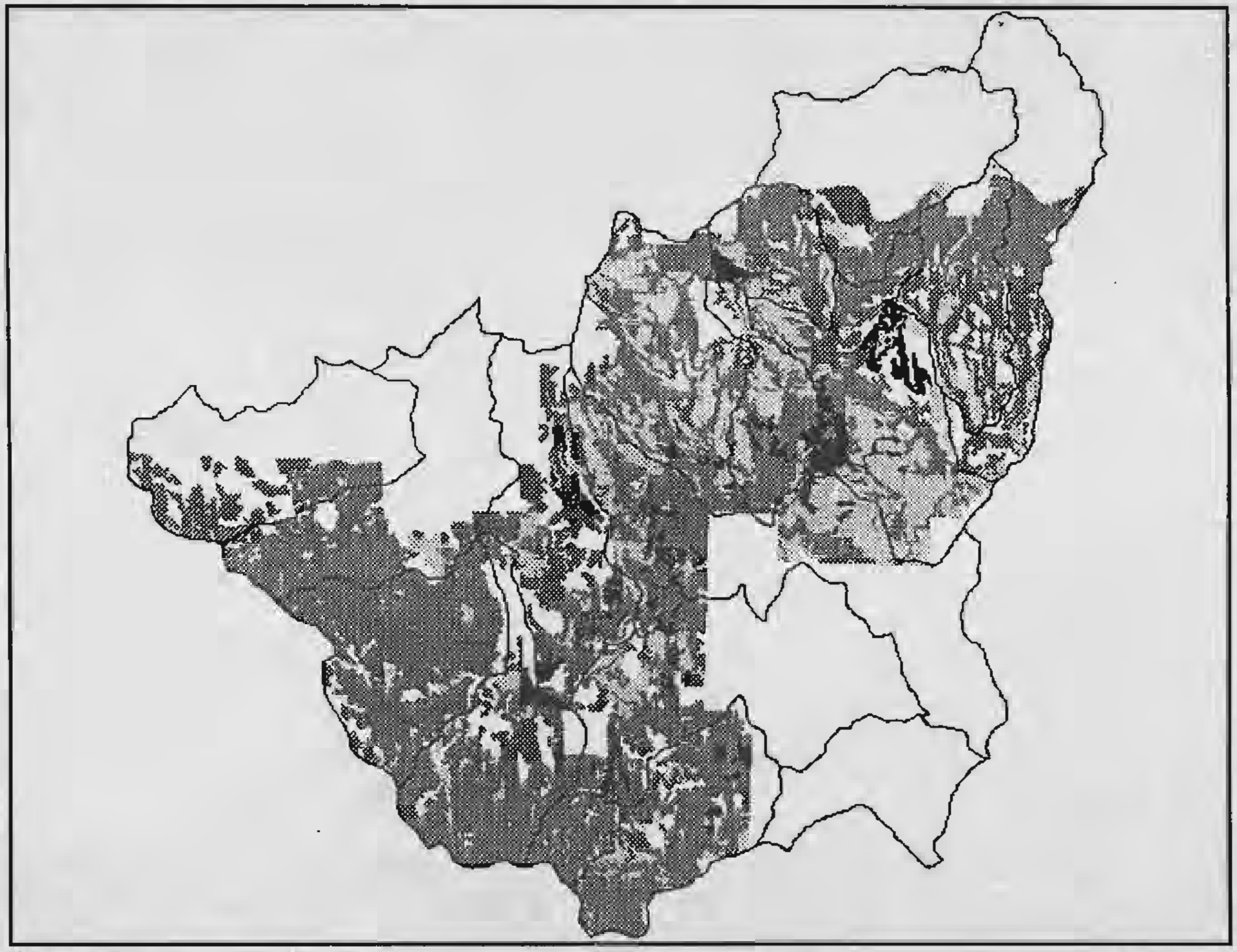
Ponderosa PAG that have little or no fir or that have fir and little or no budworm damage, have a moderate need for treatment: These stands have not progressed as far as those identified in priority 1. Generally underburning can be used effectively. Underburning can provide for natural thinning of the pine while removing fir and young juniper while regenerating grasses, forbes and other native species. Shelterwood removal of the grand fir, with a shelter of ponderosa pine retained, followed by underburning is the preferred treatment.

