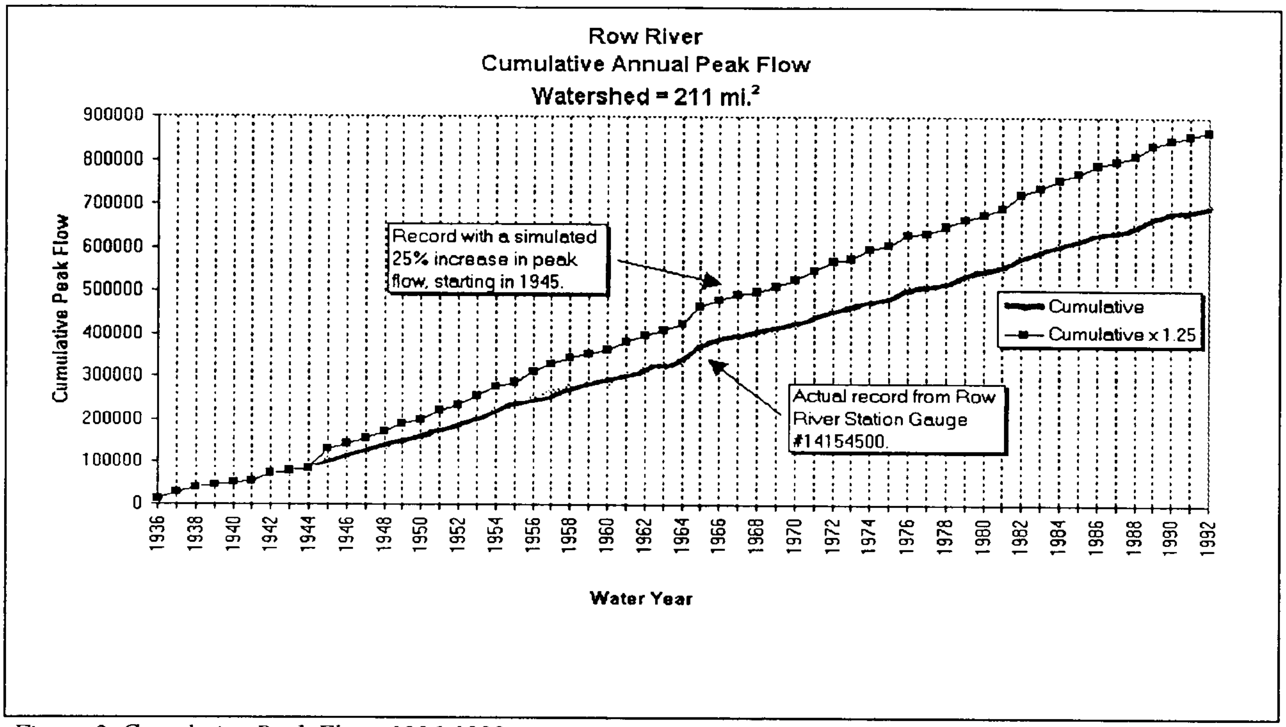


Figure 3. Cumulative Peak Flows 1936-1993

Figure 4 plots the same data over time as Figure 1 along with the median value. If flows are increasing over time more values would be above the median value during the most recent portion of the record period. A statistical test for non-randomness was made for all permutations of values above and below the median value. No non-randomness was detected at the 95% level for either the period of record or for the past 22 years [Wilkes 1948].

Also shown in Figure 4 is a plot that simulates a 25% increase in peak flows starting in 1945. The purpose of this plot is to show what the Row River data might look like if the peak flows started to increase in a consistent manner. It is apparent from the graph that this analysis method would detect a consistent 25% increase lasting several years and that no consistent increase of this size is apparent in the Row River data.

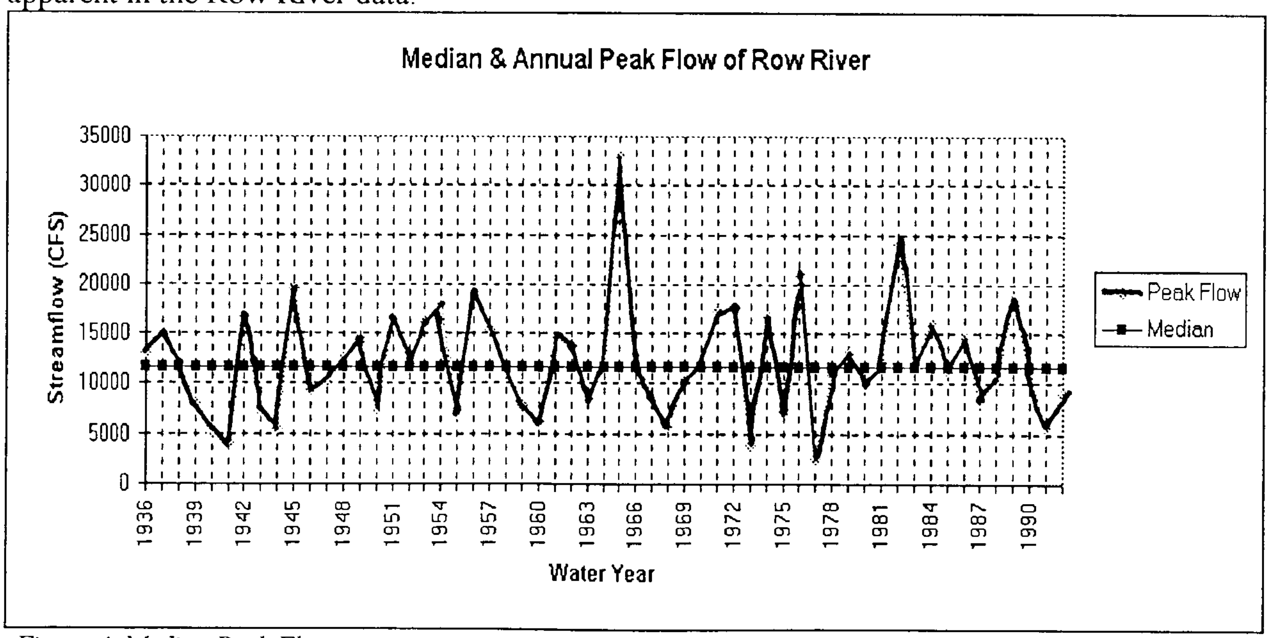


Figure 4. Median Peak Flows

Conclusions and Recommendations:

There is no obvious evidence that the Row River peak flows as measured at the gauging station are increasing over the 56 year period of record. However, it is also apparent that management activities such as timber harvest and road construction can affect the timing and quantity of storm run off in a local area. Likewise, it is apparent that peak flows are, in themselves, very significant in terms of their effect on the watershed. In view of the above, it is recommended to put less emphasis on flow management and place primary emphasis on maintaining and/or enhancing the physical integrity of the channel system and areas of potential instability.

Site management

From the processes described above, it is apparent that the rate of readjustment of unstable areas can be accelerated by high flows with an associated increase in sediment. An appropriate management strategy would be to put primary emphasis on stabilizing an area so that it reaches an equilibrium stable state with a minimum of soil loss and sedimentation. Typical actions would include pulling back or removing material susceptible to erosion or adding structure to reduce the rate of erosion. Large down wood is a natural source of structure material and has been, in the past, an important component of the stream channels. Restoring large wood within the riparian areas to historical levels should be a management priority if the integrity of the aquatic system is to be maintained.

Map 1 shows the Rain-on-Snow zone for Layng Creek. Micro basins in the vicinity of the 3,000 foot contour may have flows up to three times greater than flows at the lower and higher levels [Christner, 1981]. Culvert and drainage design for projects within this zone should reflect these higher flows.

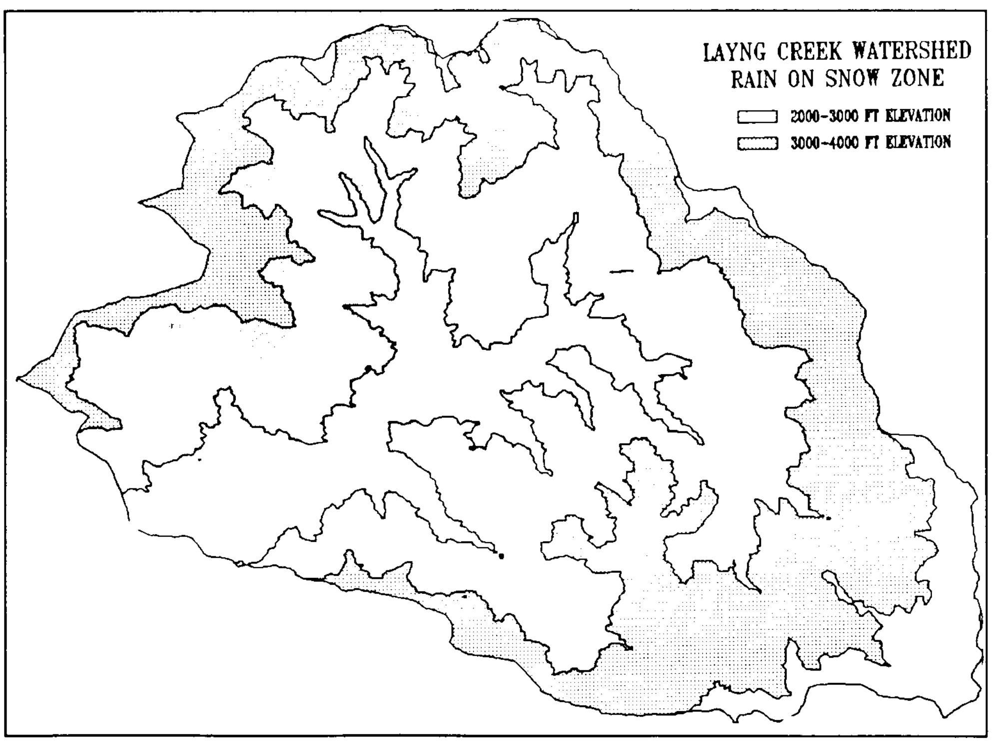


Figure 5. Rain-On-Snow Zone

Recommendations:

Maintain the physical integrity of the system by:

1. Assure that large wood material is available within the riparian areas for the long term.

2. Assure that road drainage is maintained to design capacity.

3. Inventory road crossings and develop mitigation for high risk crossings.
4. In the ROS zone size culverts higher and provide more frequent relief culverts to match natural flow conditions.

References Cited:

301 Christner, Jere. 1981. Changes in Peak Streamflows from Managed Areas of the Willamette National Forest. August, 1981.

303a Harris, D.D.; L.L. Hubbard and L.E. Hubbard. Magnitude and Frequency of Floods in Western Oregon. US Geologic Survey. Open-file Report 79-553.

305 Jones, J.A and Grant G.E. Peak Flow Responses to Clearcutting and Roads, Western Cascades, Oregon: II. Large Basins November 30, 1993.

309 Smith, Kent. A Budget Analysis of Turbidity and Streamflow Data. In: Volume 2 Proceedings of the Forth Federal Interagency Sedimentation Conference 1886.

310 Wilks, S.S. Elementary Statistical Analysis. Princeton University Press 1948.

Appendix C

Harvey Subwatershed

Appendix C: Example Standard ACS Objectives Assessment

Harvey Creek Subwatershed

The watershed analysis for Layng Creek recommends the application of a "Standard ACS Objectives Assessment" procedure Appendix A: Standard Assessment, to assure that the Aquatic Conservation Strategy (ACS) Objectives are being met.. Typically this type of Subwatershed Assessment will be completed as part of the NEPA work as projects are proposed within a particular subwatershed. Subsequent projects within the same subwatershed will be able to tier off of the same subwatershed analysis.

Contents of Appendix C:

Data and analysis requirements for Standard Assessment of ACS Objectives

The purpose of this procedure is to assure that sufficient data and analysis is developed to fully implement the methodology for Standard Assessment of ACS Objectives for Riparian Reserves in the Layng Creek Watershed. For a detailed explanation of the rationale used to develop the Standard Assessment process see Appendix A of the Layng Creek watershed analysis

Data Development:

1. Locate subwatershed(s) affected by the proposed project. (see subwatershed note)
2. Generate a map showing all roads and streams (through intermittent) as defined by the ROD. Obtain total stream miles, total road miles, and number of stream crossings.(for goal 8.2 and others). Measure the total distance of non paved roads that drain directly into stream channels (for goal 5.1).
3. Develop a map showing the vegetative classes for the Riparian Reserve areas. Determine the % of RR within each class.
4. Establish the fish cut off point. If this point has not been established by a documented field survey, a survey will be required if the proposed project is within ½ mile upstream from the point. (For goal 2.2 and needed to establish exact buffer width).
5. Locate all artificial barriers, both channel and terrestrial as described for Objective 2. (for goals 2.1-2.3)
6. Map and measure amount of road encroachment within class 2 and class 3-4 RR (for goal 2.4 and goal 7.2). Determine the road miles and acres and % of RR for each class.
7. If proposed project involves creating openings within the RR (e.g. logging corridors) determine the size of the openings and the percent of the total RR for the subwatershed.(goal 8.3).
8. Evaluate the risk rating for each crossing and the average for the basin. (goal 5.2)

Risk assessment procedure for road crossings:

Definition of terms:

C_{100} = culvert size needed for 100 year event.

C = size of existing culvert in inches

D = depth of fill in feet - from road to top of culvert

FF = fill factor (= 1 for rock fills, 2 for soil fills)

CF = Capture factor (=10 if no capture, 10000 if capture)

RI = Risk Index (roughly proportional to potential volume loss.

Risk Index for culvert failure:

$$\mathbf{RI} = \{(C_{100}/C)*D\}^2$$

Risk Index for Capture:

$$\mathbf{RI} = (C_{100}/C)^2*CF$$

Specialist Input needed for subwatershed assessments:

S1. Develop an assessment of channel restoration projects that are possible. Add to list for Layng Creek with priority implementation. (For Goal 3.2) (Specialist needed).

S2 Inventory existing channel relating structures and determine the long and short term effects on the channel function. (For goal 3.3) (Specialist needed).

S3. Inventory and review general drainage features within the subwatershed. Assess effect of existing and new projects on local hydrology including groundwater. Propose mitigation for areas adversely affecting unstable areas or critical habitat. (for goal 6.1) (Specialist needed).

S4. Assess the hydraulic characteristics of the flood plain and develop a management strategy. (goal 7.1- Specialist needed)

S5. Identify growing site and species habitat enhancement projects for the subwatershed. (goals 8.1 and 9.1 - specialist needed). Soft goal- implement 10% per project as funding and other uses allow.

S6 Assess all slides identified on the 1988 photos in the Watershed Analysis. Identify amount of material displaced, affect on productivity and water quality, possible cause, and other relevant information.

Subwatershed ACS Assessment

Harvey Creek

General Characteristics

Area of Subwatershed:	2.59 mi^2	
Total Stream Miles:	15.85 miles	6.12 mi/mi^2 Stream density
Total Class 2 Stream Miles	1.72 miles	
Class 2 RR Area	??? mi^2	
Class 3-4 RR Area	??? mi^2	
Total Riparian Reserve Area	1.32 mi^2	51% of watershed
Total Road Miles	9.61 miles	3.71 mi/mi^2
Number of Stream Crossings	20	1.3 crossings per mile of stream
Road Within Class 2 RR	??? Acres [1]	?? % of Class 2 RR
Road Within Class 3-4 RR	??? Acres [1]	?? % of Class 3-4 RR
Total Sediment Feed Distance	9000 Feet	564 feet/ mile of stream channel
Barriers in Stream Class 2	1	Culvert 10
Barriers in Stream Class 3-4	10	

Standard ASC Assessment Summary

Assessment Goals	Goal	Current Condition	Comments
Goal 1.1 Amt of LSOG	> 80 %	??	Manage for LSOG
Goal 2.1 Free of Fish Barriers	= 100%	50%	Restoration needed
Goal 2.2 Free of Non-fish Barriers	> 50%	86%	OK
Goal 2.3 Free of Longitudinal Terrestrial Barriers	> 25%	70%	OK
Goal 2.4 Amount of Lateral Terrestrial Barriers	< 10%	3%	OK
Goal 3.1 Amount of Large Woody Material	1500 -6000 ft^3	Deficient	Manage for LSOG
Goal 3.2 Channel Restoration	Good	Deficient	Restoration

[1] Assume 5 Acres per mile of road.

Assessment Goals	Goal	Current Condition	Comments
	Condition		needed
Goal 3.3 Structure Management	Minimal Impact	OK	OK
Goal 4.1 Water Quality	High Quality	OK	OK
Goal 5.1 Road Sediment Feed Distance	< 600	564	OK
Goal 5.2 Road Crossing Risk	No Risk	4 High Risk	Corrective action needed
Goal 6.1 Site Hydrology	No Risk	OK	OK
Goal 7.1 Riparian LWD	LWD	Deficient	Manage for LSOG
Goal 7.2 Road Encroachment	4%	3%	OK
Goal 8.1 Unique Habitat	Restore	OK	OK
Goal 8.2 Road Crossing	2	1.3	OK
Goal 8.3 Created Openings	0.4%	Undetermined	Check project
Goal 8.4 Plantation Management	LSOG Conditions	Undetermined	Check
Goal 9.1 Unique Habitat	Restore	OK	OK
Goal 9.2 Adjacent Lands	Connectivity	Undetermined	Assess

Assessments:

S1- Inchannel restoration projects

Channel improvement on Harvey Creek, from confluence of Layng Creek and Harvey Creek, to approximately 1/2 mile upstream .

Discussion: The riparian zone near the mouth of Harvey Creek has been severely affected by fire and timber management. In 1982 a fire in this area took out much of the riparian vegetation. In the mid 1980s large wood was removed from the channel area to reduce development of log jams

In general there has been a drastic reduction of LWD in the lower channel area which has led to a loss of channel structure. This, in turn results in a loss of habitat diversity and a change in hydraulic function of the channel. Most of the channel for the first 0.5 mi is a bedrock chute with a 5% channel gradient.

The remaining channel up to the stream crossing is largely riffle condition with a high quantity of cobble sized rock. During low summer flows these rocks are fully exposed and the water seeps between these rocks making it difficult for fish passage. At the mouth of Harvey Creek there is a 6 foot rock cascade which would limit fish passage during low flow conditions. The vegetation in this area has recovered remarkably during the past 10 years. There is abundant alder in the 4-6 inch range which is providing some riparian cover but there are no large conifers.

Two structures exist in the fish bearing portion of the subwatershed. Crossing 10 consists of two 50 inch culverts side-by-side; immediately followed by a cement dam with removable flash boards. The top edge of this dam is about 30 feet wide and, in the middle, is about 52 inches high.

A rectangular shaped notch is cut in the dam that is 42 inches high and four feet across. During low flow periods flash boards are placed in this notch to develop a pool to serve as a water sump.

The rapid flow of water through the culvert during high flows may impede the movement of the resident fish to some extent. However, during the low flow period the passability of this portion of channel is marginal because of the lack of water and the barrier caused by the flash boards is inconsequential.

Recommendations:

Removal / replacement of culvert and removal of the sump dam should be placed on low end of priority list for the District. However, installation of fish baffles in the culvert would enhance fish passage during the high flow periods.

The addition of LWD to the lower channel would be very effective in the retention of gravels and the development of pools. It appears that flying this material in may be necessary.

S2 Channel Structure Inventory

The 20 crossings are typical culvert crossings which tend to provide local control for the channel. Since the channel gradient is high, there is little meandering occurring. During high water the culverts can partially plug and provide some local temporary ponding. In, general the culverts speed the movement of the water.

There are no bridges in this subwatershed. The double culvert (Culvert 10) at crossing of Harvey Creek and Road 1746-707, does not appear to be a fish barrier relative to the existing channel since, during low flows, the cobble channel appears to effectively restrict movement of fish.

Immediately upstream is a concrete sump structure which is about 30 feet wide and, with the flashboards installed, about 55 inches high. With flashboards removed the drop is about 12 inches to a pool above the culvert entrance. This structure serves as a water sump for fire prevention. Flash boards allow for the passage of winter flows and the release of stored sediment.

10 of the crossings for the non fish bearing streams could be seen as a barrier to some type of non-fish organism. The effect of the remaining crossings do not appear to be any more of an obstacle than what is occurring naturally in the immediate vicinity. Of the 29 tributary channels, 25 do not have any culvert related barriers. (Goal 2.2: 86% barrier free)

S3 Inventory of General Drainage Features.

420 Road This road crosses the earth-flow terrain through the middle zones of the drainage sub-basins. This area appears to have deep soils and, with a moderate slope, appears to be draining well. On the east side of culvert 19 there is a wet zone that is feeding into ditch and into the associated channel. No change is recommended for this area. Culverts 8, 15, 16, and 18 have high risk values for fill failure and capture. Construction of armored overflow dips or replacement is recommended.

Table 1 lists the culverts and assigns a risk factor to them. Culverts with a risk factor of more than 500 should be assessed for some corrective action such as an armored dip, removal, or replacement.

S-4 Flood Plain Management.

The channels in Harvey Creek are Rosgen type A and B channels and, characteristically, do not have extensive flood plains. Removal of woody material from this area tends to decrease the hydraulic resistance of the bank portion of these channels and cause a corresponding increase in flow velocities and increased erosion potential. The higher flows in the bank portion does have the effect of reducing the effective flows in the central portion of the channel. The restoration of large wood in the riparian reserve areas restore the function to LSOG conditions.

S-5 Road Encroachment

20 road crossings create about 0.1 acres of openings within the RR. Below crossing 10 there is about .5 miles of encroachment on both sides of the road. This is in a class II section of stream. The road follows the contour on a 70% sideslope and impact to the flood plain is minimal. The floodplain is narrow (channel gradient about 5%) in this area and unaffected by this encroachment. The major impact to the RR is the longitudinal barrier to small organisms that move up and down the side slopes. Since the sideslopes are very steep, the adverse effect of the road as a lateral barrier is probably minimal for most organisms. The road also provides improved access for the larger animals in the area.

Of the 29 tributary channels, 20 do not have a road related barrier to longitudinal terrestrial travel. Consequently 70% are barrier free. (Goal 2.3)

S-6 Flood Plain Management

The flood plain in minimal in Harvey Creek. In a natural condition large wood would be an important component of the channel. Typically the large wood would not move much and would provide hydraulic resistance during high flows. The associated turbulence scours out pools and grades the bed gravels, greatly increasing the diversity of the channel characteristics. Managing the RR for large wood debris is consistent with this strategy. A limited amount may be flown in, the remainder needs to be grown in place. In about 20 years the present alder stand should be making a significant contribution to the debris loading.

S-7 Slide Assessment

Field review of slides identified by aerial photo survey. See Figure 3. and Slide Evaluation Chart.

Slide 1 is associated with the 1981 storm event. A large block of material shifted about 20 feet downslope. A muddy slurry flowed from the base of the block about 1,000 feet to Harvey Creek for the remainder of the winter. By the follow winter, the block seemed to have dried out and the flow ceased. The block and flow channel was seeded and planted with grass see, and alder and Douglas-fir.

Slide 2 No obvious slide was found in the field review. The lower portion of the unit at the end of the 734 Road appeared to be a blind lead area and there may some log gouging in the yarding rows. The slope in this area was in the 70-80% range. There was some exposed soils but the regeneration was good and there was not apparent erosion or loss of productivity. Harvey Creek was also checked below the unit and it appeared to be good condition with full riparian vegetation and abundant wood.

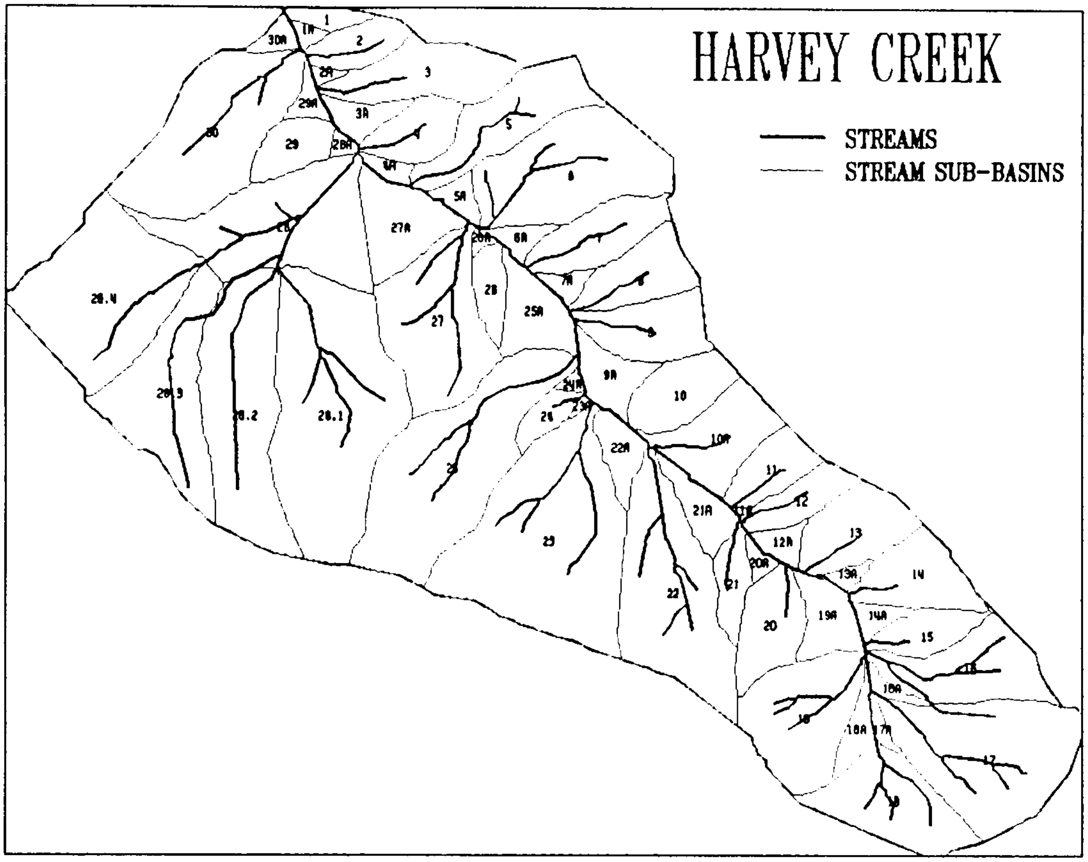
There is a draw on the NW side of the unit that was very deeply incised with a very steep headwall. This ground is too steep to support large trees and shows as an opening in the photo. However, the area did appear to be natural and in a stable condition.

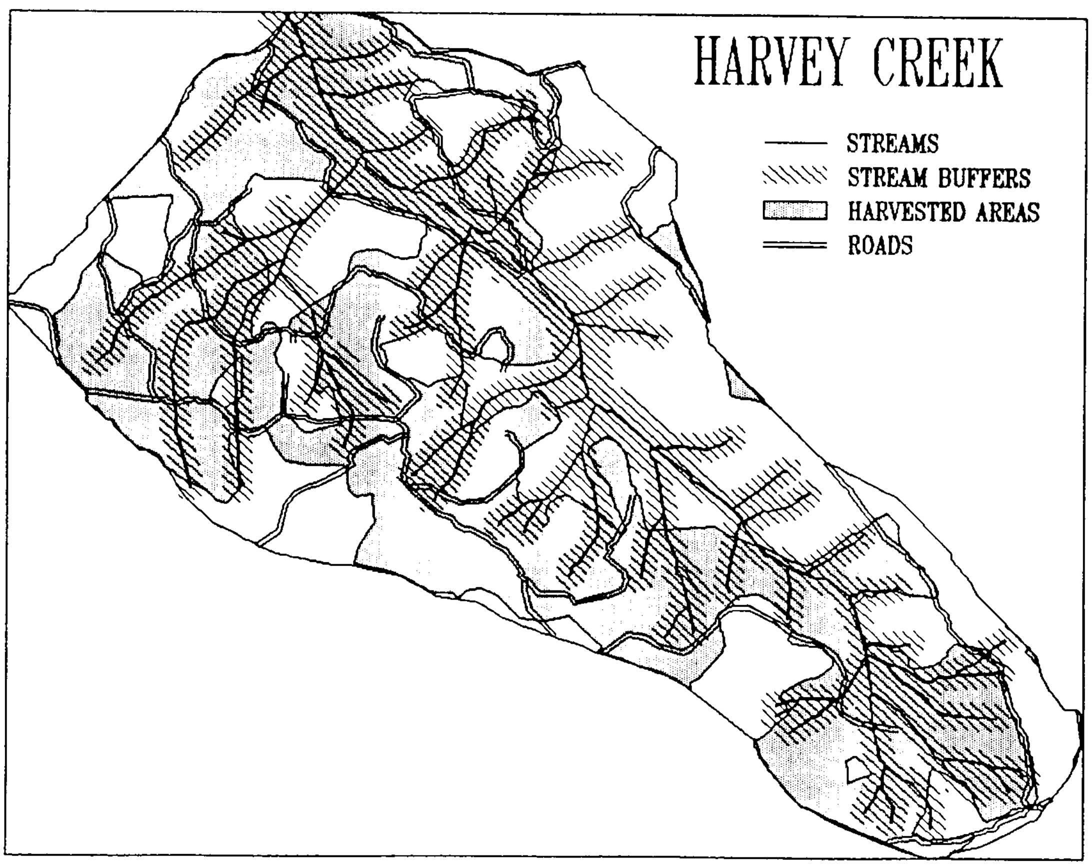
S-8 Riparian Silvicultural Treatment:

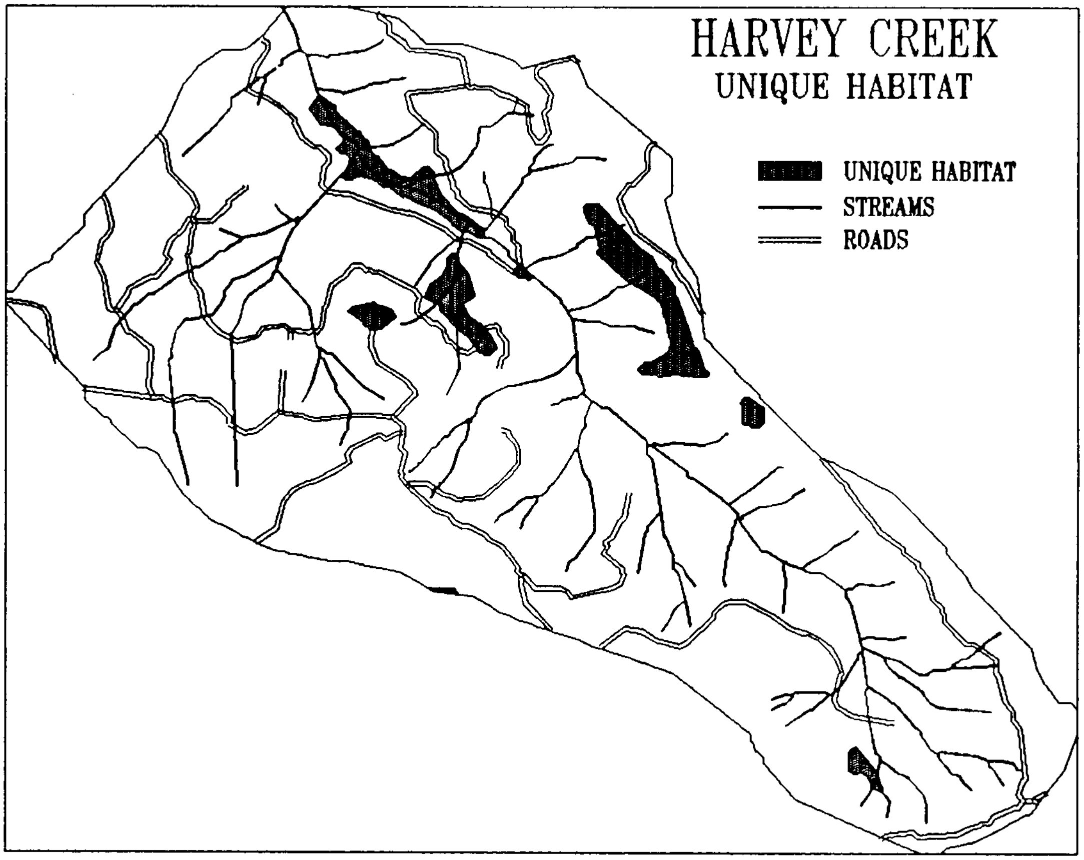
Figure 1 shows the RR areas that intersect older harvest areas. These areas need to be considered for treatment as the harvest units are managed. An assessment will need to be made on a site by site basis but in general, the goal should be to hasten the development of large wood material.

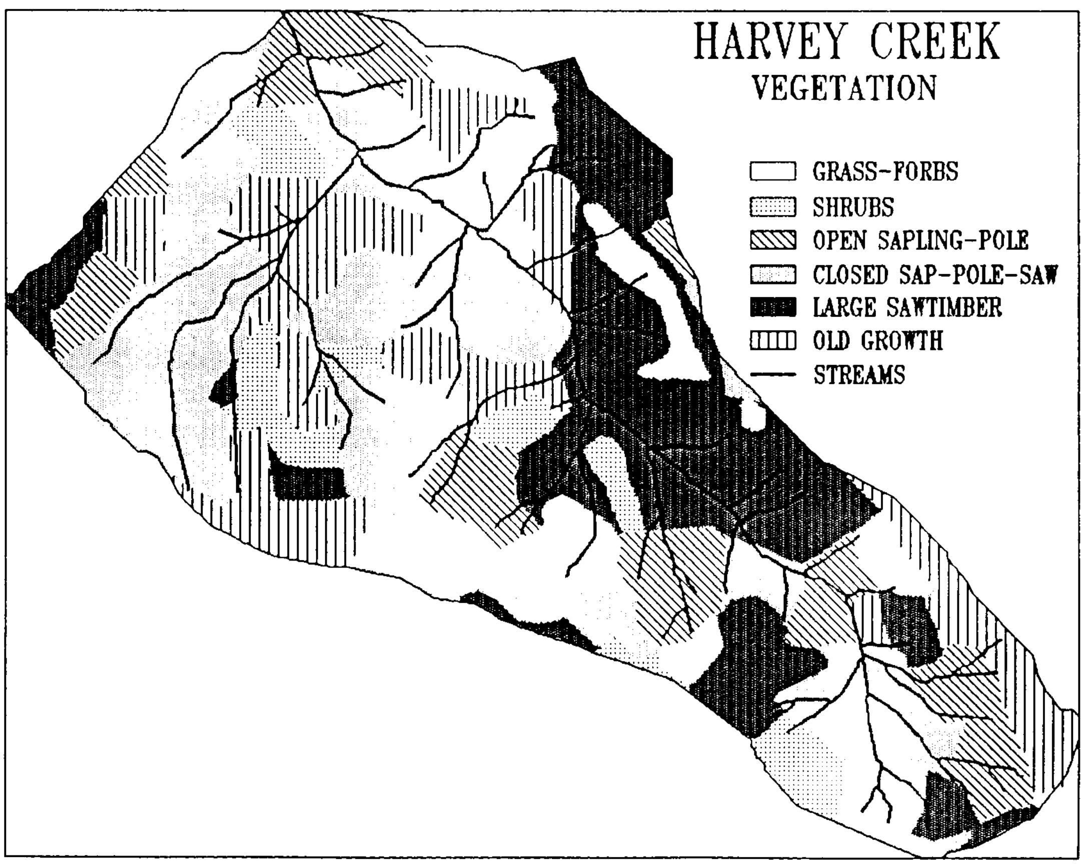
Figure 2 shows the unique habitat areas. Projects affecting these areas need additional assessment. See ACS Objective # 9.

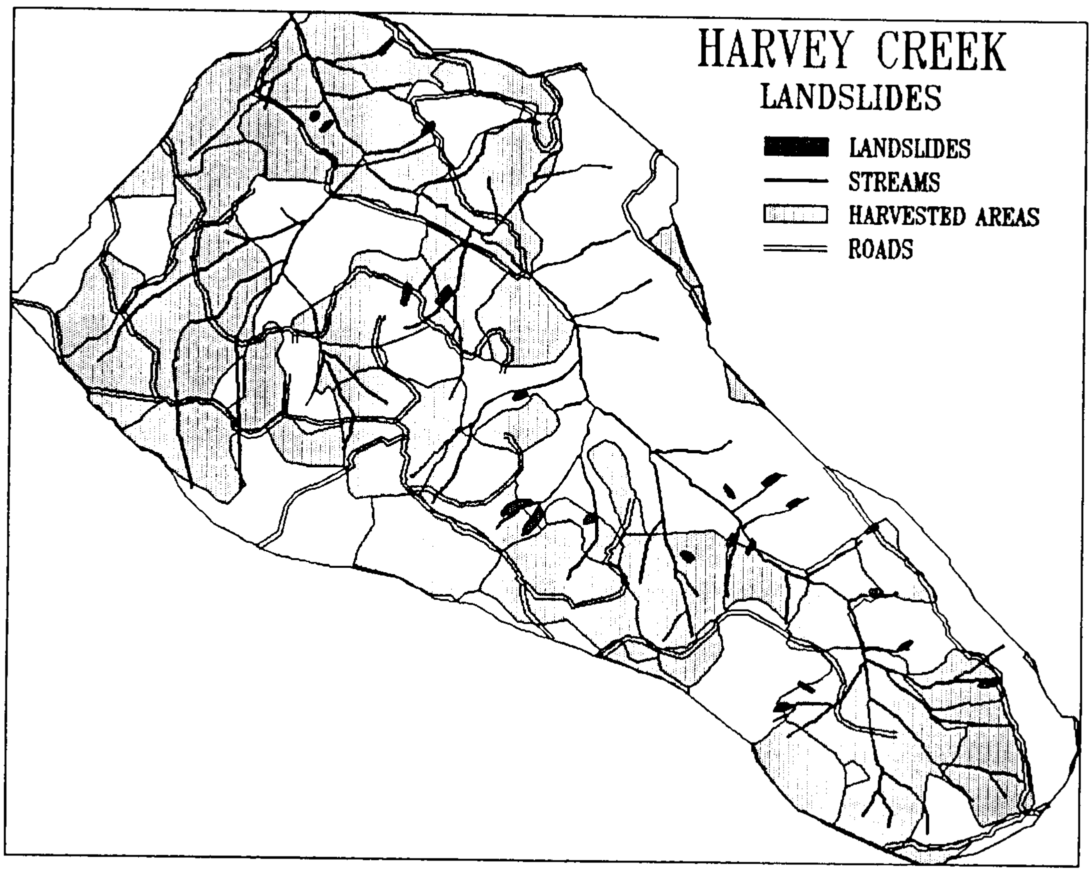
Maps:


HARVEY CREEK
STREAMS
STREAM SUB-BASINS


HARVEY CREEK
STREAMS
STREAM BUFFERS
HARVESTED AREAS
ROADS


HARVEY CREEK
UNIQUE HABITAT
UNIQUE HABITAT
STREAMS
ROADS


HARVEY CREEK
VEGETATION
GRASS-FORBS
SHRUBS
OPEN SAPLING-POLE
CLOSED SAP-POLE-SAW
LARGE SAWTIMBER
OLD GROWTH
STREAMS


HARVEY CREEK
LANDSLIDES
LANDSLIDES
STREAMS
HARVESTED AREAS
ROADS

Appendix D

Fire and Fuels Report

Layng Creek Watershed Appendix D:

Fire and Fuels Management Analysis

June 1995

B.Reed, E.Richardson, S.Tooker-Dilley

TABLE OF CONTENTS

Abstract:

The purpose of this analysis is to document past and current fire and fuels management activities, and to discuss the effects of these activities on various structures and processes in the watershed.

Where possible, recommendations will be made as to potential restoration opportunities and management strategies which may enhance current conditions. Areas that have the potential for further research or study will also be identified.

Introduction

"...Since reference variability encompasses the full range of ecosystem conditions, processes, and values within the current climactic period (the Holocene), it includes both pre-settlement and historical epochs...

"The Holocene time span is used for the reference variability for some...indicators because of its long term, evolutionary time scale...examples of these include...disturbance regimes." (Revised Federal Guide for Watershed Analysis 1995)

In order to define a reference time period, we assessed the information available to us for the Layng Creek watershed. Little documentation existed for the 1850 to 1900 period, when settlers began to move into the nearby valleys. We assumed most settler influences centered around the Bohemia gold mines, and that the Layng Watershed itself was not impacted by Euro-Americans at that time. In other words, we could assume the watershed resembled reference conditions as described in the above quote.

For the purpose of this paper, current conditions will account for the period of 1900 - 1994, for which written documentation is readily available. Reference conditions will account for the time prior to 1900. Due to time constraints, some portions of this analysis are not as detailed as they may have otherwise been. These areas will be identified and may need to be expanded on when site specific project analyses are done. With the exception of Step One - Characterization, this paper follows the format of the Draft Revision of the Region Six Watershed Analysis Guide's six step analysis process.

Step Two - Issues/Key Questions

The Draft Watershed Analysis Guide and Layng Creek Key Questions were reviewed to determine which questions should be addressed in this paper. Issues identified which may affect recommendations include air quality and public concerns relating to management activities within the municipal watershed; both will be addressed. Key Questions were grouped to fit the six step process, and objectives were written for each step. The following are the objectives to be met in this paper.

Objectives

- Identify and address issues affecting fire/fuels activities.
- Describe the existing fuels condition; describe any significant effects of fire/fuels activities on the structure/processes of the watershed; describe the current role of disturbance on the existing fuel condition.
- Identify historic uses and activities relative to fire; discuss how fire may have affected the development of the landscape pattern (as defined by fire regimes and fire intensities) during reference (historic) times; discuss the historic role of fire and it's range of variability.
- Analyze the range of effects of fuels and fire activities over time, the changes in disturbance regimes and the associated range of variability.
- Identify and recommend fire/fuels management strategies and opportunities to enhance fuels diversity, restore historic conditions, or manage for wildlife, silviculture, or other reasons.

Step Three - Current Conditions

Existing Fuel Models

The watershed is comprised of five primary fire behavior (FBO) fuel models. The FBO fuel models consider primarily the 0-3 inch size classes, and are the standard models used to estimate fire behavior.

Fuel Model 1: The meadow areas within the watershed are represented by Fuel Model One. In this grass fuel model, fire spread is governed by the fine, very porous, and continuous herbaceous fuels that have cured or are nearly cured. Fires are surface fires that move rapidly through the cured grass and associated material. Very little shrub or timber is present, generally less than one third of the area.

Fuel Model 5: Young reproduction, prior to canopy closure, is fairly well represented by Fuel Model Five. Fire is generally carried in the surface fuels that are made up of litter cast by the shrubs and the grasses or forbs in the understory. The fires are generally not very intense because surface fuel loads are light, the shrubs are young with little dead material, and the foliage contains little volatile material. Usually shrubs are short and almost totally cover the area.

Fuel Model 8: Portions of the timbered areas are represented by Fuel Model Eight, and the remainder by Fuel Model 10. In Fuel Model Eight, slow burning ground fires with low flame lengths are generally the case, although the fire may encounter an occasional heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures, low humidities, and high winds do the fuels pose high fire hazards.

Fuel Model 10: Fires burn in the surface and ground fuels with greater fire intensity in Fuel Model ten than in fuel model eight. Dead down fuels include greater quantities of 3 inch or larger limb wood resulting from over-maturity or natural events that create a large load of dead material on the forest floor.

Fuel Model 11: This is a slash model. This model would represent some thinning areas and clearcuts less than five years old. Fires are fairly active in the slash and herbaceous material intermixed with the slash. The spacing of the slash, shading from overstory, or the aging of the fine fuels can contribute to limiting the fire potential.

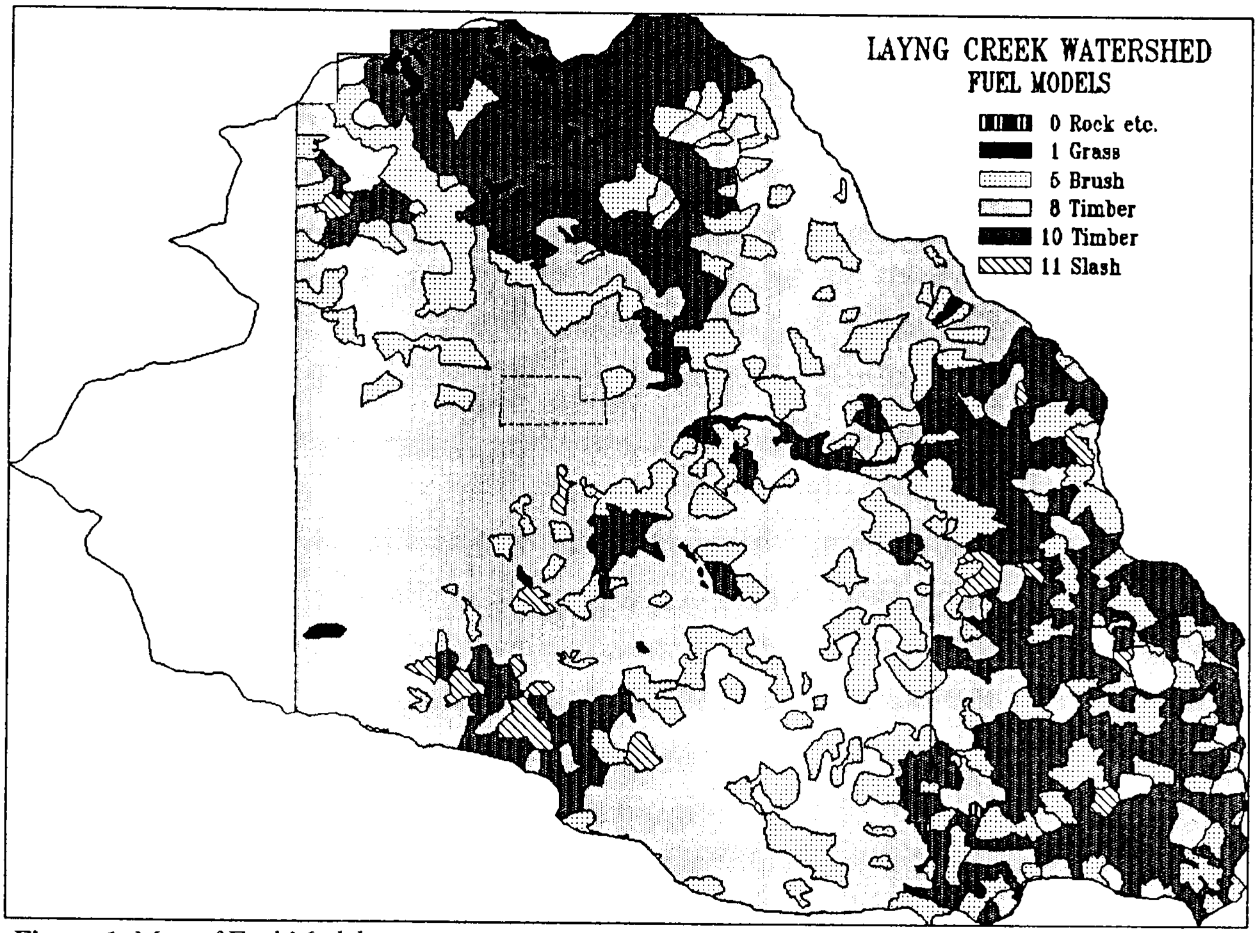


Figure 1. Map of Fuel Models

Table 1: Fuel Model Distribution
(does not include private lands to west of Forest bdy)

Fuel Model	Acres	Percent of Watershed
0	20.34	.05%
1	208.43	.56%
5	7117.25	19.06%
8	19558.19	52.38%
10	9870.69	26.44%
11	564.39	1.51%
Totals	37339.29	100.00%

Fuels Management Activities

"The advent of modern forest fire management in the Douglas-fir region began after the disastrous regional fires of 1902...Severe forest fires occurred in nearly every county west of the Cascades...Most fires seemed to be a combination of settler clearing fires and "slashing" fires, set purposefully after logging to prevent subsequent fires...Organized forest fire protection began soon after." (Agee 1993)

An editorial note accompanying Ranger Carl Henry Young's field notes of 1904 states: *"When trees were cut in a sales case, brush, bark, limbs, etc. were left scattered around on the ground, later burned by the ranger to avoid future forest fires."* (Lane County Historian 1971). Evidence suggests this was occurring regularly in the early 1900's, especially where miners were exploring.

Significant logging activity is thought to have begun in the watershed around 1913, when the railroad was extended into Layng Creek. Logging continued up to around 1930. With the knowledge that the Forest Service burned for hazard reduction as early as 1904, specifically in areas that had been harvested, we can assume the Layng Creek railroad logged areas were burned after harvest.