Stands of warm grand fir that have been impacted by the budworm at a low level: These sites were once dominated by ponderosa pine and will be subject to more intense fires if allowed to move to a fir-dominated stand. Focus should be on the removal of down and dead as well as stocking level control and reduction of shade tolerant species. In these stands utilization of the fir, if possible, should take place first followed by well planned and carefully implemented underburning. These stands have not had significant fuel buildup yet, thus low intensity burning is possible. Fir can be reduced or eliminated over time and ponderosa pine returned to a dominate role. Fire potential over time will be reduced.

Juniper encroachment into ponderosa stands, warm grand fir and the grass steppes is a major problem in this watershed. As mentioned earlier, once established, juniper resists wildfire and treatment by prescribed fire. Reduction of juniper encroachment has been identified as a priority from an ecological need, as opposed to a concern of fire risk. Juniper greatly alters the vegetation once it becomes established. In young stands (up to 6 feet in height) prescribed fire can be used very effectively to control stocking levels. Prescriptions will generally call for a sufficient amount of cured grass in order to carry the fire and reduce costs. This may require restriction in grazing the year prior to treatment. It may be necessary to slash (cut down) some juniper in order to provide fuel to kill the remaining juniper. Cutting and burning the following spring has also proven effective where the risk of escape is high. Fire wood programs have also proven effective in some areas as a means of controlling stocking of larger juniper trees.