A second map displays areas of fuels activity and the table below displays the numbers of acres treated by either broadcast burn or under burn, per decade, and the percent of the watershed they represent. Piling and burning was not evaluated because this treatment method does not usually consume enough fuels to change the fuel model or create significant fire behavior.

Refer to photographs and accompanying descriptions at the end of this paper; these photographs display the types of fuels typical of the railroad logging areas as well as the lower Layng Creek drainage from approximately 1900 to 1945.

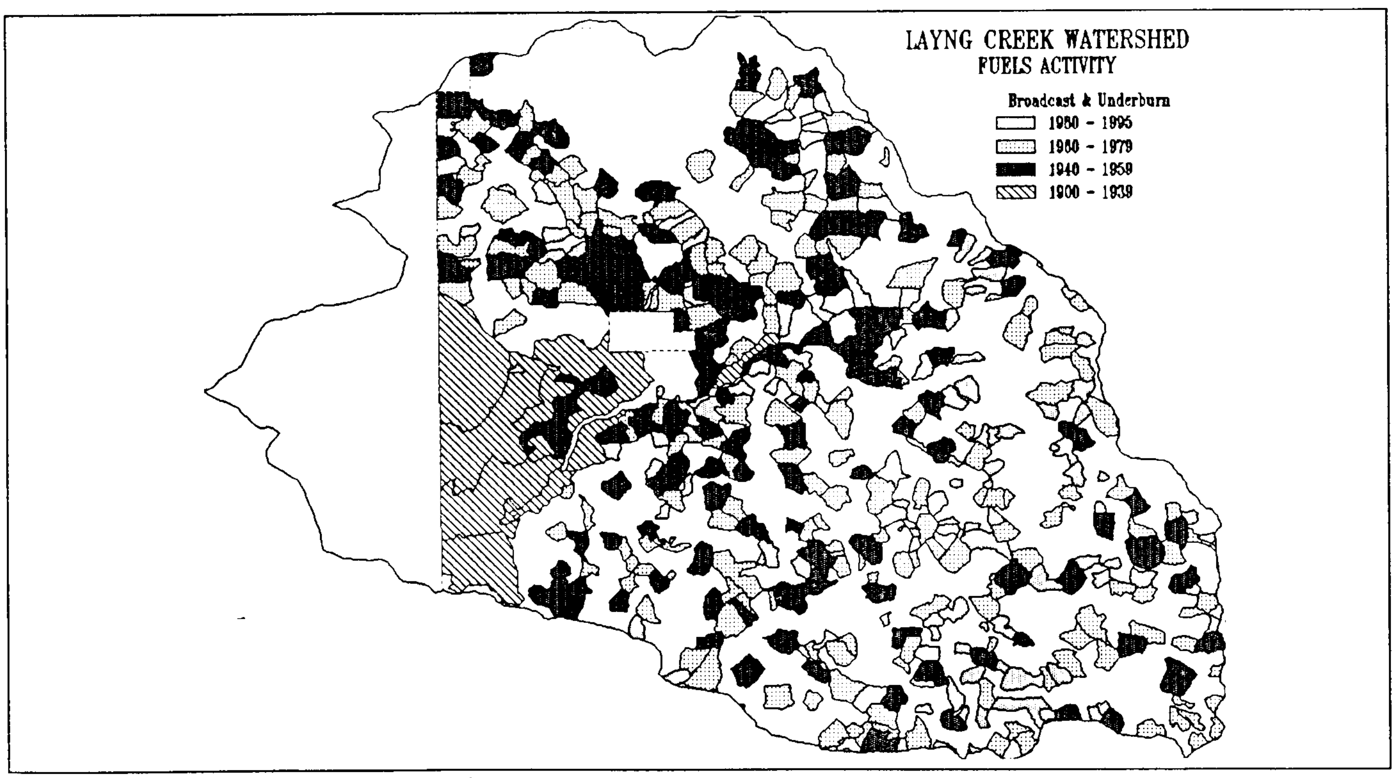


Figure 2. Fuels Activities in Layng Creek

Table 2. Fuels Treatment Activity in Layng Creek

Decade	Acres Treated	Percent of Watershed	*(42,164 ac total)*
1900-1913	Unknown	Unknown	
1913-1930	3200*	8%	
1930-1939	72	<1%	
1940-1949	1152	3%	
1950-1959	4932	12%	
1960-1969	3600	8%	
1970-1979	2516	6%	
1980-1989	2352	5%	
1990-1995	329	1%	
Totals	18,153	43%	

* Railroad Logged

Fire Occurrence - Human and Lightning

In this section, fire intensities and sizes classes are discussed. To better understand how these are defined, please refer to the table in the Fire Intensity Levels section (following this one) for clarification.

In the early 1900's fire appeared to be a regular occurrence. In his field notes, Young recounts views of a *"dense black cloud of smoke hang[ing] over the whole reserve"*; of *"immense clouds of smoke rising"*; of *"several columns at some distance apart...rising"*. Though written records of fire history were not kept prior to 1930, Young's notes, early photographs, and fire scar studies done in the watershed provide clues as to what the District may have experienced in terms of fire.

On August 14, 1904, prior to the railroad logging in Layng Creek, Ranger Carl Henry Young wrote that he *"...patrolled...up Layng Creek to sec 31 T21N R1E and found fire scattered over nearly whole section but not doing any particular damage only to the young timber. Put the fire out in several places but the high wind and the dryness of the underbrush made it impossible to kill it on account of blowing over fire line"*. (Young 1904) For the next nine days Young and his men worked on the fire; their objective was to keep it out of the "green timber". Young wrote of their efforts to *"keep it down"* and of *"turning it from crossing"* various ridges, and of backfiring *"the whole lower part to save green timber"*. On the seventh day he *"left for Bohemia to get some clothes, mine being nearly burned off me"*. Within ten days the fire was out.

This fire was on the lower north slopes below Rujada Point, adjacent to the present day Layng Creek Work Center. Given railroad logging hadn't yet begun in the area, we assume this fire was started either by lightning or someone passing through the area. It appears to have exhibited the characteristics of a partial stand replacing fire, burning through the ground fuels and occasionally making runs upslope and towards the adjacent timber. They used backfiring techniques, suggesting that intensities were such that some stand replacement may have been imminent.

Apparently the area had burned before; on the ninth day Young writes that there was *"no damage to green timber - fire only in old burn"*. There's no indication of when the previous burn happened, it is likely to have been 25 - 50 years previously, as fuels would have had to have time to build up sufficiently to create the environment necessary for this kind of fire behavior. As he had contained his fire within the confines of the "old burn", we can assume this earlier fire was stand replacing. It may have occurred as a result of lightning, or by someone passing through the area.

Sixty five years of recent lightning and human caused fire occurrence (1930-1994) were analyzed to determine fire frequency, intensity, and extent. Over the last 65 years, 68 lightning fires have occurred in the Layng Creek Watershed. These fires represent 41% of all the lightning fires that have occurred on the Ranger District. The average lightning occurrence for the Watershed is 1.05 fires per year. The majority of these fires (94%) were size class A (1/4 acre in size or less), due to either the fuel conditions or suppression activities. (The Forest Service began suppressing fires in the early 1900's.)

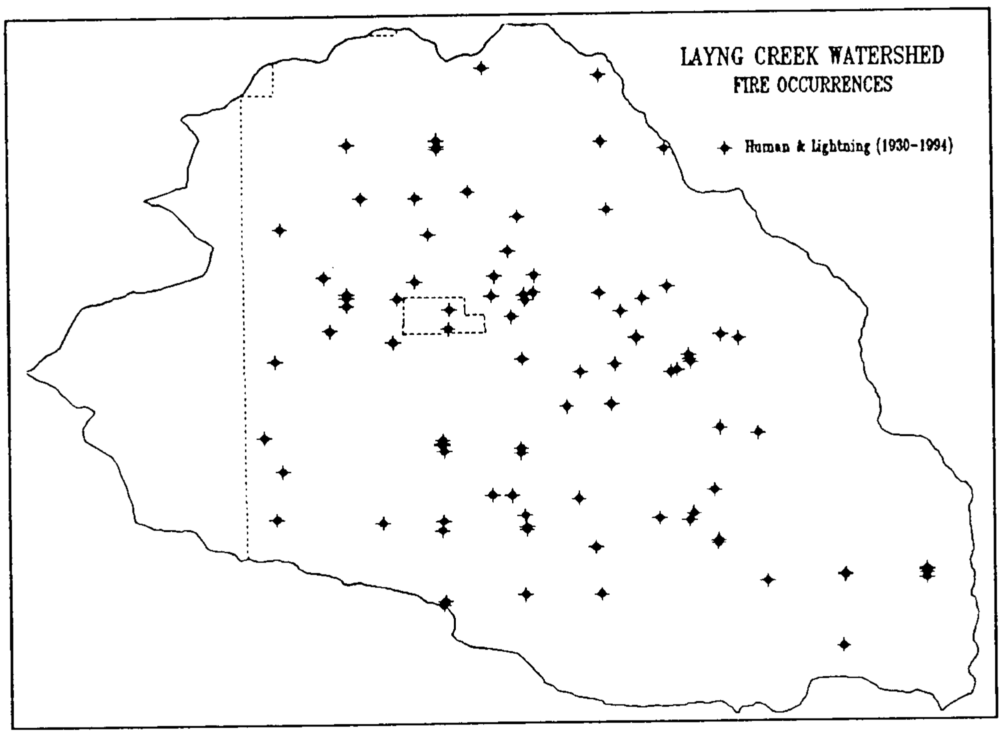


Figure 3. Fire Occurrences

In the 1960's one size class B lightning fire (1/4-9 acres) burned on the upper west slope of the ridge line directly east of Junetta creek (T21S-R1E-15 NW/NW). In the 1990's another size class B fire (the Diet Fire) burned on the middle north slope of Dinner Ridge (T21S-R1E-4 NW/NE).

In the 1940's two lightning fires reached size class C (10-99 acres). Both were located in T21S-R1E-14, with one in the NE/SE corner and the other in the SW/SE corner. They were located on the south and westerly slopes in a drainage SE of Patterson Creek, and near Layng Creek. It is likely these two lightning fires started from the same event; because we don't have exact acres, it is difficult to say if they could have burned together. The remaining small (class A) fires burned in isolated areas of heavier fuels, or creep around in surface fuels.

Though the lightning fires are scattered throughout the watershed, it appears there are two east-west bands of land in which fire starts are concentrated. The first starts near Rujada campground and ends in the upper part of the East Fork Layng Creek drainage and ranges in elevation from roughly 2200 to 2800 feet. The second begins from the upper end of Curran Creek and ends near Salt Peter Creek, and ranges in elevation from 1800 to 2800 feet. The reason for these bands is that these areas are within the range of the thermal belt on the slopes, and would likely be warmer and drier sites, thus supporting more firestarts. All size class B and C fires were within these bands.

Human caused fire occurrence was analyzed for the same time period. Prior to 1930, little is known as to the extent of human caused fire in the Layng Creek watershed. Young's field notes are full of references to fires within the Brice and Sharps Creek drainages, but there are no specific references to Layng Creek.

In the last 65 years, the watershed has experienced 26 human caused fires, which accounts for 42% of all the District's human caused fires. A human caused fire occurs at a frequency of approximately one fire every other year. Of these 26 fires, 54% (14 fires) were caused by debris burning; another 8% (2 fires) were caused by lumbering (logging activities); 8% (2 fires) were caused by equipment use. Another 11% (3) were smoker fires; 11% (3) were of miscellaneous causes. One campfire and one hunter warming fire made up the remaining 8%.

One of the smoking fires (1930's) grew to 9 acres, and was located on an easterly slope west of Junetta Creek. Seven other class B fires (1-9 acres), five class C fires (10-60 acres), and one class E fire (647 acres) were all caused by management activities. Most occurred in the 1970's or earlier. All remaining fires were kept at size class A. The larger fires appear to represent a range of aspects, and elevations, and geographical locations. The sizes of these fires were more likely due to time of year, ignition source or lighting technique, and original size of harvest units than to physical location or unique microclimate.

The most prominent fire is the 647 acre fire that started in the 1950's in the NW corner of T21S-R1E section 16. It spread up canyon/upslope and burned the equivalent of a section. The third map at the end of this paper displays human and lightning caused fire occurrence.

Fire Intensity Levels

Fire intensity data was incomplete for 1930-1969; fire intensity levels (FIL) for 1970-1994 showed majority of fires to be FIL 2 or less. We assumed fires in 1930-1969 would have displayed similar FIL's, and used fire size classes of known FIL's to assign FIL's to the earlier fires.

Table 1. Fire Intensity Levels

Fire Intensity Level (FIL)	Flame Length (Ft)	Fire Report Designation	Assumed Fire Size Class	Size Class Acreages
Low	0 - 2	FIL 1	A/B	0-1/4 ac.
	2 - 4	FIL 2	B	1/4-9 ac.
Moderate	4 - 6	FIL 3	C	10-99 ac.
	6 - 8	FIL 4	D	100-299 ac.
High	9 - 12	FIL 5	E	300-999 ac.
	12+	FIL 6	F/G	1000+ ac.

We can assume the size class A fires displayed low fire intensity levels (0-2 foot flame lengths), with occasional exceptions when the fire burned in isolated pockets of heavier fuels or torched a snag.

The Diet Fire could be characterized as a partial stand replacing fire, as it burned in heavy fuels and consumed several snags and green trees. Had it not been suppressed, it would likely have grown somewhat larger and consumed a considerable amount of dead down material. The overall fire intensity level of this fire was moderate (4-6 foot flame lengths).

The 1904 fire likely exhibited a moderate fire intensity level of 3 at times (4-6 foot flame lengths) and exhibited fire behavior as would be expected of fuel model 5 (young regen. stand) with occasionally higher intensities when winds increased.

While most human caused fires had low fire intensity levels, it is probable the size class C fires experienced moderate fire intensities; the 647 acre fire likely experienced moderate to high fire intensities.

Fire Regimes and Range of Variability

("Fire Regime" is a generalized description of the role fire plays in an ecosystem, and is described using combinations of frequency and intensity.)

The Layng Creek watershed is primarily a western hemlock (Tsuga heterophylla) forest. It is adjacent to a variety of other Pacific Northwest forest types (Agee 1993); the Pacific silver fir (Abies amabilis) forest in the Holland Meadows area is one such type. In the western hemlock forest, "much of the area covered by this series is called the Douglas-fir region because of its dominance, but Douglas-fir is not a late successional or climax species. The dominance of Douglas-fir in the western hemlock zone at the time of European settlement was largely due to disturbance, primarily by fire, for many centuries prior to settlement. Over the western hemlock zone, there is considerable variability in the age of stands that burn, as well as in fire frequency, intensity, and extent, which creates a variety of post-fire effects.

> *"Recent work suggests a higher fire frequency in the drier western hemlock forests of the Oregon Cascades...Morrison and Swanson* (1990) *suggest a natural fire rotation of 95-145 years over the last five centuries...these studies strongly indicate that a variable fire regime with much higher frequency...occurs in the central Oregon Cascades and in other mesic to dry western hemlock forests."* (Agee 1993)

> *"Working in the H.J. Andrews area, Teensma (1987) calculated a mean fire return interval for stand replacement fires of 130-150 years, about 50% longer than the fire return interval that included moderate severity fire...A moderate severity fire regime is characteristic of the southern portion of the western hemlock zone."* (Agee 1993)

> *"In a moderate severity regime, fires are infrequent (25-100 years); they are partial stand replacement fires, including significant areas of high and low severity. In this regime, fires occur in areas with typically long summer dry periods and fires will last weeks to months. Periods of intense fire behavior are mixed with periods of moderate and low intensity fire behavior; variable weather is associated with variable fire effects. The overall effect is a patchiness over the landscape as a whole, and individual stands will often consist of two or more age classes."* (Agee 1990)

Fires appear to have been a frequent occurrence within the watershed in the last 94 years; most were small in size. When the fires grew in size, overall intensities tended to be moderate. Had suppression policies not been in place, it is very likely the size class A fires would have become larger, with higher intensities. The advent of fire suppression, however, has gradually set up an artificial regime which is characterized by infrequent, high intensity, stand replacing fires.

Air Quality

> *"Air, with the passage of the 1977 Amendments to the Clean Air Act (CAA), attained the status of a natural resource that must be guarded and used with an eye for the future. As such, the Congress, through the Environmental Protection Agency (EPA), has set minimum standards and goals for improving the nation's air quality."* (Deeming 1989)

> *"Another provision of the Clean Air Act is the Prevention of Significant Deterioration (PSD). The premise behind the PSD provisions is to prevent areas that currently have very clean air from being polluted up to the maximum point established in the standards. Three air quality classes were established, Class I, Class II, and Class III. Class I areas are subject to the tightest restrictions on how much additional pollution can be added to the air. National parks and wildernesses fall into this category. All other Forest Service lands are Class II."* (Peterson 1993)

Adjacent to the Umpqua National Forest, the Crater Lake National Park and the Diamond Peak Wilderness are Class I areas. The remaining areas, including the wildernesses within the Forest, are Class II areas. We are required to comply with the Oregon State Smoke Management Plan. One objective is to prevent smoke from being carried to or accumulating in designated areas or other areas sensitive to smoke. The western boundary of the Layng Creek Watershed is approximately 11 miles east of the southern-most edge of the Willamette Valley Designated Area (DA).

The Willamette DA includes the town of Cottage Grove and the Dorena Reservoir area. Just over the ridge to the east and north of the watershed is the Oakridge Special Protection Zone (SPZ). This zone requires us to adhere to possible additional restrictions to prescribed burning between November 15th and February 15th of each year.

Within the Oregon State Implementation Plan for Visibility Protection (SIP), a general prohibition on prescribed burning applies to Lane County during the July 1st to September 15th period of each year. The goal of this strategy is to reduce substantially impaired visibility within select Class I lands. The Class I areas nearest the watershed are 20 or more miles away and include the Diamond Peak Wilderness to the southeast, and the Three Sisters Wilderness to the northeast.

Particulate matter (PM-10) has been identified as an air pollutant. Particulate matter emissions are produced from activities such as prescribed fire and events such as wildfire. The PM-10 health standard established by the EPA is aimed at respirable sized particulate matter that penetrates deep into the lungs. This particulate matter is that which is 10 micrometers and smaller in size.

Residual smoke from prescribed fire is a related concern.

> *"When...the convection column dissipates...all subsequent smoke produced...remains near the ground as residual smoke. [This smoke can cause a] visibility problem immediately downwind of a burn area...In complex terrain the residual smoke can flow down drainages at night...the concentration of smoke experienced at down wind locations greatly depends upon weather conditions at the fire site and on the down wind smoke path."* (Prescribed Fire and Fire Effects Working Team 1985)

Generally, prescribed fire residual smoke has not been an issue to down canyon communities. In most cases winds are from a westerly direction during the day, so carry smoke to the east; at night down canyon winds are normally light, and smoke settles in the adjacent valleys. Down wind smoke dispersal can become an issue to down wind communities, however. An example is the Oakridge community which lays within a special protection zone.

> *"The State Department of Environmental Quality (DEQ) defines prescribed natural fire as fire ignited by natural sources...which are permitted to burn within predetermined conditions outlined in...[a] fire management plan. Prescribed fires fitting this definition and covered by an approved fire management plan which includes consideration of smoke impacts are not covered by the restrictions of the Oregon Visibility SIP. The Oregon DEQ and the Oregon Department of Forestry will participate in the development and be provided an opportunity to comment on draft fire management plans..."* (Peterson 1993)

Prescribed natural and management ignited fire techniques are not currently being implemented within the Layng Creek watershed.

Water Sources

There are 25 water sources scattered throughout the Layng Creek watershed. A map and detailed information regarding sizes and capacities are available from Fire Management upon request. Any proposed restoration/changes to the existing water sources should be coordinated with fire management to assure these minimum needs are met.

Minimum requirements for water sources within the watershed are as follows:

- Refill rate of 300 gallons per minute during periods of low flow;
- 100,000 gallon capacity per water source;
- Flow and storage rate of 20-25,000 gallons per hour;
- High in elevation;
- Evenly distributed across the landscape;
- Accessible by engines.

Role of Fire on the Existing Fuel Condition

The primary role of fire since the early 1900's has been that of a management tool to reduce the fuels hazard and associated risk of fire starts. The fuel conditions under which the burns were carried out were unnatural (extensive clearcutting), but the resulting human created mosaic of various burn intensities may in some way mimic the overall effects of fires that occurred in reference times.

Outside the human caused larger fires, the role of fire has been minimal. Regardless of ignition source, partial stand replacement fires have been a rare occurrence in the watershed since 1900. Of the small fires, the vast majority have burned only small concentrations of fuels, occasional snag patches, or individual snags or trees.

Significant Effects of Fire/Fuels Activities

Slash burning has had the most obvious effect on the watershed since 1900. At least 18,153 acres have been broadcast or under burned, representing 43% of the watershed area. Early slash burns were done at various times of the year, and had a wide variety of effects. Burns occasionally exceeded cutting unit boundaries, stressing or killing nearby live trees. For the most part this occurred a limited distance from the unit's edge, but with at least one major exception. The 1950's escaped fire in lower Junetta Creek burned up-canyon and upslope, eventually burning 647 acres. It's likely this was a moderate to high intensity, stand replacing fire which consumed large amounts of larger coarse woody debris on the ground as well, particularly where concentrations of fuel occurred.

To some extent the earlier slash burns were of greater intensities than the watershed would have experienced in this era of fire suppression, had timber not been harvested. Effects on soils were in some cases moderate to severe, in other areas light. Topography, weather, and fuel availability were factors in burn intensities and duration.

In the last 15 years or so, burns have been carried out under spring burning conditions. Results for the most part have more closely resembled the moderate to lighter intensities typical of fires in the watershed in this century.

In the earlier part of this century, the fire near the present day Layng Creek Work Center occurred within an already burned over area. This second fire displayed moderate intensities, and probably consumed mostly the fuels under eight inches, except where concentrations of heavier fuels existed. This fire had the potential to exhibit partial stand replacement characteristics, had suppression not taken place. Given the topography of the area, it could have continued burning upslope for some distance, consuming both ground fuels and occasionally patches of trees. The result may have been a mosaic burn of varying intensities.

Of the lightning caused fires, four resembled partial stand replacement fires, or more severe surface fires with occasional torching. Effects of these fires were not significant to the watershed's structure or processes, but had the potential to become so. Had fire suppression policies not been in place, these fires may have continued to grow in size and intensity to some extent. They were all within the thermal belt area, where intensities tend to be greater due to warmer, drier site conditions. The remaining small (class A) fires had minimal effects on the watershed.

Step Four - Reference Conditions

Historic Uses, Activities, Occupancies

"Every early description of the "pristine" landscape describes open, park-like forests and vast meadows. Human disturbance...contributed to...changes and the subsequent secondary succession that we see nearly everywhere. A careful search...make[s] a powerful...case for the prevalence of Indian burning at the time of contact with Europeans.

"Since hundreds of plants and animals were utilized by Native people for food, fiber, shelter and medicine, a wide variety of habitats were created and maintained - primarily by working with and directing natural processes like fire. Because different areas were burned at different times, for different reasons, a "fire mosaic" was maintained, a kind of patchiness which tended to maximize ecological niches, ecotones, and edge habitat. Instead of a uniform climax stage of ecological succession (the unmanaged model), subject only to interruption by natural disturbances like catastrophic fires...all stages of succession were represented in the same watershed...In the Pacific Northwest where lightning caused catastrophic fire cycles were relatively longer than in other parts of the continent (up to 500 years), the present relative uneven-aged structure of some old growth forests in Oregon...can be attributed to short-cycle (10-20 years) Indian burning as well as other natural disturbances." (Martinez 1993)

"These purposeful fires by almost every American Indian tribe differ from natural fires by the seasonally of burning, frequency of burning certain areas, and the intensity of the fire (Lewis 1985). Indian tribes tended to burn during different times of the year...hardly ever did they purposefully burn during mid-summer and early fall when the forests were most vulnerable to catastrophic wildfire. Often the Indians burned selected areas yearly...or [in] intervals as long as five years." (Williams 1995)

At least three common patterns of Native American burning were found in the Northwest; one pattern was frequent burning in west side prairies and adjacent dry Douglas-fir forest. (Agee 1993)

What follows is a list of documented reasons for intentional burning. This activity has greatly modified landscapes across the continent in many subtle ways that have often been interpreted as "natural" by the early explorers, trappers, and settlers.