WALL WATERSHED FIRE/FUELS

PRIORITY 2 FIRE HAZARD REDUCTION AREAS



PONDEROSA PINE NO BUDWORM DAMAGE

WARM GRAND FIR LOW BUDWORM DAMAGE

JUNIPER

figure 9

WALL WATERSHED FIRE/FUELS

PRIORITY 3 FIRE HAZARD REDUCTION AREAS

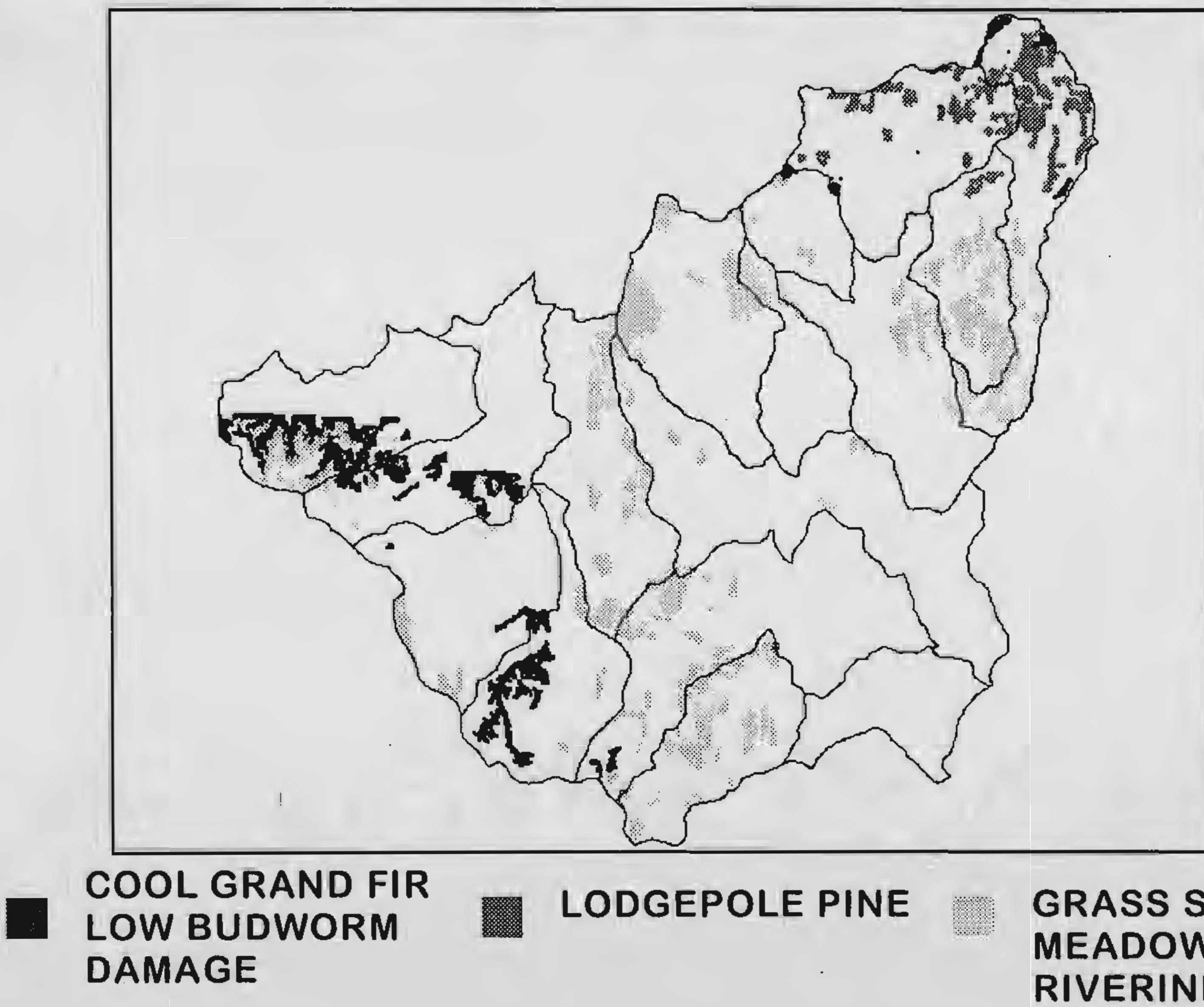


figure 10

Priority 3 Fire Hazard Reduction Area. (Figure 10)

Cool grand fir stands will eventually need treatment to correct the species imbalance, to control stocking levels, and to diversify age groups and structure. Fire may not be the appropriate tool in these stands, at least not without first utilizing some of the fuel. Prescribed fires will be difficult to implement successfully and the risk of escape will be high. A strategy of breaking up the stands to prevent costly fire suppression is appropriate. Unit sizes as constrained by NFMA may be a barrier to obtaining the structure change needed.

Lodgepole stands do not lend themselves to treatment by fire. By their nature, they will be eliminated if fire is used. Over time strategies need to be developed to treat these stands, but higher priority work exists at this time. In these stands the natural processes will continue to dominate.

Grass steppe, meadows, and riverine plant associations do not pose a significant threat of large costly fires except they provide pathways to other fuels. The grass dominated groups can certainly use treatment by fire in order to help maintain a healthy stand and could be a useful multifinanced project to enhance wildlife and livestock grazing on the uplands. However, it is not necessarily a high priority from a fire hazard reduction perspective. Treatments by fire are encouraged especially when they can be included in landscape level prescribed burns. Grazing should be tightly controlled following the use of fire to ensure stand re-establishment.

Appendix 1
Wall Watershed Analysis
Fire/Fuels

A general discussion of Fire Processes, Fire History and Fire Effects

Recent Wildfire History

Recent wildfire history only reflects actual wildfire starts or numbers of wildfires where suppression work was actually done on a fire. Even today some fires start and spread but are never detected and go out on their own. Current wildfire suppression efforts are extremely effective in reducing wildfire size (acres burned). During historic times when there was no wildfire suppression organizations, wildfire would have had the potential to burn more acres.

The ''acres burned'' as reported in a watershed analysis or other report, includes the total area within the control line of the wildfire. This presents a problem with using historic records to evaluate the effects of fire for several reasons. The effects of a wildfire are related to the intensity of the fire as opposed to the size of a fire. It is possible to have large wildfires of a low intensity that will have little if any effect on the vegetation present. It is also possible to have small high intensity wildfires that totally remove the vegetation. Areas may also be left unburned within a perimeter. Most large wildfires exhibit the full range of fire intensity levels. This tends to create a mosaic of fire effects within each wildfire. It is rare for any but very small wildfires to burn at just one intensity level.

Fire Processes

Fire intensity is a measure of the amount of energy (heat) released by a fire. It is generally defined as the heat released by the flame front and does not include the heat that is released through consumption of the larger diameter fuels and duff. This burn out intensity is sometimes referred to as residence intensity. A fire releases heat as the fire front passes and then continues to release a lesser amount of heat as heavy fuels (large diameter fuels) and duff burn.

The potential for heat release is a function of the size and amount of fuels present, the current and recent weather and the topography of the area where the wildfire is burning. Size and amount of fuels are important because it is the small fuels that release heat as the fire front passes. So generally the greater the amount of small fuels present the higher the intensity of the flame front. Where large amounts of dead and down fuels larger than 3 inches in diameter are present or if there is a considerable depth of the duff layer (greater than one inch), there is the potential to release more heat during the burnout of the larger fuels and duff. This burnout can last up to an hour or more.