"There are at least 11 documented reasons for American Indian ecosystem burning... hunting... crop management ... improve growth and yields (of grasses, camas, seed plants, and berry plants)... fireproof areas... insect collection... pest management... warfare... economic extortion ... clearing areas for travel...felling trees...clearing riparian areas. By the early 1500's, [Old World] diseases were introduced on both coasts, as well as the interior. Dobyns (1983) estimates that native populations collapsed from perhaps 18 million in 1500 to less than 1 million in 1800...This would suggest a possible reduction in Native American burning in the early 1800's." (Williams 1995)

"...The oak savanna of the Willamette Valley was...maintained by frequent firing. [It is hypothesized] that regular aboriginal fires were the main cause...[Despite the introduction of disease] large scale burning by Indians continued over sizable segments of the valley until...settlers forced an end to the practice in the mid 1840's.

"[Many] first hand observations [are] preserved in the daily journals and diaries of explorers, traders, and early settlers...smoke and fire were sometimes mentioned as part of a daily weather report or as a hindrance to travel. Taken by themselves, such passages have little meaning. Considered in the context of what is known from the field of fire ecology, however, they gain substance...The picture that emerges is one which shows that Indian burning practices in the...Valley were highly patterned, occurring year after year at regular times and in particular kinds of environments." (Boyd 1986)

Use of the Layng Creek watershed prior to Euro-American settlement is thought to have been limited to seasonal hunting and gathering by local Indian tribes. "Fire was...1.7 times more prevalent during the aboriginal influence period than during the Euro-American settlement period...When aboriginal populations were in decline from disease...and when settlers had not yet entered the area in large numbers, [there was a] period of low human influence." (Morrison and Swanson 1990)

Settlers started appearing in this area around 1850. "At least through the turn of the 20th century, settlers often used fire to clear the land...while others deliberately burned to reduce the threat of major fires...many settlers adjacent to the public domain often either deliberately set fires or allowed fire to "run free". Also, sheep and cattle owners... often set the alpine meadows and prairies on fire at the end of the grazing season to burn the dried grasses, reduce brush, and kill young trees, as well as encourage the growth of new grasses for the following...season." (Williams 1995)

Fire History, Occurrence, and Intensity Levels

Methodology for Fire History Study

Data for the fire history study was collected from a selection of units within the Layng Creek Watershed which were less than 10 years old and represented a diverse mixture of aspect, slope, and elevation. Some areas in the watershed such as the railroad logging area and Mt. June area are not represented well or at all. Three fifty foot circular plots were taken in each of the units. In each plot, tree age and scar ages were counted for each stump. Accuracy of each of these counts was estimated. After data collection, scars and origins were analyzed and mapped to determine fire episodes. In order to determine fire episodes, rules were followed similar to Augusta Creek Fire History Study (1991).

- Both scar and tree origin dates had to exist for each fire episode.
- Each episode includes at least 5 sites with fire evidence or tree origins dating from a particular fire. Leniency was given for the Mt. June area due to lack of information.
- Only fire evidence data with a count reliability of 3 and above were used to determine fire episodes.
- A cluster of sites had to have both spatial and temporal affinity.

Restrictions on fire evidence data resulted in a reduced data set to determine fire episodes. For the final analysis, only fire events containing high counts and reliability were included in fire episodes. It was apparent that these criteria excluded or lumped a number of apparently low intensity more localized burns.

Determination of historical fire occurrence, intensities, and associated regimes began with an assessment of wildfire history since 1500 AD, based on tree ring counts of fire scars and tree origin dates. Maps of fire episodes were then created by looking at fire event dates and tree origins for spatial and temporal affinity. Successive events were also compared geographically. Episode boundaries were estimated based on patterns of regeneration (from fire history data, stand exam data, and historical aerial photos), fire scars and topographic features. These maps were interpreted to identify the long term fire disturbance regime. A composite map was then developed to display fire regimes. Overall fire intensities were mapped as well.

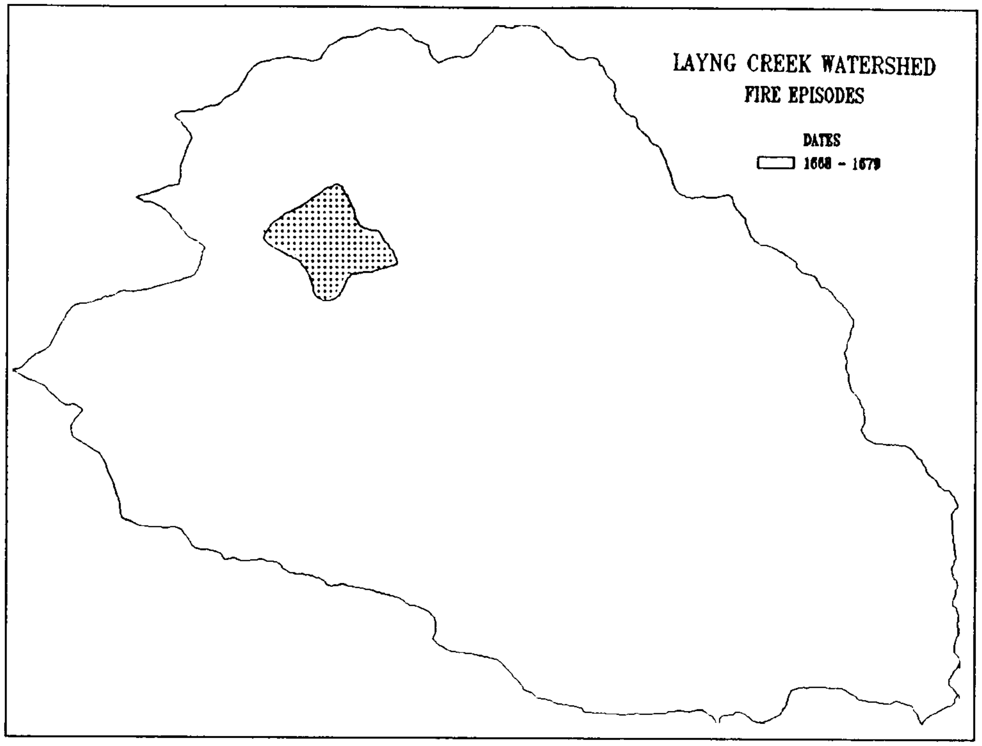
Findings of Fire History Study

15th and 16th Century

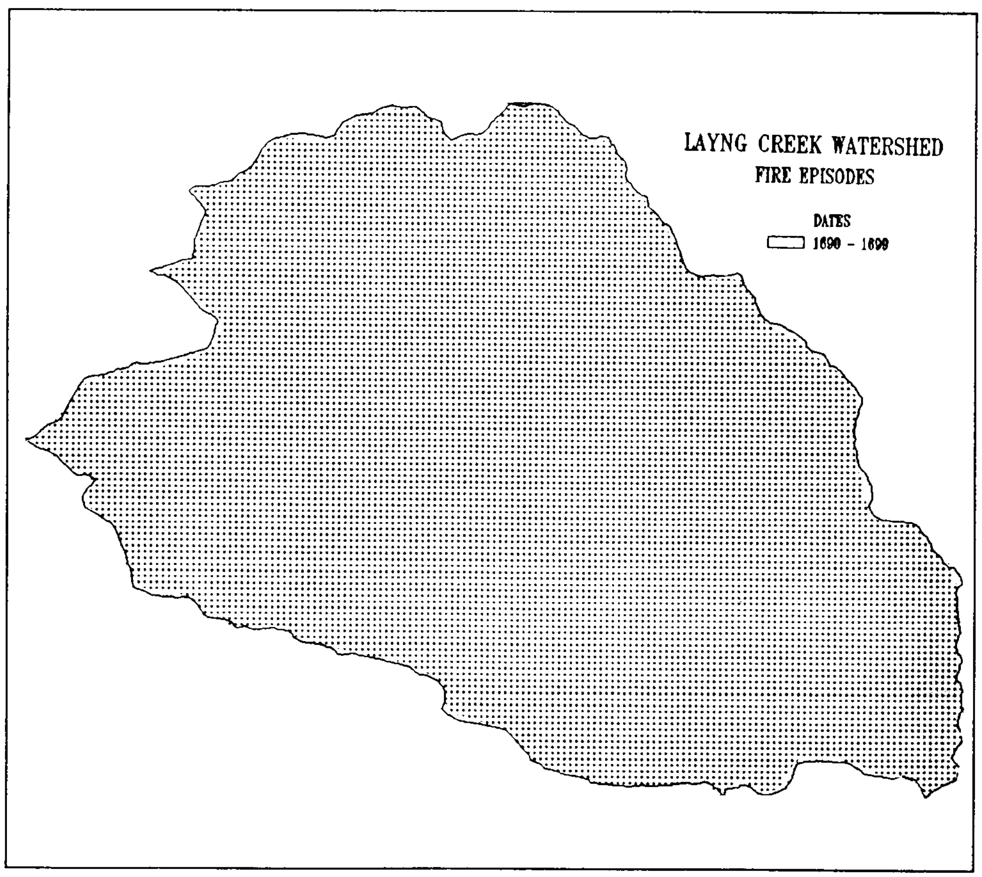
Most of the oldest trees in the study area date between 1447 and 1550. This implies a series of stand replacing events occurred during that time period. These fires removed much of the existing forest; new stands of trees eventually regenerated across the landscape. The oldest trees were located in the June Mountain/Junetta Creek area.

17th Century

Fire Episode 1668-1679. Fire scar and tree origin data for stand ages in the June Mountain/Junetta Creek area indicates that in an episode occurring 1668-1679, trees survived a low intensity, localized fire. Though primarily a ground fire, there would have been occasional torching of individual trees or concentrations of slash. This episode encompassed approximately 960 acres, which was 2% of the total watershed acres.

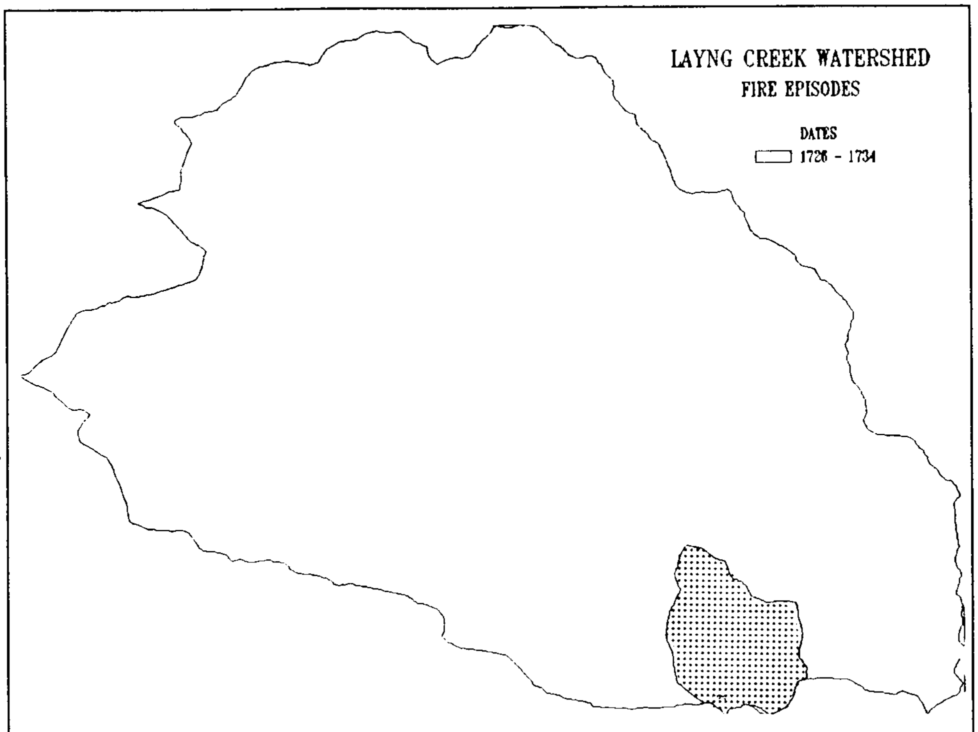


Fire Episode 1690-1699 In this episode, fire burned through the majority of the watershed. Stand replacement, partial stand replacement, and low intensity fire created a mosaic pattern throughout the area. Areas of significant stand replacement are located primarily in the Upper Silverstairs Creek and East Fork Layng Creek drainages. The Upper Dinner Creek and Layng Creek drainages had areas of significant partial stand replacement fire as well. This episode encompassed approximately 42,164 acres, which was 100% of the total watershed acres.

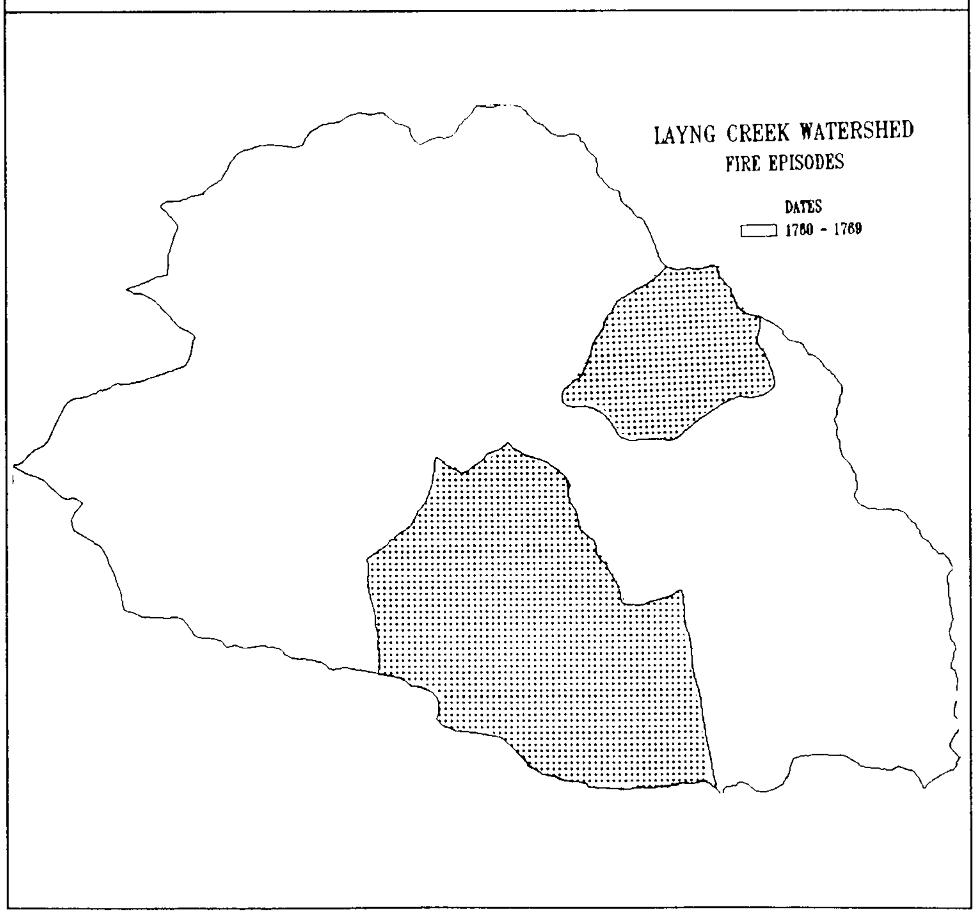


18th Century

Fire Episode 1726-1734
This was a small, localized fire on Dinner Ridge in the Upper Layng Creek/ headwaters of Dinner Creek area. This episode burned at mostly lower intensities, except for a small pocket of stand replacing fire on the Ridge. This episode encompassed approximately 1600 acres, which was 4% of the total watershed acres.

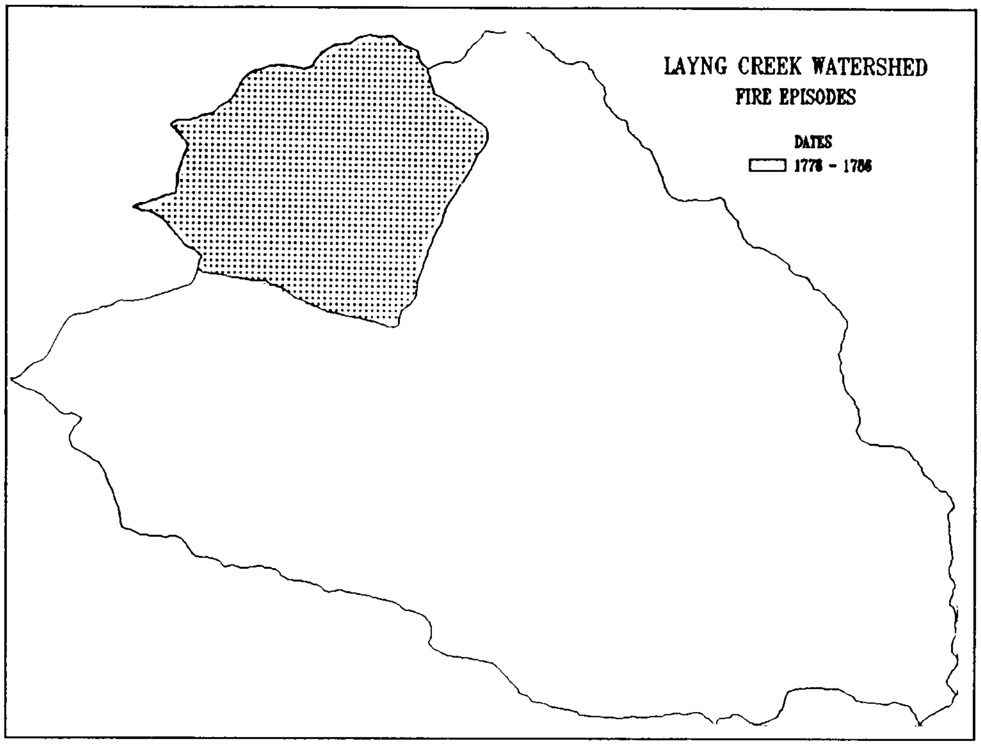


Fire Episode 1760-1769
In this episode two fires burned. In the first, most of the Dinner Creek drainage burned. Harvey Creek and Upper Layng Creek burned also. Stand replacement occurred at the top of Dinner Ridge. The remainder burned at low intensities interspersed with occasional stand replacing events. The second and smaller fire burned in the Upper Saltpeter Creek drainage, and burned down into Patterson and Alex Creeks. For the most part, this was a low intensity fire. Some partial stand replacement occurred on Patterson Mountain. This episode encompassed 9382 acres (22% of total).



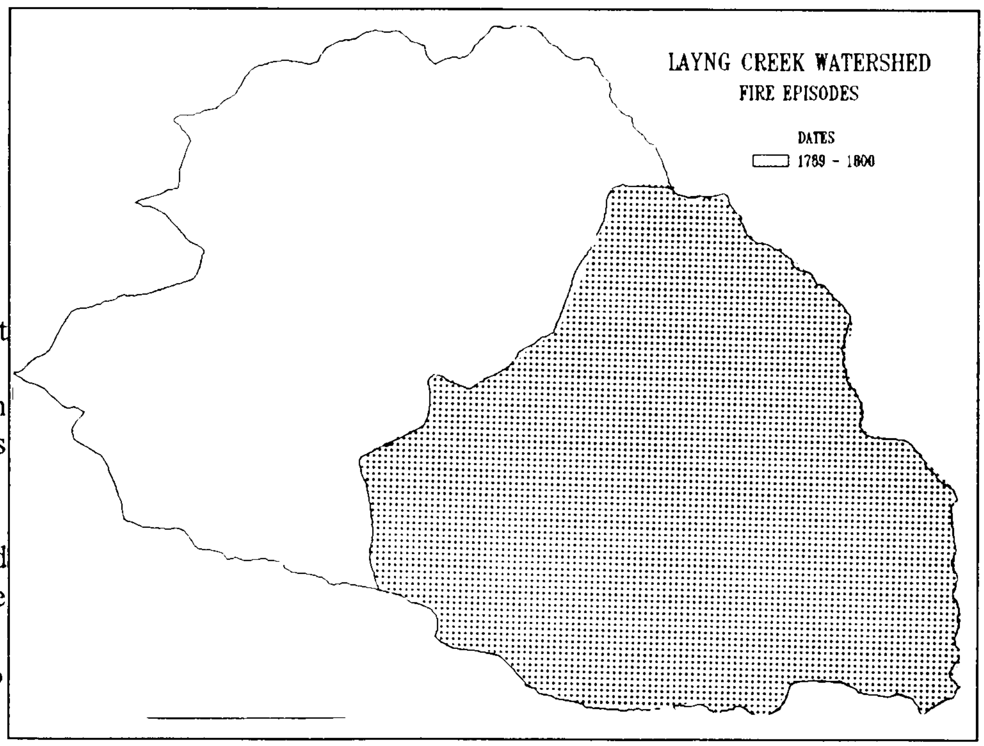
Fire Episode 1778-1786

A low intensity fire occurred in the Junetta Creek/June Mountain area. This episode encompassed approximately 7040 acres, which was 17% of the total watershed acres.



Fire Episode 1789-1800

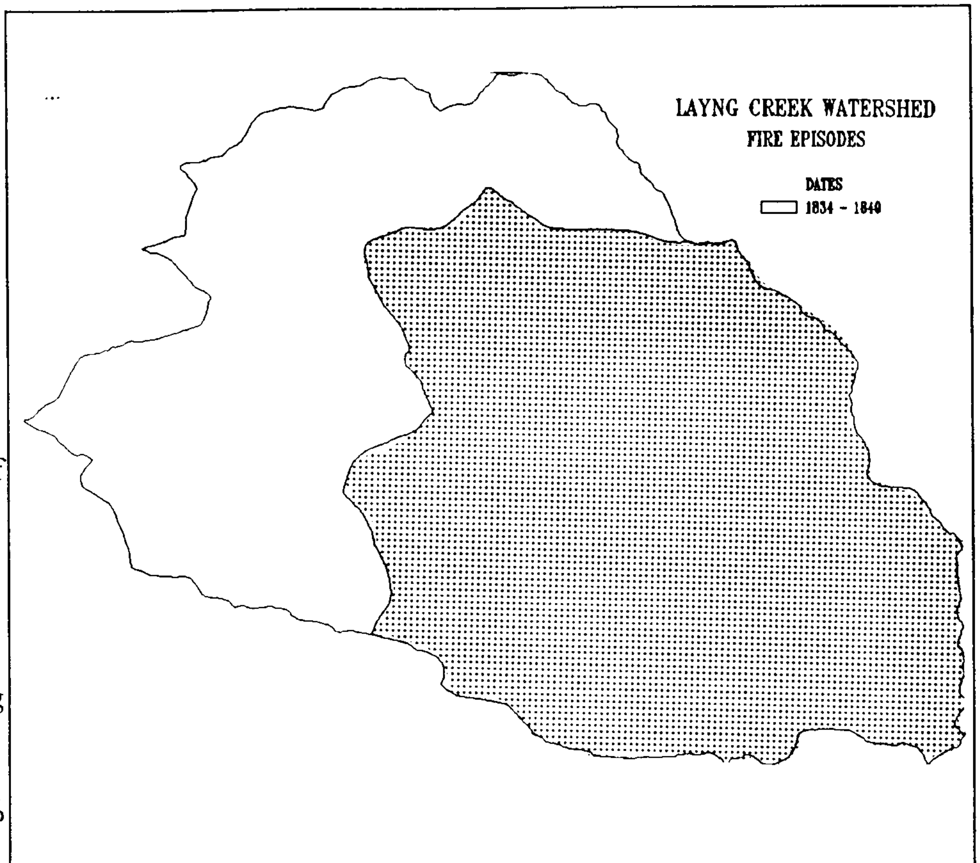
In this episode, fire burned a large portion of the eastern Layng Creek watershed. Fire burned in a mosaic pattern of low, moderate, and high intensities, leaving areas of both partial stand replacement and stand replacement in Saltpeter, Alex, and Patterson Creeks, and in the headwaters of Layng Creek. The area between Dinner and Harvey Creeks also experienced stand replacement fire. This episode encompassed approximately 29,760 acres, which was 71% of the total watershed acres.