Total fuel loading is not the only factor that determines the intensity of the wildfire. Moisture in the wood can reduce the total amount of available fuel. Fine fuels easily pick up moisture and will not burn when wet. Larger fuels dry slowly and get wet slowly. Large wet fuels may not burn at all or may only partially burn depending on the fuel moisture. Duff reacts much the same as large fuels. When duff is wet it may not burn at all or may only partially burn. Duff and large diameter fuels may smolder for very long periods of time when partially wet and may hold fire until they dry enough to burn rapidly.

Wind also plays an important role in wildfire spread and intensity. Under windy conditions the flames are pushed into unburned fuels allowing more fuel to be ignited in the same period of time. This will increase the intensity of the fire as more energy is released. Higher fire intensities are related to longer or higher flame lengths.

Topography plays a role similar to wind in that it can allow more fuel to be ignited then if the fire were occurring on flat ground. If a fire is spreading upslope on steep terrain, the flames are brought closer to the fuels allowing for faster ignition, hence greater fire intensity and rate of fire spread.

Historical Fire

Under historical conditions without wildfire suppression, fires that started could easily spread in the available fuels with only natural breaks and weather to restrict their sizes. Of course, wildfires spread less and had a lower intensity where the amount of available fuels were less. In areas that burned frequently there was little time for dead and down fuels to accumulate. In open stands with grass fuels, fires spread quickly and heat is dissipated up through the crowns. Where stands become more dense and fuels accumulate, the heat from fire is trapped by the overstory causing damage to the trees. (Hall, 1977) In areas where conditions are more moist (north slopes, riparian areas and high elevations) wildfires are less likely to burn (as conditions to dry the fuels out do not occur in all years). In this wetter environment, fuel could accumulate over time and then burn more intensely when conditions are dry.

Fire effects different vegetation in different ways along a continuum of wildfire intensities. Low intensity fires have little impact on fire resistant species but can be fatal to fire intolerant species. For example, grand fir of any size class is easily killed by moderate and high intensity wildfires while the smaller trees can be killed by even low intensity wildfires. Ponderosa pine is very tolerant of wildfire and older mature trees will rarely be killed by a single high intensity wildfire. Even the smallest of saplings can survive low intensity wildfires.

The historical types of wildfire intensity fell on the continuum of frequent low intensity wildfires to infrequent high intensity wildfires found on moist sites. The vegetation which occurs on these historic sites were adapted to the wildfire regime which occurred there. Fire tolerant species like ponderosa pine were best adapted to the dryer sites. Grand fir and subalpine fir were adapted to the rare high intensity wildfire regime areas.

With the advent of wildfire suppression the potential for wildfires to spread has become very small. Historically, about 95 percent of all wildfires are suppressed at 10 acres or less. This has allowed fuels to accumulate in the areas where once frequent low intensity wildfires existed. In addition, species which would not have been historically located in high wildfire frequency areas have invaded due to the lack of fire. This has increased fuel loading on these sites. Recent wildfires have demonstrated very high fire intensities. Examples are the Foothills Fire near Boise, Idaho, the Lone Pine Fire near Bend, Oregon, and the Tyee Fire near Entiat, Washington, just to name a few.

The Blue Mountains were once dominated by frequent low intensity wildfires. Wildfire suppression and, to some extent, harvest practices have allowed fuels to increase to critical levels. This is not to say that other factors such as several years of drought and insect epidemics have not had a role in placing the Blue Mountains forest in crisis. But over all wildfire suppression has effected more acres then any other management activity.

The Effect of Wildfire on Stand Structure and Regeneration

Stand composition:
Periodic wildfires tend to maintain dominance by fire tolerant species like ponderosa pine, western larch and to some extent Douglas- fir. Grand fir, western juniper, lodgepole pine and subalpine fir tend to be removed by frequent wildfire. True firs tend to regenerate in the shaded duff and debris on the forest floor. Ponderosa pine and western larch demand bare mineral soil and abundant light for regeneration (Kozlowski, 1974).

Subalpine fir: Most wildfires are stand replacement events because of the species intolerance to fire (Agee, 1994). The extent of wildfires is a function of weather and the distribution of the subalpine forest. Unless conditions are very dry and windy, the size of the wildfire is restricted to a single clump of trees in pure subalpine fir stands. This is caused by a lack of fuels between the clumps. Where subalpine fir is intermixed with other species, the wildfire size is more a function of weather. In mixed stands subalpine fir may be killed while more tolerant species may only be scarred and will then dominate the stand until a new generation of subalpine fir grows back. Re-establishment may take as long as a century (Agee, 1994).

Grand fir: Grand fir is usually found higher on the slope or on cooler sites than ponderosa pine and at a lower elevation that subalpine fir. Stand structure and composition are largely a function of the composition and structure at the time of the wildfire. Low intensity surface wildfires tend to kill the grand fir and encourage dominance by ponderosa pine, western larch and Douglas-fir. Crown fire tends to kill all of the species in the stand. The site is then invaded by pioneer species. If present near by, lodgepole pine and western larch will be the first to become established (Agee, 1994)..

Ponderosa pine: For the most part ponderosa pine exists as a dominant seral species with Douglas-fir and grand fir, however, some almost pure stands do exist. Historically the stands were maintained by frequent light wildfire. The forest may appear to be extensive but it is actually made up of numerous clumps of trees. Each of these clumps is made up of trees of about the same age. Each of the clumps is of a different age. The clumps are generated by numerous small fires or from larger fires that burned with varying intensities across the landscape. Regeneration only took place where older trees had fallen to the ground and then were consumed by wildfire. Ponderosa seedlings became established in the areas where mineral soil was exposed. The low intensity fires tended to thin out the clumps of seedlings allowing only a few to survive. The appearance of the stand is park like, dominated by large trees with some scattered clumps of regeneration and scattered pole stands. Due to successful wildfire suppression, many of these stands have been invaded by Douglas-fir and grand fir. Stocking levels of all species has also increased. Fuel loadings have increased as well over time.

Lodgepole pine: Lodgepole pine is often the pioneer tree species following wildfire. In many locations it is later replaced by Douglas-fir, grand fir or subalpine fir. Generally, lodgepole pine will survive to maturity as it does not produce much fuel to carry fire until such time as old age usually coupled with insect attacks tend to increase the fuel loading. Once fuel loadings increase to support surface wildfire, crowning will occur and the stand will be replaced. Ground fires are also possible. In this case, the fire is carried by the dead fall from the previous crown fire. Fire spreads along the downed logs and may scar nearby trees and provide a seed bed for new seedlings. In the Blue Mountains, lodgepole pine tends to release some seed each year and is not as strongly serotinous as is the lodgepole pine genotypes found in the Rocky Mountains. Ground fires can also provide a seed bed for grand fir, Douglas-fir and subalpine fir.

Douglas-Fir: Douglas-fir is found in association with ponderosa pine for the most part and, along with ponderosa pine, occupies the drier sites. It is more wildfire resistant than grand fir. It generally prefers sunlight and seedlings establish in mineral soil.

Western juniper: Found on the driest forested sites, western juniper will invade the ponderosa pine stands and grass steppes. It is not tolerant to wildfire and will be reduced or eliminated with frequent wildfire. On some sites it can grow to an old age as it tends to use most of the available water once it becomes established, thus eliminating any other plants near it. It tends to produce very little fuel so once established it is able to avoid wildfire except in extreme weather conditions. Western juniper produces alliopathic chemicals that inhibit the growth of other vegetation, also helping to minimize fuel build up.

Western larch: Resistant to wildfire particularly as it gets older. Generally found mixed with lodgepole pine and Douglas-fir. Generally found on more moist sites than ponderosa pine. Ground wildfires and surface wildfires have little effect on it once it is established. It is even resistant to crown wildfires as it can regenerate it's foliage. Requires mineral soil for seedling establishment and prefers abundant sunlight.

Grasslands: Early grassland ecologists considered North American grasslands as 'climax' formations, ignoring the role of fire except to consider it's possible detrimental effects. It was later noted by other ecologists that grasslands fires were not unusual occurrences but a natural and integral part of most grassland environments. (Kozlowski, 1974) Surface fires tend to remove all of the dead vegetation and kill most of the live vegetation. Under drought conditions or on very dry sites, ground fires may consume the under ground parts of the plants. The size of the fires is generally controlled by natural andman-made barriers and by the weather. Fire has been found to generally improve the production and palatability of grasses. The removal of litter generally allows for denser growth to develop. Repeated fires tend to promote grasses at the expense of shrubs and trees. In the absence of fire, shrubs and trees (particularly juniper) will invade the site.