19th Century

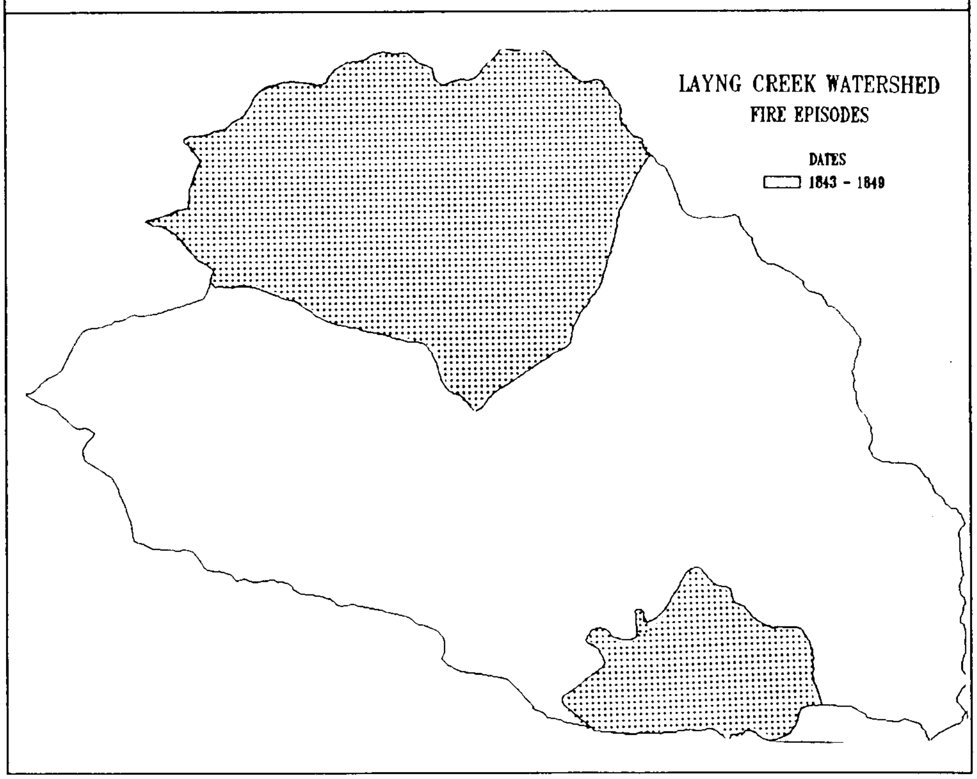
Fire Episode 1834-1839

In this episode, the eastern portion of the watershed again burned in a mosaic pattern of low, moderate, and high intensity fire. Stand replacement occurred in pockets in the area between the headwaters of Alex and Patterson Creeks. Another area of stand replacement occurred in the headwaters of Upper Layng Creek near Holland Point. The area from the mouth of Dinner Creek down into the main stem of the Layng Creek drainage also burned at stand replacing intensities. This episode encompassed approximately 25,920 acres, which was 61% of the total watershed acres.



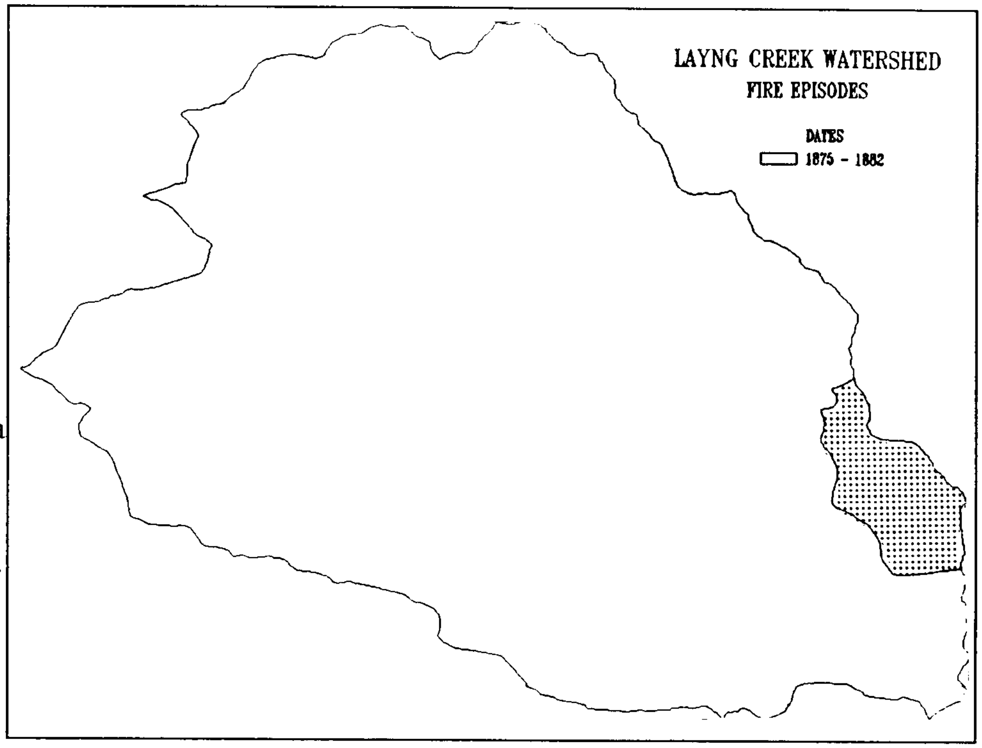
Fire Episode 1843-1849

Two large fires occurred in this episode. In the Curran Creek to Patterson Creek area, and down into the main stem of Layng Creek, a fire burned in a mosaic of low to high intensity. Stand replacement occurred in the June Mountain to Hardesty Mountain area. A second fire event burned at what appears to have been a low intensity in the headwaters of Dinner and Layng Creeks. This episode encompassed approximately 14,880 acres, which was 35% of the total watershed acres.



Fire Episode 1875-1882

In this episode, a fire appears to have come up from the Rigdon Ranger District side of the easternmost ridge of the watershed. It may have burned at a low intensity and backed down the slopes. There was at least one small pocket of stand replacement which may have occurred as a result of spotting below the main fire. This episode encompassed approximately 1760 acres, which was 4% of the total watershed acres.



Unknown Fire Events

In the lower Layng Creek drainage and in the vicinity of the railroad logging, there was little opportunity to gather fire scar data. Given the evidence surrounding this "unknown" area, we will assume that fire was as common an event there as elsewhere in the watershed.

Fire Regimes and Range of Variability

The results of the fire history study indicates that the June Mountain/Junetta Creek area is a high severity fire regime. This regime is characterized by very infrequent fire (more than 100 years between fires) that is usually high intensity, stand replacement. Old District records, personal accounts, and early aerial photographs validate this determination. Ground verification in the June Mountain/Junetta Creek area has not been done due to time constraints.

The remaining watershed area is best described as a moderate severity fire regime. This regime is characterized by infrequent fires (25-100 years). They are generally partial stand replacement, with significant areas of both high and low severity. The fire history study supports this determination. Agee's description of the southern portion of the western hemlock zone as a moderate regime (see excerpt in the current condition Fire Regime discussion) appears to be validated by this study.

Table 2. Mean Fire Return Interval

Mean Fire Year	Fire Episode	Time Since Prev Fire	Sites With Scar Record	Sites With Tree Regen Record
1674	1668-79	N/A	2	2
1695	1690-99	21	8	23
1730	1726-34	35	3	4
1765	1760-69	35	8	12
1782	1778-86	17	3	1
1795	1789-1800	13	11	22
1837	1834-40	42	15	22
1846	1843-49	9	5	9
1879	1875-82	38	4	2

The mean fire return interval in this watershed appears to be approximately 26 years, with a natural fire rotation of 71.3 years. (This is the length of time necessary for an area equal in size to the study area to burn. In this case, the study area was the total acres within the watershed.) The mean fire return interval was determined by summing the "time since previous fire" column and dividing this sum by the total number of fire occurrences.

The natural fire rotation was calculated by estimating the proportion of the watershed which burned in each episode and using the following formula:

$$NFR = \frac{\text{Total Time Period}}{\text{Proportion of area burned in period}}$$

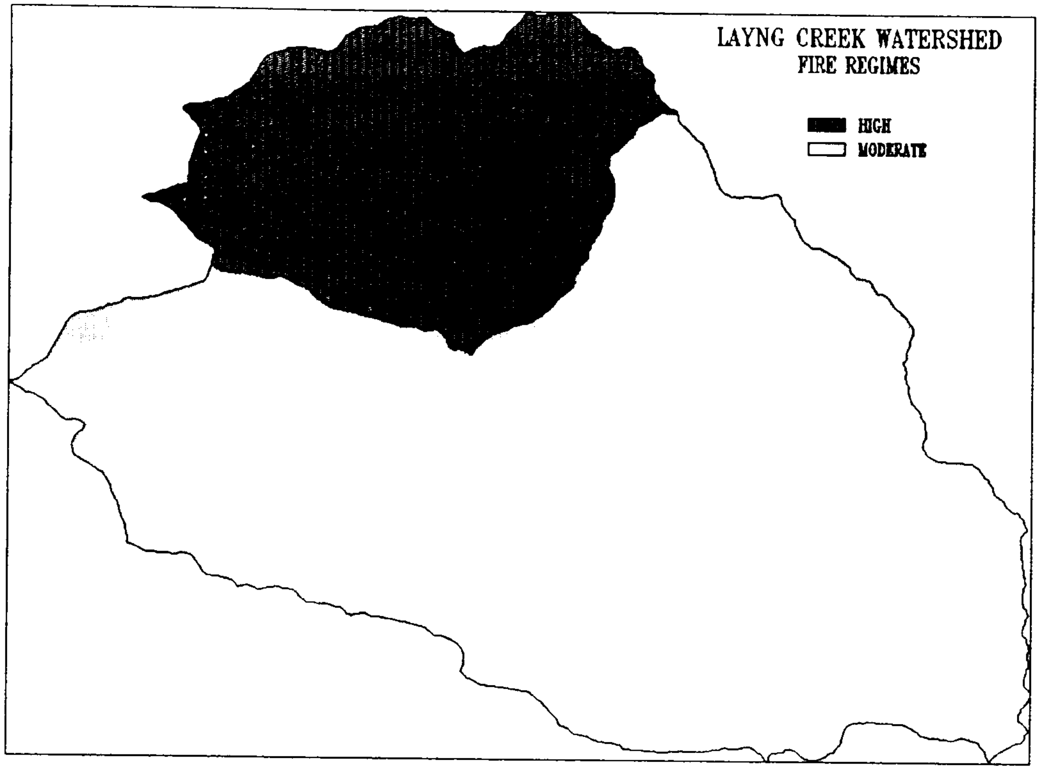


Figure 4. Fire Regimes

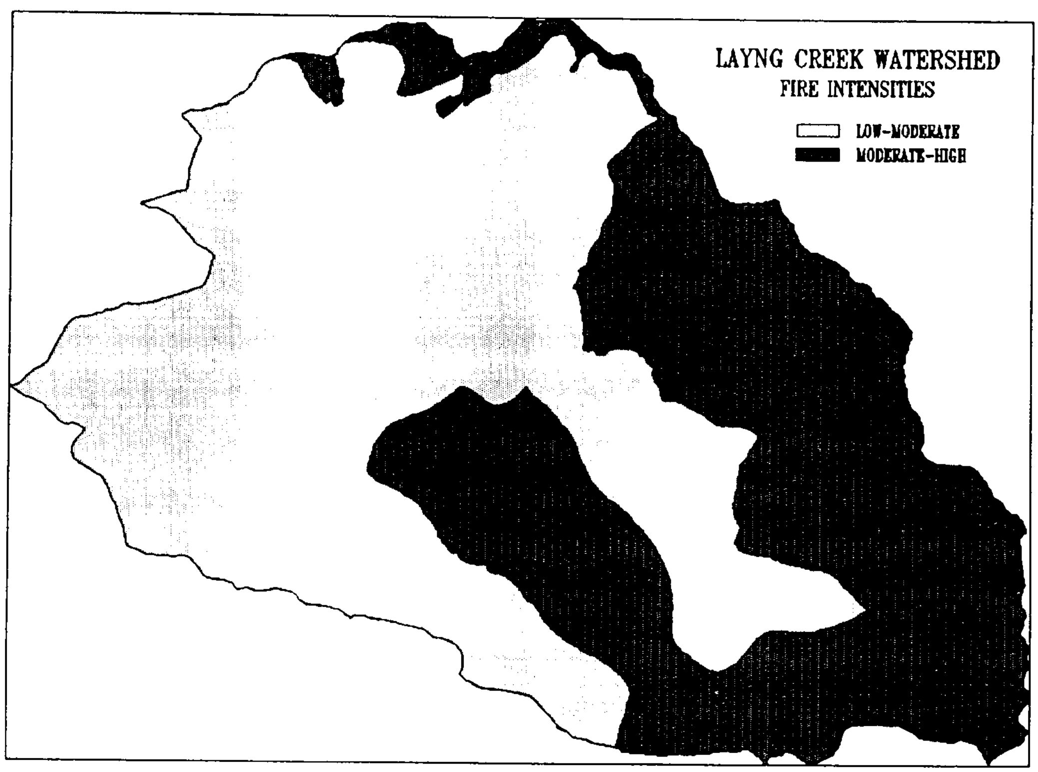


Figure 5. Fire Intensities

Air Quality

Prior to Euro-American settlement it is evident that fire was a common occurrence, regardless of ignition source. With the combination of Indian and settler burning in the Willamette Valley and Calapooya Mountain foothills in the spring and fall months, the lightning fires in the summer months, and with possible human ignited fires in select areas of the watershed for grazing, game, or gathering purposes at various times of the year, it is obvious that smoke was present at varying densities throughout much of the year. Air quality ranged from a light haze from distant fires to a dense layer over areas in which fires were large, intense and of extended duration. Smoldering fuels probably contributed much of the emissions, given the nature of the fires that occurred in the watershed.

Residual smoke from fires within the watershed can be assumed to have drifted into the Oakridge area with the predominantly westerly winds. Localized drainages would have accumulated smoke during the evenings and early mornings, and been lofted somewhat with the lifting of the inversions typical at certain times of year. East wind conditions would have carried smoke into the Disston valley and possibly down into the Cottage Grove area (the southern end of the Willamette Valley). Smoke in this area may have accumulated during evening hours and occasionally during daytime, as it tends to be prone to inversion conditions.

Role of Fire on the Historical Fuels Condition

> *"Morrison and Swanson (1990) point out that, if all recorded fires in [the] central Cascades study area had been stand replacement fires, very little old growth habitat would have existed over the past 500 years. The observed frequency of fires of low to moderate severity, however, suggested that such events may have sustained extensive areas of old growth conditions through multiple disturbances and through many centuries..." (Swanson, et al 1993)*

In the June Mountain/Junetta Creek area, fire does appear to have sustained most of the area in an old growth condition. It has been some time since a stand replacement fire occurred; numerous low intensity fires are likely to have burned through these older stands, reducing litter, smaller understory, and pockets of concentrated fuels. Some partial stand replacement or individual torching probably occurred when fire encountered these concentrations. Given the topography and southeasterly lay of the area as a whole, sustained crown fire would have been possible. Strong winds, especially those coming from a southeasterly direction which were channeled up the Junetta Creek drainage, would have contributed to crown fire conditions.

The types of fuel models in reference times were likely similar to what we see today. The differences would be in the distribution and amount of each fuel model over the landscape. Rather than the patchy distribution seen today due primarily to logging activities, fuel models in reference times were maintained over larger, contiguous areas. Fire was a random event in terms of location, intensity and extent, and created and maintained a mosaic that is not evident today. An exception may be the administratively withdrawn area (AWA) in the June Mountain/Hardesty Mountain/Junetta Creek area, as described above.

Fire was probably used within the watershed for hunting, at gathering sites for berries and other plants, in high elevation meadows for game or grazing, and possibly for other reasons. The roles fire played would be to set back or kill brush that impeded big game movement or reduced visibility and ease of travel, and to maintain gathering and grazing sites. Fires set for these reasons would have been mostly low intensity

(2-4 feet flame lengths), and with few exceptions would have been ground fires. If Indians maintained select areas as has been suggested in various writings, fire was probably set every year to five years, depending on site needs.

Significant Effects of Fire on Watershed Structure or Processes

Fire played a major role in structure and process in reference times. As previously discussed, fire created and maintained a mosaic landscape pattern which changed through the centuries. The fire episodes indicated several areas of stand replacement, as well as significant areas of partial stand replacement. Very little of the watershed was left unburned within the 1600-1900 time period.

In those areas that had recurrent stand replacement, fires would have burned at intensities that consumed coarse woody debris (material greater than one inch in diameter) as well as some larger down logs in various stages of decay. Fire would have burned within riparian areas with relative ease, primarily those higher in elevation and somewhat exposed to prevailing winds. After these fires, fuels would slowly accumulate as fire killed trees and brush fell to the forest floor; trees and brush would eventually re-establish themselves; after a period of time, another stand replacing fire would sweep through the area, and the process would repeat itself.

Areas of partial stand replacement were dispersed throughout the watershed. Within these areas, isolated incidents of stand replacement occurred as fire encountered concentrations of heavy fuels, or where weather and topographical features affected fire behavior. Partial stand replacement fires would have burned through the undergrowth and ground fuels at lower intensities, occasionally burning into the overstory and torching individual and clumps of trees. This kind of fire creates a diverse mosaic, leaving not only openings in the canopy, but unburned patches of ground throughout the burn area. This kind of fire is less likely to burn intensely in riparian or other moist areas. Subsequent fires moving through these areas would burn the previously unburned fuels, and possibly the fine fuels that had accumulated since the earlier burn.

Of the human ignited fires in reference times, with few exceptions it is unlikely that these fires had any significant effect on watershed structure or processes. Most of these types of burns would have been low intensity fires lit outside what we would now call fire season.

Step Five - Interpretation

"The question as to what is the "natural" condition of...forests is a problematic one...Are "natural" forests only those in which humans have played no significant role? Under that definition, there would have been few natural forests, even in 1500---for humans have occupied and influenced...forests since the time these forests migrated northward behind the retreating continental glaciers more than 8000 years ago." (MacCleery 1994)

"An important question in defining natural...variability is how to treat burning practices by native people. In many areas intentional and unintentional burning by native people probably occurred over a sufficiently long period (perhaps thousands of years) that effects were thoroughly incorporated in the ecosystem. Alteration of fire regimes by suppression or ignitions by people of European descent has been of shorter duration, sometimes greater magnitude, and commonly accompanied by grazing, logging, or other practices that in some areas have caused the system to deviate markedly from conditions before influence of Europeans." (Swanson, et al 1993)

Changes in Fire Intensity Levels - Impact of Settlement, Fire Suppression Policy, and Management Activities

The immediate impact of Euro-American settlement was a significant reduction in the frequency and extent of land burned by local Indian tribes. Settlers used fire, but for different reasons and with diverse results. While Indian burning tended to be patterned in terms of seasonally, frequency, and intensity, settler ignited fires were more random in nature. We cannot determine whether the pre-settlement fire history in the Layng Creek watershed was influenced by Indians or lightning, nor can we determine whether the settlers had any significant influence on the fire history in the last half of the 1800's.

Fire suppression policies were developed to protect the forest reserves after the devastating fires of 1902. Severe fires occurred in almost every county west of the Cascades. Fires found in the watershed were extinguished, often before they attained any size or intensity. With few exceptions, most lightning and human caused fires were extinguished at less than one acre. Today full suppression (control) is still the primary action taken; occasionally limited suppression (contain) is used; rarely is nothing more than monitoring a low risk fire (confine) done. A full suppression fire policy has had a direct and significant effect on the role fire played in the watershed.

Slash burning has also had a significant effect on the watershed. Since at least 1904, slash burning has been a common practice on the District. Since 1900, over 18,153 acres of the Layng Creek watershed has been either broadcast or underburned. Past harvest practices have created a patchwork mosaic of land, which was then burned and replanted. In many places these burns were probably more severe than the area had experienced previously, while in other places the opposite was probably true. Prior to the mid-80's slash burns often took place in the summer and fall months when fuels were at their driest. These burns were generally more intense, and had greater negative effects overall. Since spring burning began, overall intensities and negative effects have lessened.

Changes in Fire Regimes and Range of Variability

The optimal conditions for interpreting natural disturbance regimes are a long, pre-European settlement record with a high frequency, low severity disturbance regime, which permits sampling numerous events per site with dendrochronologic methods. For the most part the fire history done for the watershed met this criteria; exceptions were select areas of repetitive stand replacing fire.

Current Condition

Fires appear to have been a frequent occurrence within the watershed in the last 94 years; most were small in size. When the fires grew in size, overall intensities tended to be moderate. Had suppression policies not been in place, it is very likely the size class A fires would have become larger, with higher intensities. The advent of fire suppression, however, has gradually set up an artificial regime which is characterized by infrequent, high intensity, stand replacing fires.

Reference Condition

Again, fires were a frequent occurrence in the watershed. A wide range of fire intensities occurred, resulting in an extremely complex, dynamic mosaic of forest composition and stand age structure. Throughout the centuries, the overall fire regimes have been maintained (high severity in the June Mountain/Junetta Creek area, moderate severity in the remainder of the watershed).

Changes in Air Quality

In the past, air quality was often poor. Regardless of ignition source, fires would have burned longer and more intensely, resulting in increased consumption and resulting emissions. Down canyon and down wind effects would have varied, depending on weather conditions. Smoke in the Willamette Valley and Willamette River drainages (such as the Oakridge area) would have been a common occurrence, and inversions would have contributed to prolonged poor air quality in the valleys. Wood burning for heat in the winter months would also have contributed to poor air quality; inversions are most common in the area at this time of year and sole reliance of wood for heat resulted in high emissions on a daily basis for several months.

In the early to mid-1900's air quality began to improve. Indian ignited fires were no longer a regular occurrence, and settler fires were decreasing as land was cleared for homes and pasture land. Logging was starting to pick up in the forest, however, and slash burning smoke filled the air, mostly in the summer and fall months. It was during this time period that fire suppression policies were in full swing, and most fires of other origins were suppressed before intensities were such that significant emissions were produced. Wood burning in the winter months was still a major contributor to poorer air quality.

In the 1950's logging activities increased dramatically; slash burning emissions increased as well. In the next three decades logging decreased somewhat, but slash burning was still the accepted and preferred disposal method. Most of these burns were still carried out in summer and fall, but until the mid-60's there was little concern about air quality and residual smoke impacts to people. In this four decade period, other sources of heat were developed and winter wood burning decreased to a limited extent.

With the passage of the Clean Air Act in 1967 and amendments in the 70's, regulations were put into effect which restricted activities that contributed to air quality degradation. By the mid-80's prescribed burning techniques were being implemented which further reduced negative impacts to air quality. Restrictions were in place which also reduced winter wood burning impacts.

In the 1990's we have only burned 329 acres within the watershed, all within the spring burning period. None of these burns impacted air quality outside the immediate vicinity of the burn. Through the techniques we employ and the regulations we adhere to we have minimized air quality impacts, and have not had a smoke intrusion due to prescribed burn activities for several years. Since pre-settlement times, air quality has gradually improved. Technology has advanced to the point that most smoke management and air quality concerns can be mitigated. The exception might be the uncontrolled wildfire.

Changes in the Role of Fire on the Fuel Condition

Fire once played a major role in creating, modifying, or maintaining fuels conditions within the watershed. Both low intensity and partial stand replacement fires served to keep the forest floor relatively clear of large build-ups of fuels that would contribute to stand replacement fires. These fires also maintained a dynamic mosaic of fuel models over large areas of land. Stand replacement fires burned in areas that saw infrequent fires, completely consuming most of the heavy fuels that would have built up in the area over time due to disease, insects, blow down, or other reasons.

The role fire played in relation to human manipulation was one of maintaining conditions for hunting, gathering, traveling, and grazing. Most of the time these fires would be of lower intensities, usually to clear out brush or burn off grasses. Exceptions probably occurred when higher intensity fires resulted, but for the most part human set fires maintained fuels conditions previously established.

In this century fire has played the role of hazard reduction. Clearcuts and other harvest areas have been burned primarily to reduce wildfire risk, an objective that goes back to 1902. A secondary role has been to use fire as a silvicultural tool to clear slash for replanting. Fire has not been allowed to burn after natural ignitions (prescribed natural fire), nor has it been re-introduced to the watershed purposefully (prescribed management ignited fire).

Changes in Effects of Fire on Watershed Structure or Processes

"Reduction in historic fire has had the effect of creating forests with stands that are older on-the-average than historically...[these] older and [denser] forests function much differently ecologically than they did a century ago. In some forests a type conversion is going on from a fire resistant species to fire susceptible ones. Due to both forest density and to the kinds of tree and other plant species that are emerging to replace the existing forest overstory, they will be forests which are decidedly more unstable than the ones they are replacing, i.e. more susceptible to...catastrophic fire. When fires do occur in such forests...they will be intense, stand replacing, soil damaging fires, beyond that which would have been typical in pre-European forests." (MacCleery 1994)

"The environmental costs incurred from a policy of fire exclusion can be an artificial advance of forest succession in some fire regimes. This can result in dense thickets of small, slow growing trees in what were once open stands of large trees; extensive forest mortality from insect and disease epidemics; loss of seral tree, shrub, and herbaceous species important for natural diversity and wildlife habitat; and heavy fuel build-up leading to larger, more severe wildfire. The change to the ecosystem can alter the numbers, locations, and actual species of both plants and animals that inhabit an area. The larger more intense wildfires that eventually will occur are expected to result in more significant impacts to water, soil, and air resources."(Region One 1993)

The quotes above can to some extent be applied to the Layng Creek watershed. Fire played a major role in maintaining or modifying the watershed condition in reference times. Exclusion and suppression of fire has either allowed fire to become ineffective in maintaining and modifying structure and processes, or has set the stage for a major, destructive fire event at some point in the future.

While slash burning plays a part in reducing hazard within an isolated area, it does not benefit surrounding areas; i.e. the landscape in the drainage or sub-watershed around it doesn't receive the treatment it may require to effectively mitigate the hazard over the total potential burn area. A clearcut burned within an area susceptible to stand replacement fire, for example, may not be an effective control point to slow or stop a fire's spread.

Potential Effects of Future Activities

Should silvicultural and fuels management use of prescribed fire continue as it has in the past, the watershed will continue to receive limited prescribed fire in isolated pockets, to the neglect of the area as a whole. Eventually a large, stand replacing fire will occur which will probably have some level of severe effects on the watershed and on air quality.

Instituting prescribed natural or management ignited prescribed fire may not immediately or effectively mitigate any current stand replacement fire risk, but over time may lessen the risk significantly. Application of fire to select areas may have the added benefit of restoring fire's maintenance role to portions of the watershed.

Relationship to Standards and Guidelines - Fuels Management and Fire Suppression

Both the Umpqua National Forest Land and Resource Management Plan (FLRMP) and the Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (Forest Plan) were reviewed to insure that any recommendations made would fall within requirements of both plans.

Page C-35 of the Forest Plan discusses fuels treatments and fire suppression activities affecting riparian reserves. Any prescribed burning done within these areas must contribute to attaining Aquatic Conservation Strategy (ACS) objectives; strategies should be planned to avoid damage to long term function.

Wildfires and fire suppression activities carry an element of risk to riparian areas as well. Trade-offs and consequences of not carrying out prescribed burning in select areas of the watershed should be evaluated in terms of fire, human, and chemical effects, in the event wildfire occurs.

Page C-40 of the Forest Plan discusses maintenance of coarse woody debris. This may be accomplished by maintaining areas that simulate the reference condition of a moderate severity regime by means of silviculture, prescribed fire, or utilization. Page C-44 recommends minimizing intensive burning. Maintaining portions of the watershed in near reference conditions might minimize potential stand replacing fire events, though not immediately. Continued light spring burning in harvest units is one method that can play a maintenance role.

Appendix VIII. of the Forest Plan contains the Fire Management Standards and Guidelines. Its content can be summarized as recognizing fire's role as part of ecosystem function, and that fire should either be used or suppressed in the context of achieving ecosystem management objectives at the landscape level.

Guidelines within this appendix include writing fire management plans that cover the use of prescribed fire for ecosystem management, fuels hazard reduction, and wildfire suppression. The overall goal would be a reduced risk of large scale, high intensity wildfire. This fire/fuels analysis is a first step in developing any future fire or fuels plans for areas within the watershed. (The remainder of Appendix B expands on the guidelines discussed above, and can be found on pages B-135 and B-136.)

The FLRMP contains several standards and guidelines to which planned fire/fuels activities must adhere. These include provisions for recreation; visual quality; cultural resources; fisheries; wildlife habitat and threatened, endangered, or sensitive species; water quality; soil productivity; protection; pest management. This paper does not attempt to address each of these standards and guidelines. Prior to any prescribed fire activities, a thorough fuels analysis is done which includes detailed discussion of the methods by which these guidelines would be met. In the event of a wildfire, an interdisciplinary fire situation analysis would be done to evaluate resource concerns and strategies to mitigate them.

From a fire/fuels standpoint, there are no obvious conflicts with any of the standards and guidelines. They allow for both prescribed natural and management ignited fire within the watershed, once approved plans are in place. Current suppression policies are adequate, as well.

Summary

The Augusta Creek Project yielded some general lessons about historic vegetation patterns that appear to be relative to the Layng Creek watershed as well. Both areas have the same fire return interval of 25 - 26 years, and both have similarities in fire regimes. Three main points were made in the Augusta Project summary. First, that fire has been a significant and persistent component of the ecosystem, resetting stand conditions and influencing stand development. Second, that the resulting vegetative patterns have been highly variable in time, space, and structure. Lastly, that fire and vegetation patterns appear to be correlated with topographic features.

The opening paragraph of the Augusta Fire History states: "Fire has been an important disturbance process in the western Cascade Mountain landscape...Fires of varying intensities and of diverse temporal and spatial extent have resulted in an extremely complex mosaic of forest composition and stand age structure. This complexity of forest composition and structure has created a diversity of habitats for biological organisms. The maintenance of this rich...diversity might be achieved by managing the forest landscape more closely along the patterns of natural disturbance. The patterns of historical fire occurrence and extent might be used as a "template" for forest management." (Connelly and Kertis 1991)

Ultimately, a focus on maintaining or restoring the ecosystem to something resembling reference conditions will require evaluating wildfire suppression methods and the potential use of prescribed fire, as well as addressing air quality and municipal watershed concerns.

Step Six - Recommendations

Fire as a Replication of the Ecological Process

"To suggest that fire is an appropriate process in the preservation of old-growth forests seems paradoxical. Yet it is apparent that almost all the natural forests of the western hemlock zone are first or multigeneration stands born of fire. Fire is responsible for their destruction, yet it is also responsible for their creation and maintenance. Without fire, the proportion of Douglas-fir in natural stands will decline, particularly on more mesic sites, and western hemlock will assume a more important role." (Agee 1993)

"We cannot perfectly replace disturbance events like fires with timber harvest or vegetation manipulations. Fire provides unique processes like chemical changes...compositional changes...and alteration of microclimate conditions...Therefore wherever possible we must keep fire as an active function in the system. (Weber and Atzet)

However..."at this point, allowing unfettered natural fire cycles to return to the ecosystem is not a feasible option. The threat of uncontrolled fire...to forested lands which now support unnatural accumulations of fuels would be unacceptable. Also, because of fire exclusion and past logging practices, modern fires may not restore the historic range of ecological conditions..." (Region One 1993)

"Fire may [have been] necessary to sustain species at individual sites while also historically having shaped landscape patterns. In managed landscapes, fire may still be used to play its role in sustaining species while other management activities may replace it as determinants of landscape patterns." (Swanson,et al 1993)

Potential Restorative and Enhancement Opportunities

With the exception of the June Mountain/Junetta Creek area, the fire regimes of the majority of the watershed have been gradually replaced with an artificial high intensity regime. The primary causes have been fire suppression and lack of landscape prescribed fire. Several components which determine fire regimes have been affected by fire suppression.

Fuel loadings are increasing; overall the fuels condition is deteriorating gradually, and stands are becoming more susceptible to fire. The role of fire as a maintenance function has changed significantly throughout the watershed due to changes in fire intensities. For the most part, fire effects are currently either ineffective or destructive.

If we maintain the status quo, continuing full fire suppression and doing little prescribed burning other than for silvicultural or hazard reduction purposes within timber sales, fuels will continue to build; the artificially high regime will be maintained; eventually an intense, stand replacing event will occur.

> *"Wildfires which produce flame lengths in excess of eight feet are generally not affected by any known control technology. Control may be effected when flame lengths drop below eight feet, caused by increased moisture, loss of fuel continuity, drop in wind velocity, and/or change in slope. As fuels continue to build in the forests from fire suppression, wildfires continue to become larger and more severe. When controlling the size of wildfires is mentioned, it is intended for wildfires burning within the limits of control technology.*
>
> *"Most large wildfires incur significant spotting. It [can be] very difficult to impossible for aerial retardant to be effectively delivered on the spot fires due to the smoke, intense heat, and strong turbulence. Fuel breaks and roads are usually ineffective in stopping or slowing the spread of a spotting wildfire."* (Region Two 1993)

Region Two's draft "Strategies for Fire in Land Management" discusses how to develop suppression and prescribed fire strategies once desired ranges of disturbance are established. This paper may be useful in the planning process.

Recommendations for restoration or enhancement include:

* Identify and evaluate opportunities for prescribed natural or management ignited fire in select areas to restore fire's role of maintenance. Priority areas would be:

- Those that have historically experienced moderate intensities, and recurrent partial stand replacing fires.
- Meadows and winter range habitat within the influence zone of the thermal belt;
- Planning areas for which an analysis shows prescribed fire would be beneficial, either inside cutting unit boundaries or adjacent to them;
- Low intensity areas;
- High intensity areas.

* Assess risk of using or excluding fire in these areas. Include:

- Values at risk;
- Potential fire behavior;
- Cost analysis;
- Air quality concerns;
- Fire effects;
- Road access or potential closures.

Management Strategies

- Identify opportunities for partnership projects.
- Prepare prescribed fire plans for areas within the watershed that would be high priority for application of fire.
- Identify landscape prescribed fire skills required to carry out any proposed projects.
- Identify opportunities for monitoring and evaluating prescribed fire applications and effects beyond what is currently required.
- Use an interdisciplinary approach to assess areas that would benefit from prescribed natural or management ignited fire.
- Develop fire behavior predictions for use in Escaped Fire Situation Analysis (EFSA) and fire planning for AWA.
- Identify several prescription windows to maximize opportunities for a variety of landscape scale treatments.
- Model potential smoke management emissions given proposed projects.
- Delineate proposed wildlife corridors on Hazard Reduction Standards Risk Map and identify protection priority. For the near future, Wildlife desires full suppression within these corridors.
- As the landscape surrounding the proposed corridors develops, consider opportunities for prescribed fire within the corridors.

Areas Needing Further Study or Research

The June Mountain/Junetta Creek AWA is one area which will be evaluated more thoroughly. Fire management personnel will survey representative areas to gather data such as visible fire scars, tree age samples, fuels and stand characteristics. The information collected will be used to validate assumptions made in this study as to the fire regime for the AWA. This survey would be an opportunity for other disciplines to collect data as well, and could be a collaborative effort.

Areas identified as possibilities for prescribed natural or management ignited prescribed fire may require pre-burn preparation. Those areas requiring reduction of understory fuels as a pre-burn preparation could be expensive. An economic evaluation of potential costs and losses associated with this type of preparatory work would be necessary.

Significant Issues or Areas of Concern

In order to implement management ignited and prescribed natural fire programs, and to meet current management suppression policies, qualified personnel with good suppression training and experience are needed. Also, skills in landscape prescribed burning need to be emphasized in the following areas:

- Fire and fuels planning for landscape projects
- Knowledge of fire effects
- Prescribed fire behavior analyst skills
- Complex prescribed fire manager, burn boss, and specialist skills

Should the District choose to plan and implement prescribed burning as suggested in this paper, training and skills of employees should be evaluated and enhanced where necessary.

Air quality has been gradually improving since the early 1900's. This trend should continue, and any prescribed burning would need to be planned to meet air quality standards and restrictions. With any larger scale prescribed fire project, an assessment of the public's concerns relative to potential smoke emissions would need to be addressed.

Other public concerns that would need to be addressed in any prescribed fire planning effort for the watershed would be not only the issue of using prescribed fire but also the risks and consequences of human use or lightning triggering a wildfire. At a minimum, human use of the watershed, especially in fire season, and the potential use of chemicals (i.e. retardant) during fire suppression activities would need to be addressed.

There are strong public expectations for protection and fire suppression programs. Through educational opportunities, people can be taught the role of fire and its effects. They will better understand the historical role fire has played in the watershed prior to our management activities. An increased public awareness of fire management issues may lead to more tolerance for prescribed fire after understanding some of the trade-offs and risks associated with fire.

Conclusions

The following quotations encompass our findings of the role of fire in Layng Creek Watershed.

"There has been a lot of discussion about ecosystem restoration...It is not always clear...what people mean by it, e.g. what condition will those ecosystems be restored to? Will we seek to bring them back to pre-World War II conditions, before logging really got going? To conditions pre-fire control? To pre-Euro/American settler conditions? If to pre-Euro/American settler conditions, should it be before or after the holocaust of Old World diseases...?" (MacCleery 1994)

"It is clear that many of today's forests are considerably outside the range of [historic] variation...[historic variation] recognize[s] the influences of native peoples.

"...the task of bringing these forests back within this historic range (or any range that is likely to be considered desirable)...will require reintroducing natural and prescribed fire." (MacCleery 1994)

"Expanding a prescribed fire program seems to be a simple and biologically sound way to restore sustainable conditions...however, the use of prescribed fire - especially on a landscape scale - presents managers with a serious dilemma: Although fire regulates the biotic productivity and stability of fire adapted ecosystems in ways that cannot be fully emulated by chemical or mechanical means, the negative effects of smoke and the risk of consequences inhibit its use.

"Pre-burn vegetative/fuel management actions may be needed to incrementally reduce hazard and allow for prescribed fire use in some areas, but mechanical or chemical treatments might be controversial and may be difficult to accomplish on landscape scales.

"Avoiding treatments [may create] serious consequences [such as a] change from relatively low damage, stand maintenance fires to more severe high damage, stand replacement fires; conversion from fire resistant species to fire intolerant species having less resilience to fire disturbances; less controllable and more costly wildfires; increasing danger to firefighters; increasing potential for higher particulate matter emissions as fuel loads and understory biomass increase.

"Present vegetative stand characteristics [may] impede managers' ability to use prescribed fire within reasonable limits of risk or within the range of a species' or systems' ability to respond or recover.

"Risk is an inherent part of prescribed burning. The uncertainties surrounding prescribed burning in wildlands are considerable and are not always subject to effective management control. Escapes will occasionally occur without negligence on the part of the agency but could erode public support and diminish agency support for an expanded fire use program.

"[Fire managers need to] develop an operational risk assessment and mitigation strategy in support of prescribed fire treatments. [It should] include a determination of escape thresholds and identification of high risk factors that trigger or contribute to escaped prescribed fires. A risk assessment process must become the basis for the go-no-go decision. Managers must know and avoid high risk prescribed burning treatments, unless they can be adequately mitigated. (Washington Office 1993)

Beverly A. Reed	Ellen E. Richardson	Sheryl Tooker-Dilley
Beverly A. Reed	Ellen Richardson	Sheryl Tooker-Dilley
AFMO- Fuels Specialist	Fuels Technician	AFMO - Crew Coordinator

Bibliography

Agee, James K., 1990, The Historical Role of Fire in Pacific Northwest Forests, in "Natural and Prescribed Fire in Pacific Northwest Forests", Corvallis, OR, OSU Press

Agee, James K., 1993, Fire Ecology of Pacific Northwest Forests, Covelo, CA. Island Press

Anderson, Hal E., 1982, Aids to Determining Fuels Models for Estimating Fire Behavior, GTR-INT-122, Ogden, UT, USDA - Forest Service, Intermountain Forest and Range Experiment Station

Boyd, Robert, 1986, Strategies of Indian Burning in the Willamette Valley, Canadian Journal of Anthropology

Cissel, John and Others, 1993, Draft: Integrating Landscape and Watershed Planning for Ecosystem Management: The Augusta Creek Project, Cascade Center for Ecosystem Management

Connelly, Kathy P. and Jane A. Kertis, 1991, Augusta Fire History, USDA -Forest Service, Willamette National Forest

Deeming, John E., 1989, Region Six Vegetation Management Environmental Impact Statement Air Quality Impacts, presented at the May 1989 Technical Fire Management "Fire Effects" Module, Seattle, WA

MacCleery, Doug, 1994, Understanding the Role the Human Dimension has Played in Shaping America's Forest and Grassland Landscapes, Eco-Watch, 1994

Martinez, Dennis, 1993, Back to the Future: Ecological Restoration, The Historical Forest, and Traditional Indian Stewardship, presented to "A Watershed Perspective on Native Plants" conference, Olympia, WA

Maxwell, Wayne G. And Franklin R. Ward, 1980, Photo Series for Quantifying Natural Forest Residues in Common Vegetation Types of the Pacific Northwest, USDA - Forest Service, General Technical Report PNW-105, Pacific Northwest Forest and Range Experiment Station

Morrison, Peter H. and Frederick J. Swanson, 1990, Fire History and Patterns in a Cascade Range Landscape, GTR-PNW-254, Portland, OR, USDA - Forest Service, Pacific Northwest Research Station

Peterson, Janice, 1993, Draft Guidelines for Preparing a NEPA Air Quality Analysis, USDA - Forest Service, Mt. Baker-Snoqualmie National Forest

Prescribed Fire and Fire Effects Working Team, 1985, Prescribed Fire Smoke Management Guide, National Wildfire Coordinating Group

Regional Ecosystem Office, 1995, Ecosystem Analysis at the Watershed Scale (The Revised Federal Guide for Watershed Analysis), Portland, OR

Swanson, Frederick J. and Others, 1993, Draft: Natural Variability -Implications for Ecosystem Management, USDA - Forest Service, Pacific Northwest Research Station

Unknown Authors, 1993, Draft: The Strategies for Fire in Land Management Goals and Objectives, USDA - Forest Service, Region Two

Unknown Authors, 1993, Region One Key Fire Messages, USDA - Forest Service, Region One

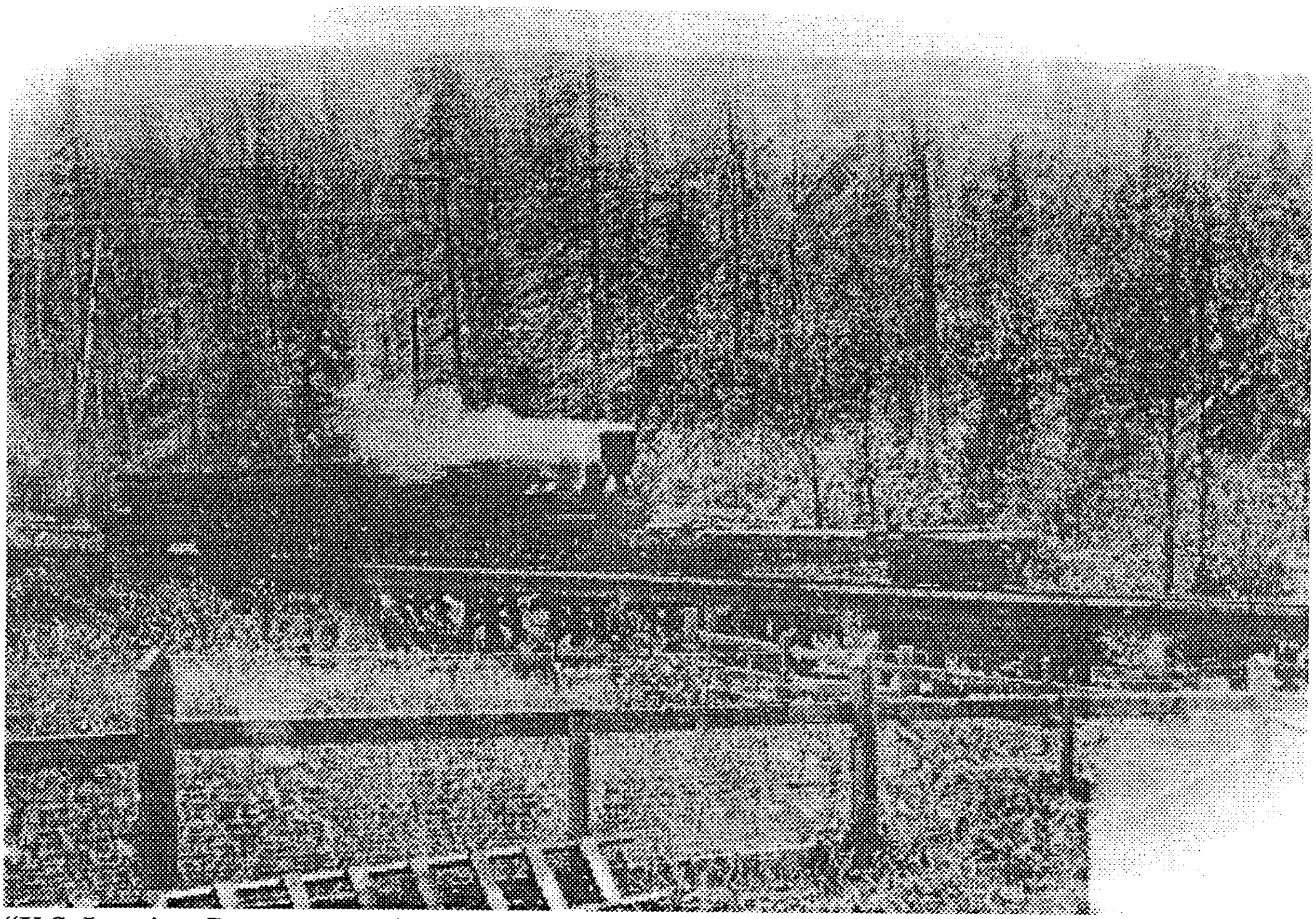
Washington Office, 1993, Fire Related Considerations and Strategies in Support of Ecosystem Management, USDA - Forest Service, Washington Office, Fire and Aviation Management

Weber, Chip and Tom Atzet, Draft: A Summary of Ecosystem Management Principles, USDA - Forest Service

Williams, Gerald W., 1995, References on the American Indian Use of Fire in Ecosystems, USDA - Forest Service, Pacific Northwest Region

Young, Carl Henry, 1904, Field Notes of July 1 - October 15, 1904, in "Lane County Historian", Lane County Historical Society, Winter 1971

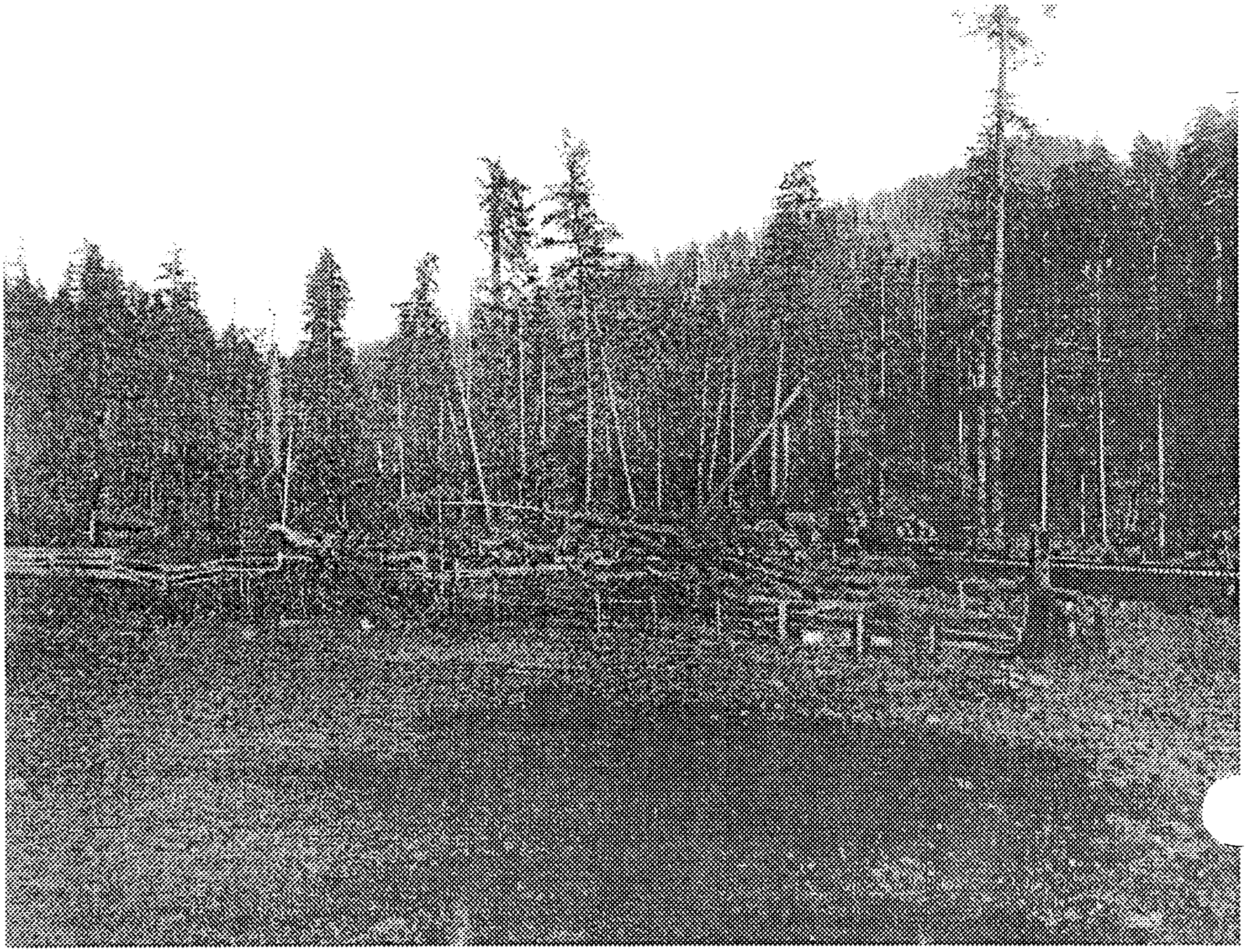
Railroad Logging Near Rujada - 1912



"U.S. Logging Company sale in 1912. Logging train near Rujada."