Wildfire effects on soils:
A portion of the heat created by combustion of fuels is transmitted down into the soil. Ground and surface wildfires with little or no burn out of larger fuels will raise the temperature of the soil near the surface very little. When heavy fuels burn under dry conditions they tend to increase the soil temperature at increasing depths depending on soil characteristics and moisture content. Moist soils will experience less temperature rise than dry soil (Agee, 1994). High soil temperatures can kill the portions of plants that exist there and micro-organisms. High soil temperatures can also effect the structure of soils and can produce a water repellent layer that can reduce water infiltration.

Wildfire has the ability to volatilize nutrients from the soil and the amount of loss is a function of amount of fuel consumed.(Agee, 1994). A substantial amount of nitrogen is lost during a wildfire. However the loss in the total amount of nitrogen in the short term is unimportant as most of this nitrogen was not available for use. The decomposition of fuels is very slow and therefore releases very little nitrogen to the system at any one time. Wildfire increases the amount of available nitrogen to the organisms on the site (Kozlowski, 1974).

Wildfire effects on air:
There is no doubt that wildfire creates smoke and contributes to air pollution. Particulates are a major cause of reduced visibility and are harmful to human life. Forest wildfires produce particulates in the size that are most harmful. The type and amount of particulates produced are a function of the type of combustion. Flaming combustion produces less particulates than does smoldering. (Agee, 1994)

Current smoke management plans in Oregon have been reevaluated to consider the importance of wildfire in ecosystem management. A study is under way to analyze the trade off between the smoke from prescribed wildfire and the smoke created by wildfires. Prescribed burning allows the manager to pick the time of ignition. In doing so it is possible to remove a portion of the fuel for wildfire protection needs while leaving fuels for long-term site productivity, prevention of erosion and for other benefits. Picking a time when the amount of smoke generated is less.

Management implications:
"The problems of overstocking and increasing wildfire hazard must be corrected, and in my opinion, this can only be accomplished by restoring periodic wildfire, under ridged control, to its rightful place as an ecological factor in ponderosa pine and mixed conifers. Until this can be accomplished on an adequate scale, I can entertain little optimism concerning the future of forestry in the ponderosa pine region." (Kozlowski, 1974)

"Wildfire protection has created homogeneous high fuel conditions across the entire landscape... Selective logging of pine and Douglas-fir has accelerated successional processes, so that reintroduction of wildfire alone may not restore historical conditions." (Agee, 1994)

" Control of underburning in the mixed conifer/pinegrass community has created an increased fire hazard in a *known fire environment.* We have changed from a fire-resistant plant community to a fire-susceptible plant community. We may *NOT* be able to manage for fir in this environment due to fire hazard. We may not have a choice about burning--only a choice of how to burn; prescribed fire or wildfire." (Hall, 1977)

Monitoring:
The effects that a wildfire has are a direct result of the intensity of the wildfire. Currently only information regarding the location, date, size, and cause of the wildfire is stored in a data base. Recently much of this information was entered in the Umatilla Forest's GIS data base. Larger wildfires will soon have their perimeters input as well. In order to do monitoring regarding the effects of wildfires it is essential that we also map the intensity levels of wildfires. This has been attempted successfully on several large wildfires and the information is stored geographically in a GIS type data base. Carl Davis of the Wenatchee National Forest has recently mapped the Tyee Fire near Entiat, Washington, by fire intensity levels.

Fire History Studies:
Little fire history research has been conducted in the Blue Mountains until recently. In 1976, Hall studied fire return intervals and found a mean return interval of about 10 years in ponderosa pine dominated mixed conifer stands. In 1994, Maruoka studied the fire history of 15 Douglas-fir and grand-fir sites. She found that "grand fir and Douglas-fir were rarely present in the oldest age classes (>200 years), but were well represented in age classes younger than 200 years." She also sites numerous investigators who have "documented increases in fire-intolerant species following a reduction in fire frequency." (Maruoka, 1994)

A fire history study focusing specifically on fire size by intensity levels has recently been started. Preliminary results were presented at a meeting this spring of 1995 and resulted additional field sampling. The preliminary results indicate that historic fire sizes exceeded the 4000-acre sampling areas. The study indicates a higher fire frequency low on the slope as opposed to high on the slopes. This may indicate the human caused fires played a larger role in the development of riparian vegetation then previously thought, however, this is only speculation. The final results should be available in the winter of 1995/1996. The study is aimed at the warm grand fir sites.

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