The hillside has been logged and probably burned from the amount of short black snags throughout the area.

Rail Logging - 1913



"Logging on Layng Creek on the Bohemia Ranger District. The first two car loads of logs taken from the Umpqua forest at Layng Creek Ranger Station by the U.S. Logging Company. Timber here was considered mature and that it should be harvested. The amount of timber sold was 163,000,000 board feet. Protection of such timber against fire results in larger returns to the state from timber sales."

> *There are at least two fire scars on the hillside in the background or possibly one fire that burned a large area. The smaller area to the left (downslope) and the upper slope near the top of the ridge burned at a stand replacing intensity. The area in between burned at a lower intensity primarily a ground fire with occasional torching of trees creating a mosaic pattern throughout the area. The fire had to be prior to the year 1913 because the U.S. Logging Company began business in this area in June of 1912 with the timber being cut from April 1913 to November 1922.*

Steam Engine "Two-Spot"

"The Anderson and Middleton Lumber Company steam engine "Two Spot" near Rujada on the Bohemia Ranger District on May 17, 1924.

Timber near Prather Creek - 1913

"Timber after falling on a flat east of Prather creek. Brush and tree tops on a logged over area, a veritable fire trap. The safe disposal of this is one of the problems of the forester."

This picture was taken approximately about the time the first car load of logs was take from the Layng Creek area in 1913. On the hillside a fire scar is visible which burned in some areas at high intensities and other areas at low intensities causing it to burn a mosaic pattern. The tree just right of the middle has evidence of another fire that burned with an intensity that left a large cat-face scar half way up the tree.

Layng Creek Ranger Station - 1914

"A picture of the Layng Creek Ranger Station in 1914. The post card was sent from the ranger station to the superintendent of foresters S.C. Bartram in Roseburg, Oregon."

The timber in the background looks like it has been cut or at least thinned. Some of the stumps and snags look like they have been blackened, so it is an assumption that after logging it was burned.

Logged Area - 1914

"A Layng Creek cut over area which was logged at the turn of the century in 1914. Loading into rail cars was done by steam operated jammers. The picture was taken in October 25, 1926 by Carl B. Neal."

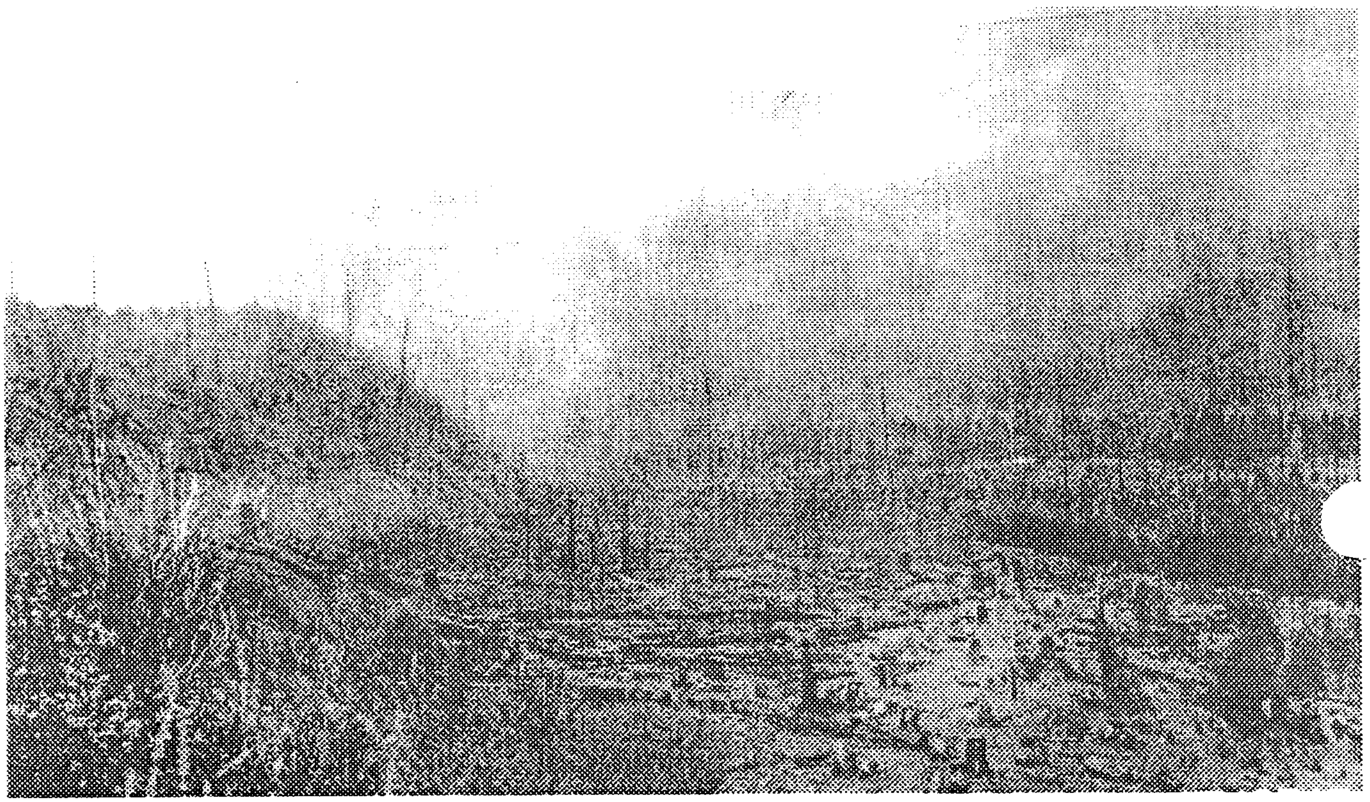
A fuel model 11 is represented here, new trees are starting to grow and reforest the land.

Reproduction Following Fire - 1920

Reproduction after the U.S. Logging Company area burned it in 1913. The result of recent protection against fire, reproduction reforesting an old burn."

This picture was probably taken in the early 1920's. The amount of blackened snags and tree trunks indicate a hot burn.

Old Logged Unit - 1926



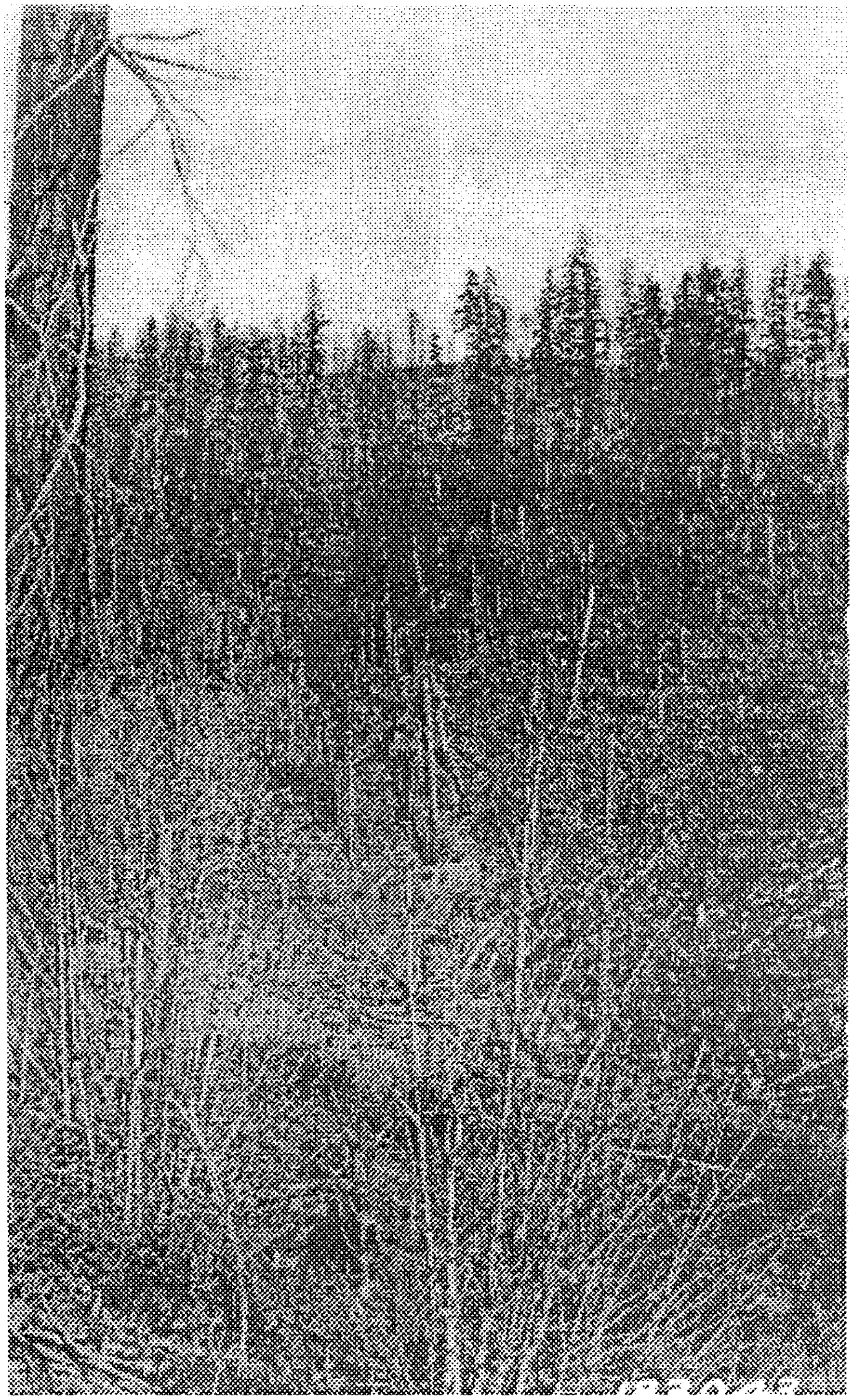
"Railroad logging in 1902 near the Bohemia Ranger District. The photo was taken on October 15, 1926."

This photo denotes that the majority of the timber was cut and burned. There is still some timber on the higher slopes and new trees are growing in the valley.

Panorama looking NW - 1923

"U.S. Logging Company sale area that was burned in the fall of 1913. Photo was taken on November 4, 1923 looking in the NW part of a panorama from a boulder on the point of the hill about 8 chains north."

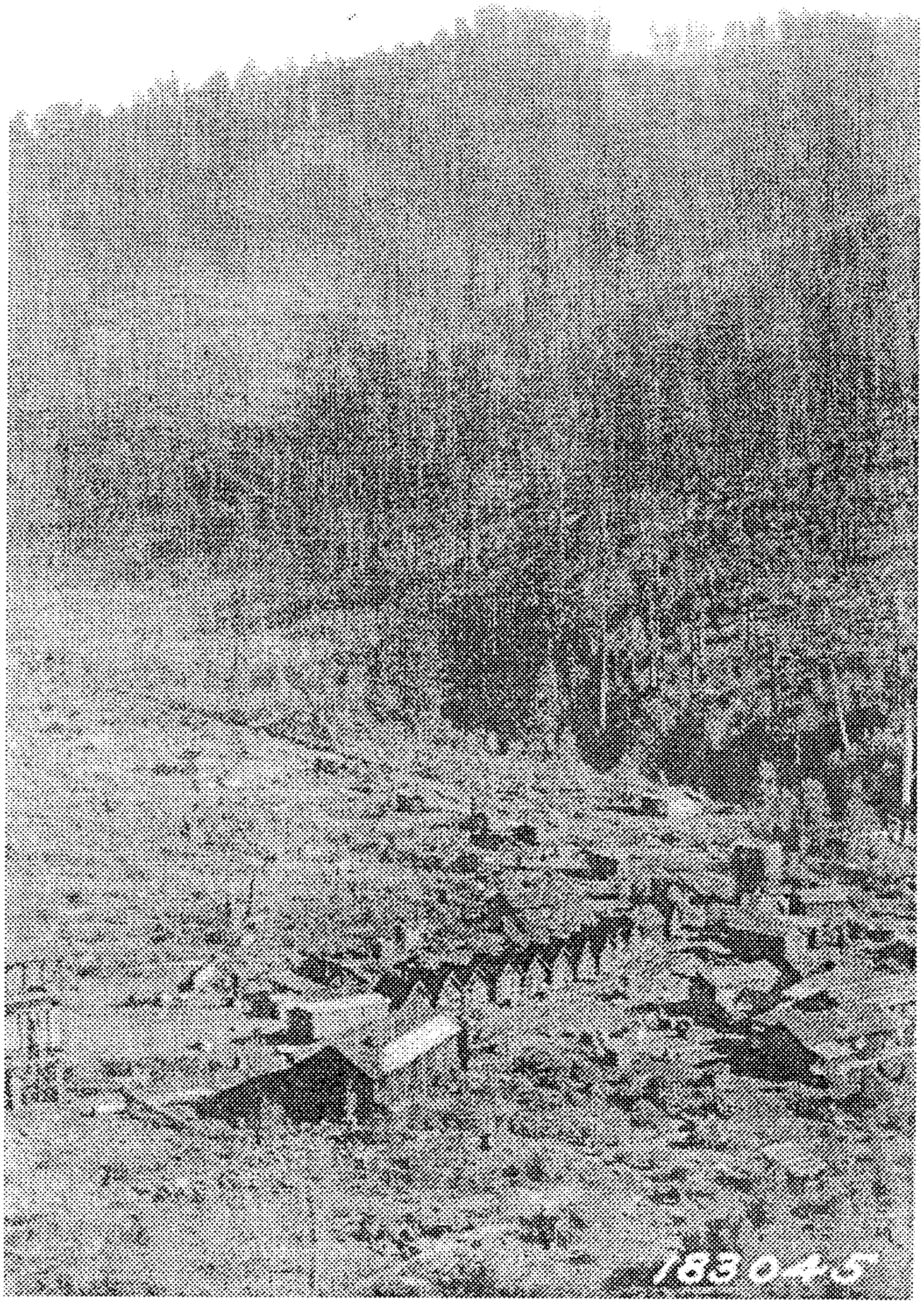
Panorama looking NE - 1923



"U.S. Logging Company sale area which was burned in 1913. Photo was taken looking NE across the landing of Western Lumber and Export Company which is part of a panorama. Photo was taken on November 4, 1923."

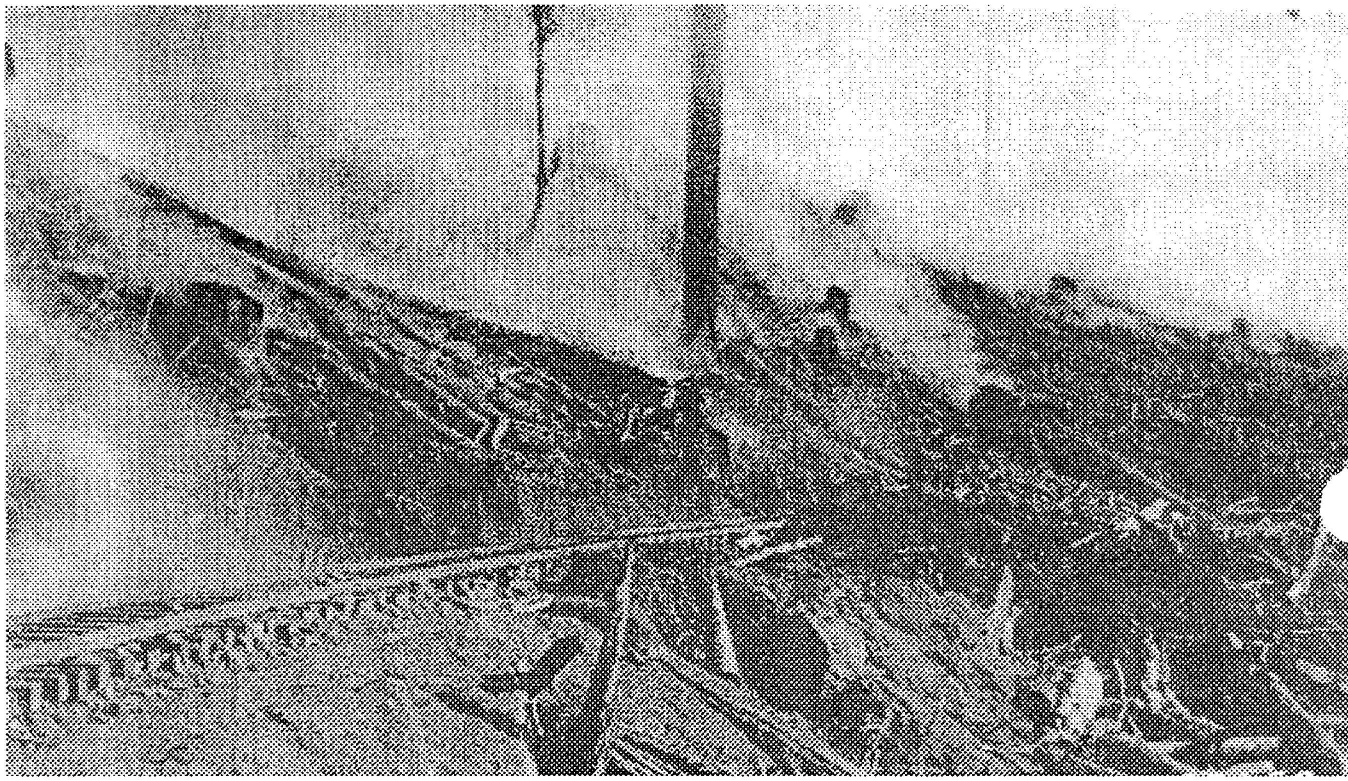
It looks as if it burned at a moderate to high intensity because of the amount of dead trees and snags left in the sale area.

Panorama looking SE - 1922



"U.S. Logging Company sale looking SE across camp of Western Lumber and Export Company. Area was burned in the fall of 1913 and part of the area has reburned since. Photo was taken on November 4, 1923 and is part of a panorama view."

Slash Burning - 1923

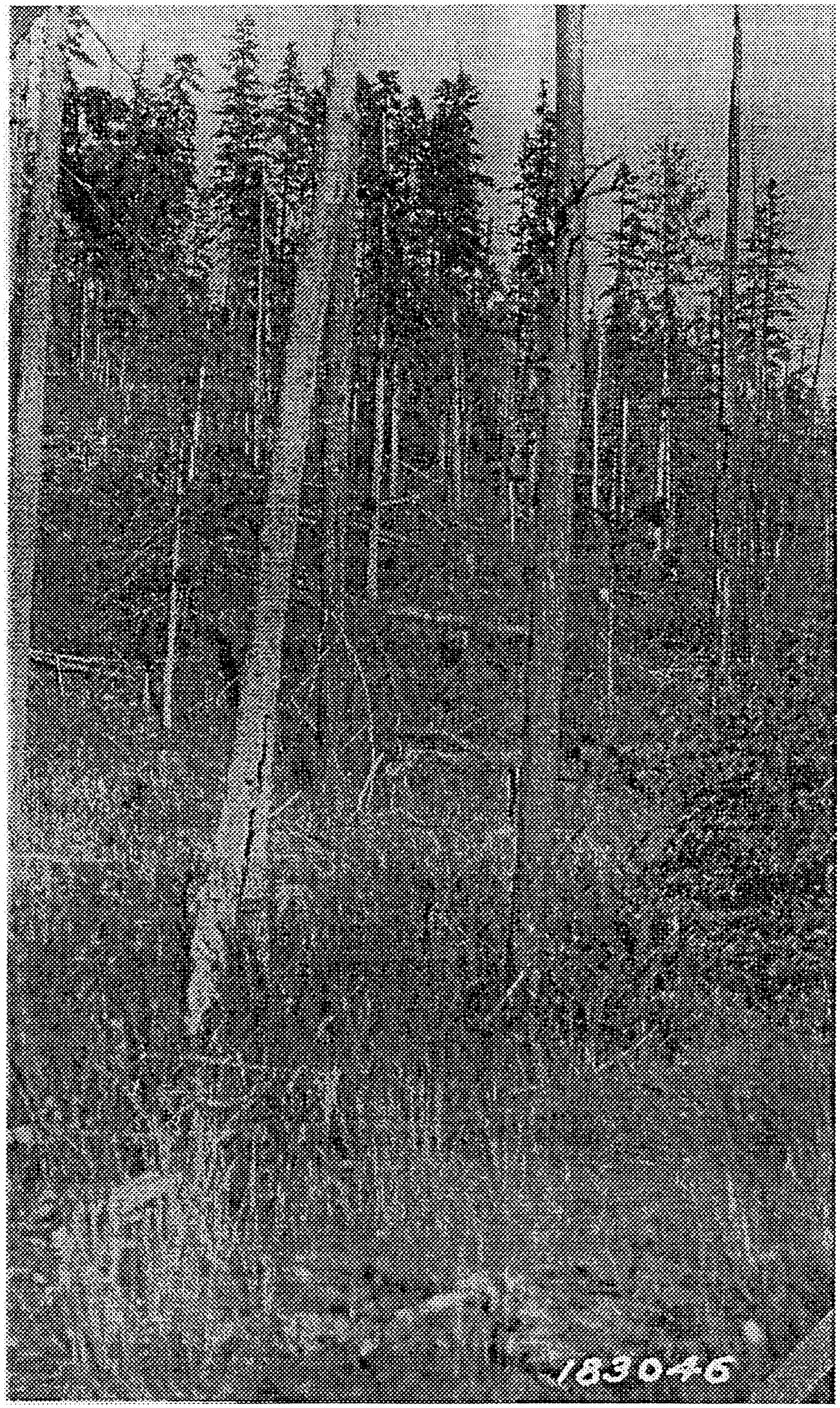


"Area logged by Western Timber and Export Company adjacent to the forest boundary. Picture was taken on November 8, 1923."

This picture depicts early slash burning in the Layng Creek area. The U.S. Logging Company was sold to Western Lumber and Export Company in 1922 and went bankrupt in 1924.

Reproduction - 1923

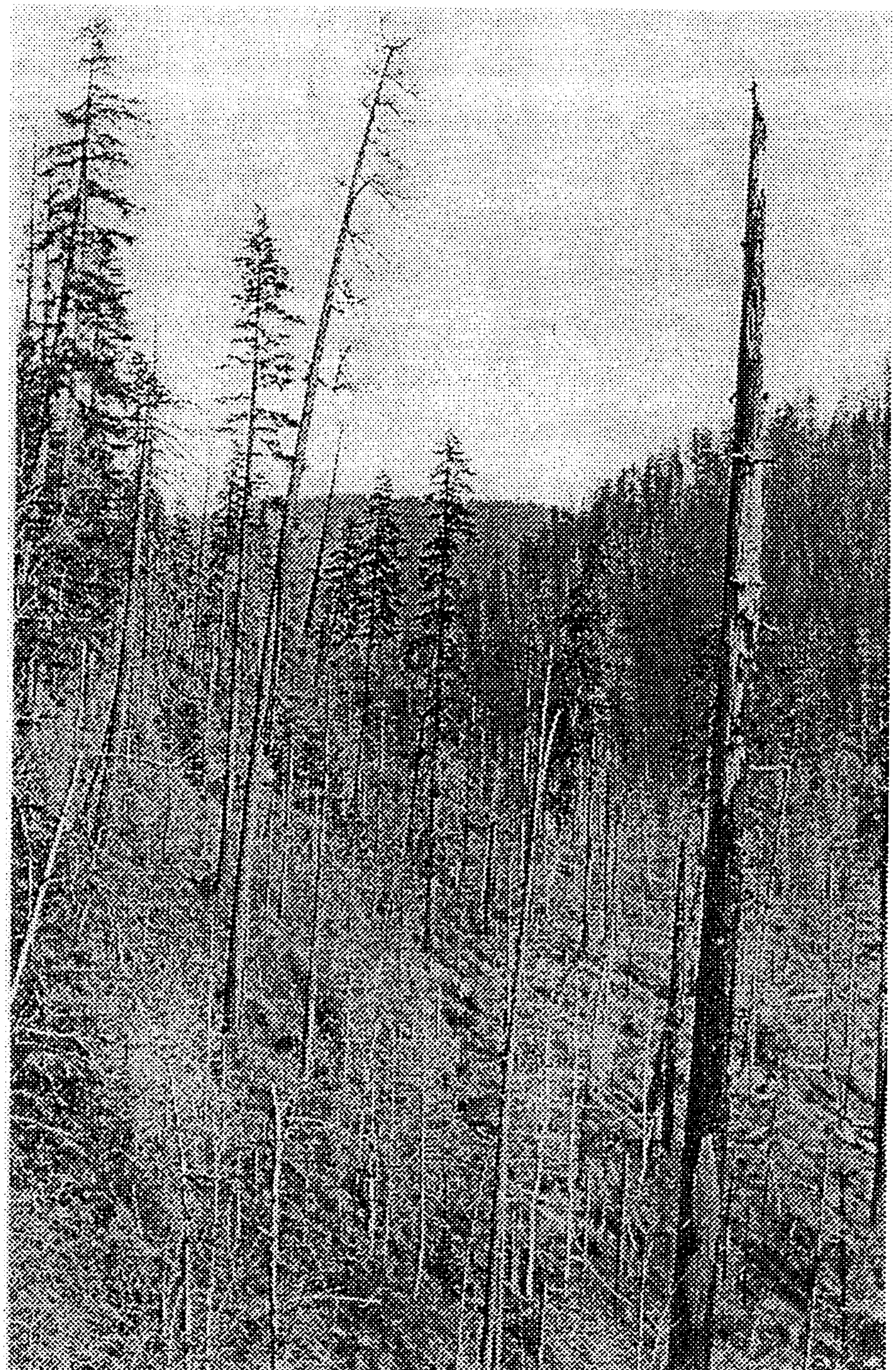
1918 Timber Sale in 1923



"U.S Logging Compay sale that was burned in 1918. The picture was taken looking North from a point opposite the mouth of Dinner Creek on November 6, 1923."

There are fire scars on some of the trees in the foreground.

Switchback Number Two



"Looking up Layng Creek from near the end of swichback number two."

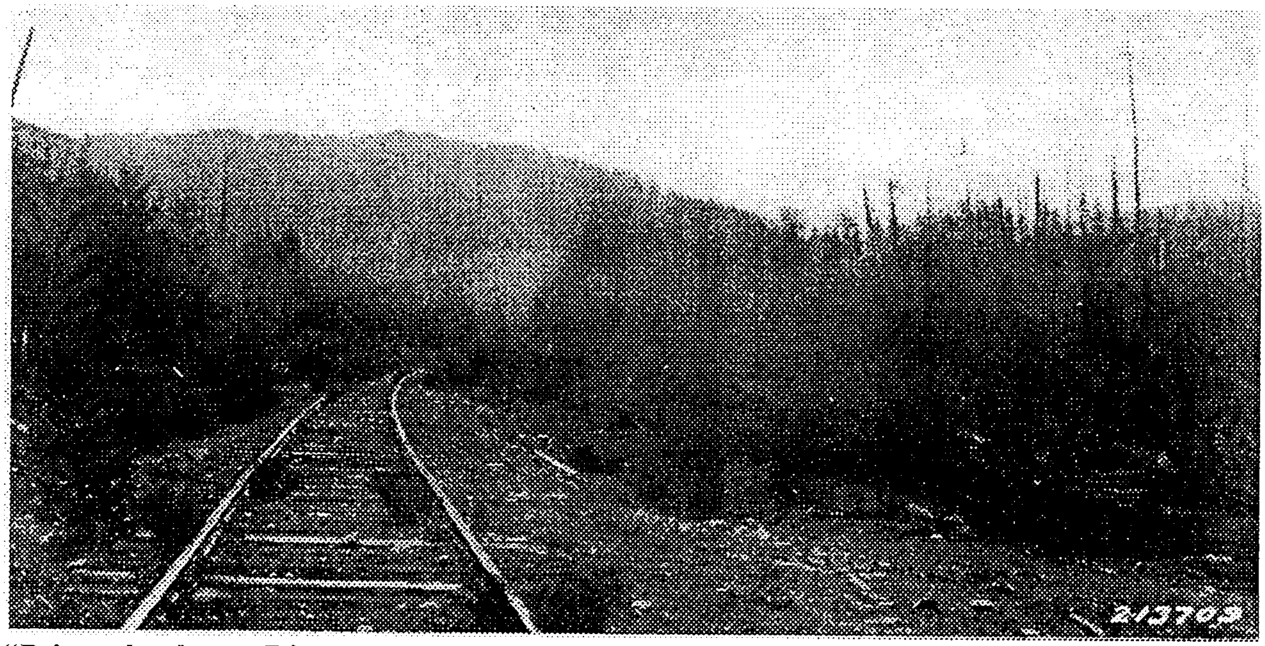
It is assumed that when they logged this unit they left a lot of the smaller diameter trees and that is was also burned after being logged.

Switchback #5 - 1923

"U.S. Logging Company sale wich reburned in the spring of 1917. Photo taken looking East from the trestle abouve switchback number five on November 7, 1923."

The area looks as if it has not started the regeneration of trees yet.

Row River Vicinity - 1926



"Private land near Disston taken by Carl B Neal on October 25, 1926 shows railroad logging along Row River in 1902. All of the trees were removed by this method of logging."

New trees are growing where it was logged and burned.

Herman Creek - 1934

"The Anderson and Middleton Lumber Company won the bid in 1924 for the Herman Creek timber sale area to railroad log. The photo was taken on March 20, 1934."

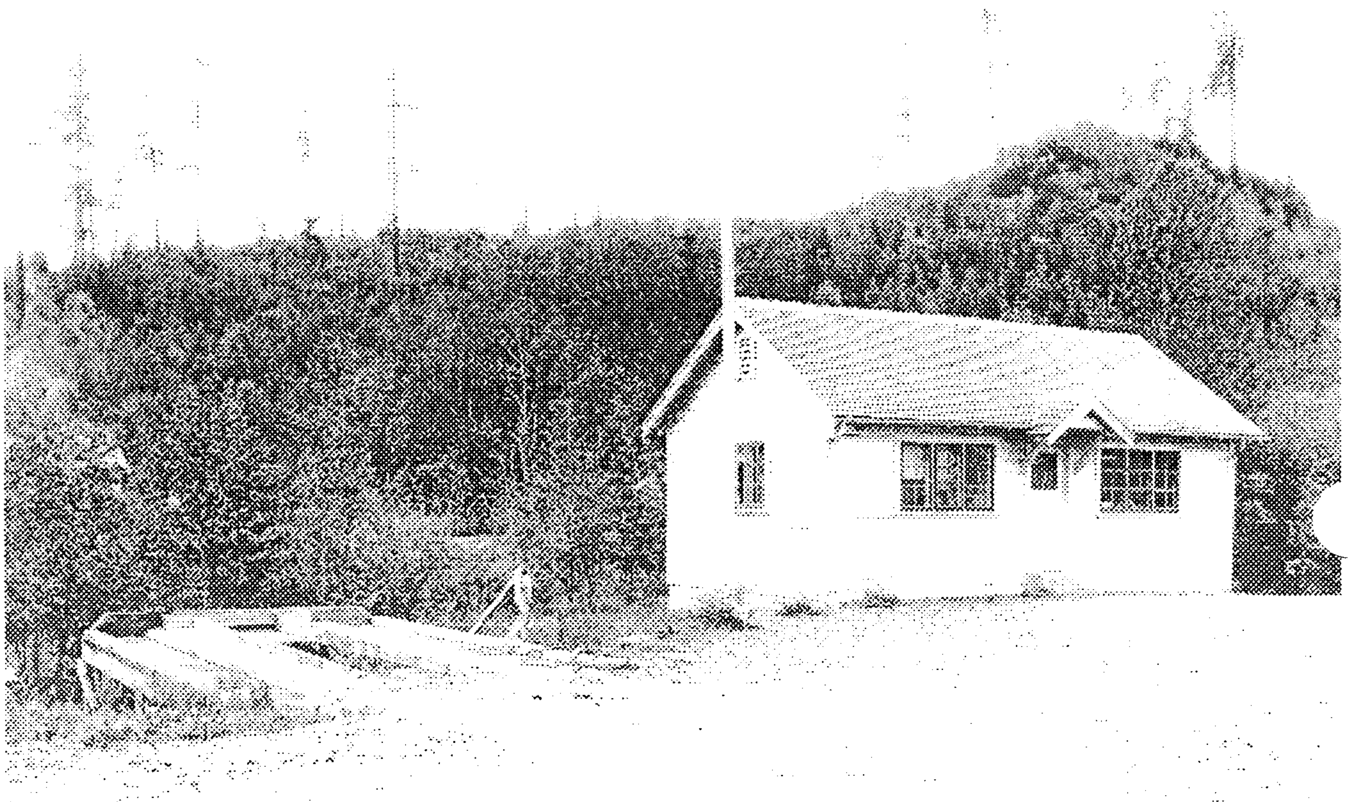
The hillsides in the background have not been logged. The clear cut in the foreground is a slash fuel model 13 which represents a heavy loading of the larger size class material.

Layng Creek Ranger Station - 1934

"Layng Creek Ranger Station photo taken in October 1934."

Area was mostly logged off with some trees starting to grow on the hillside in the background.

Layng Creek RS Office - 1936



"Office and grease rack at Layng Creek Ranger Station on May 13, 1936."

This picture represents a fuel model five and shows us how the area has been cut over with smaller diameter trees being left for seeding of wildlife purposes.

Rujada Forest Camp Entrance Portal - 1936

"The entrance portal and bridge at the Rujada Forest Camp, taken on May 15, 1936."

Timber has been cut over most of the area, it is assumed that the larger trees were left in place for the forest camp and would be considered a fuel model eight. The brush has grown up in most of the open areas and represents a fuel model five.

Layng Creek RS - Ranger's House 1936

"Layng Creek Ranger Station residential house. The photo was taken on May 15, 1936."

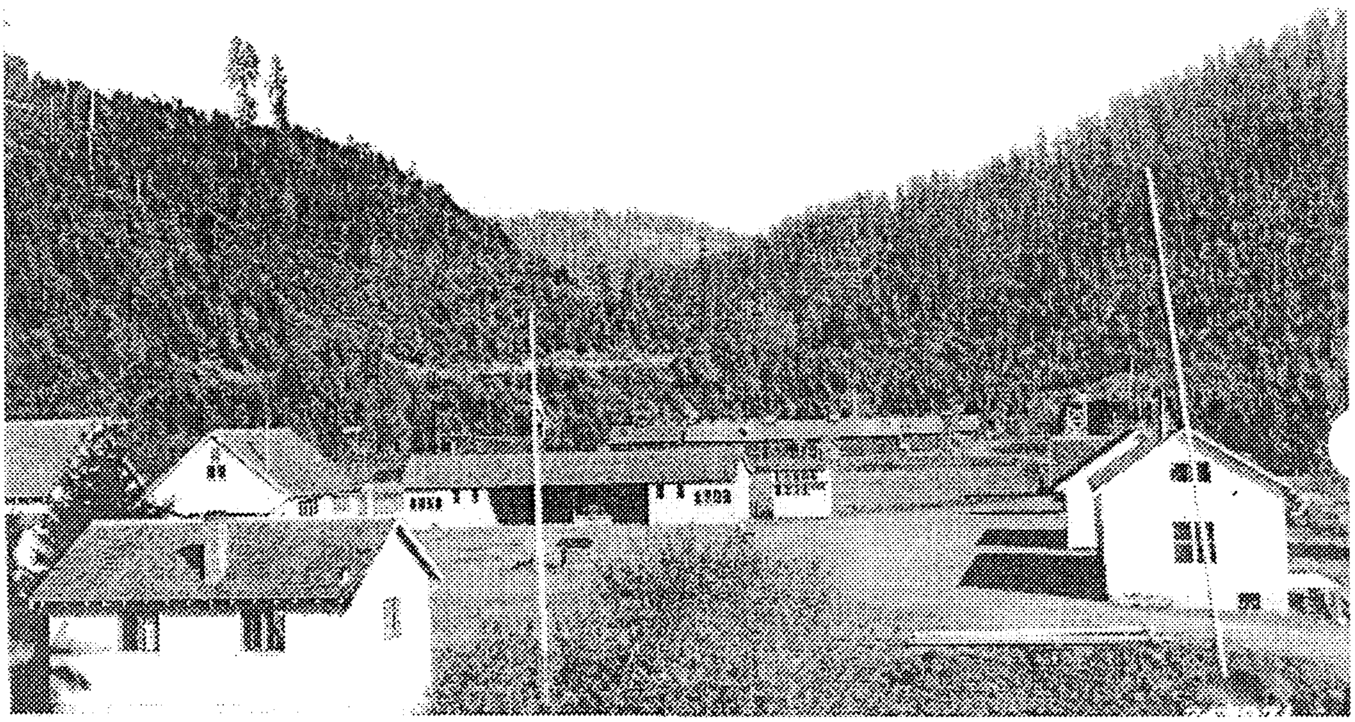
The area is covered in brush and natural reforestation, representing a fuel model five.

Layng Creek RS and CCC Camp looking W - 1936

"A general view of the Layng Creek Ranger station taken on May 15, 1936."

The entire area around the station has been logged and is now covered with brush on some natural reforestation from the seed trees left during logging. A fuel model five would best portray this area.

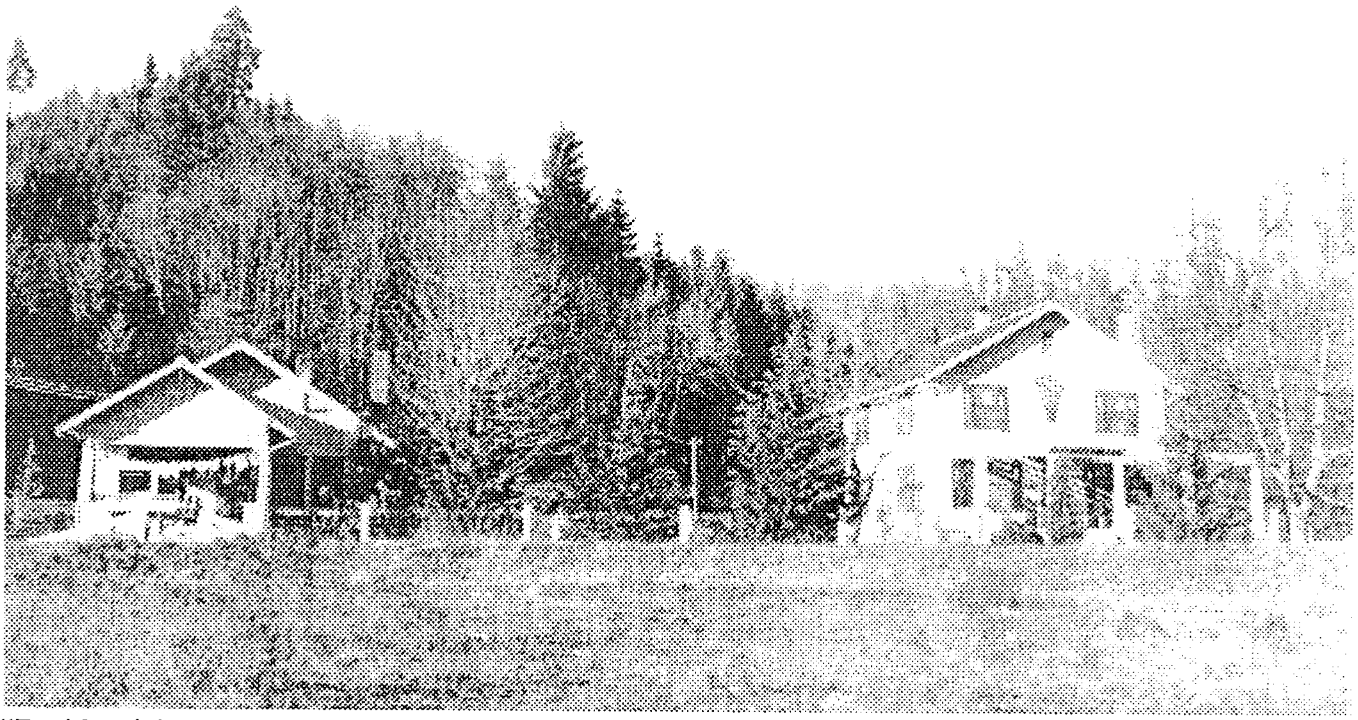
Layng Creek RS and CCC Camp looking E - 1936



"Service Court of Layng Creek Ranger Station taken by H.E.D. Brown in the fall of 1937."

There area fire scars about mid-slope on the hillside on the right hand side of the photo. Possible the same fire scar that has shown up on three other pictures taken in the same area.

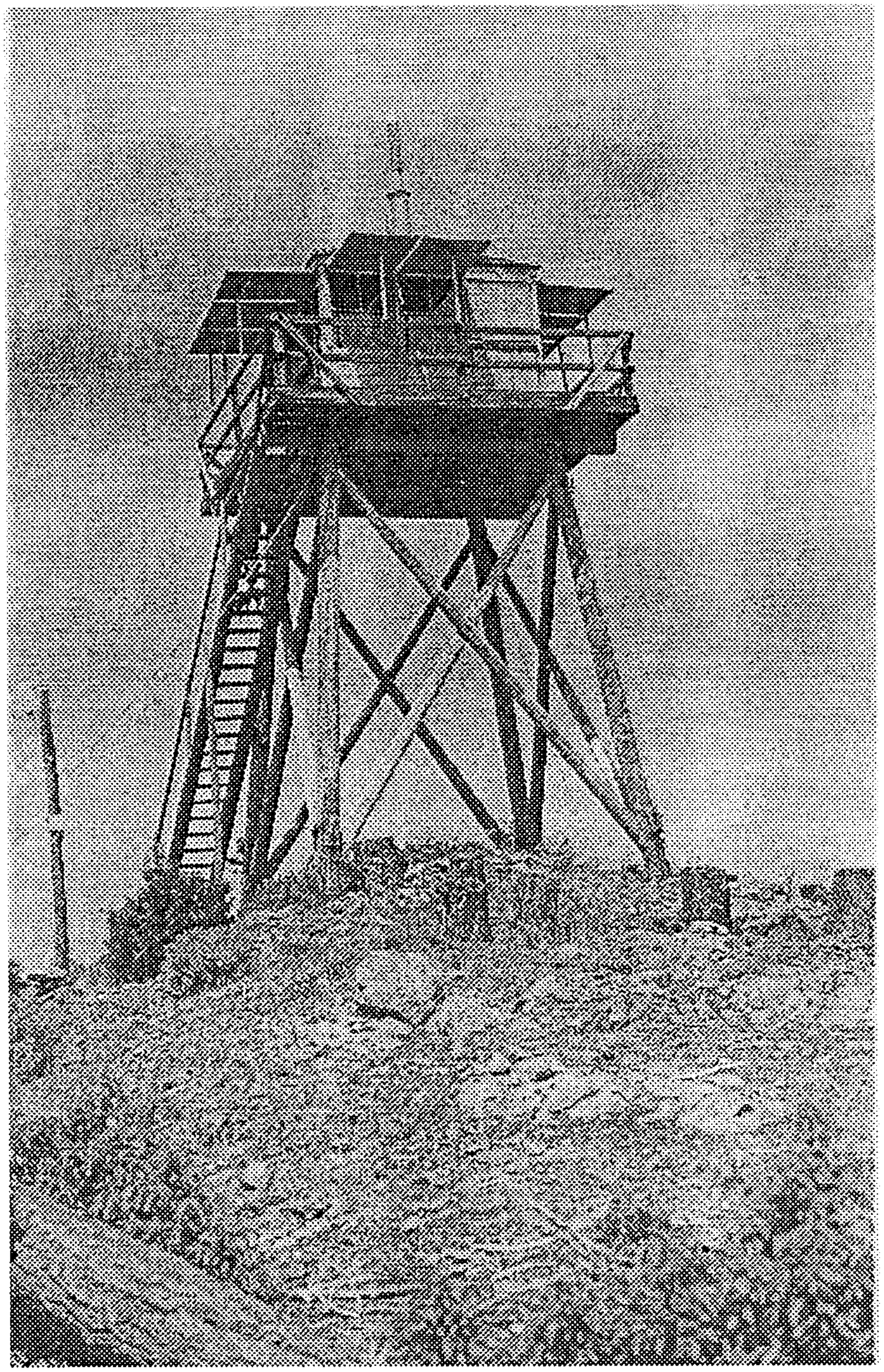
Layng Creek RS - Residences 1941



"Residential homes at the Layng Creek Ranger Station in March of 1941."

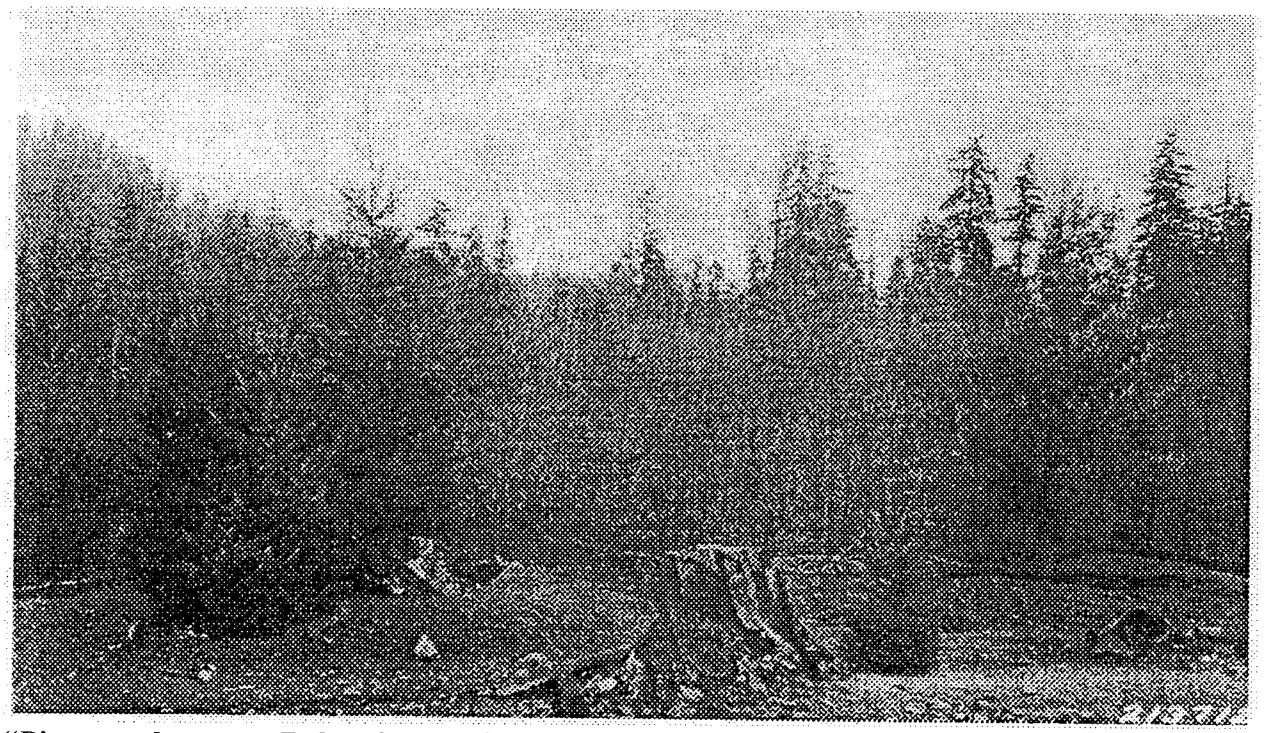
Most of the trees on the hillside are deciduous with a few conifers coming up where it has been logged.

Swastika Lookout - 1940



"Swastika Lookout, Photo taken by R.B.H. on July 15, 1940."

Bohemia Road



"Picture taken near Bohemia Road"

This is along present day Layng Creek Road. A fire has burned the reproduction leaving a fire scar.

Holland Point Lookout - 1940

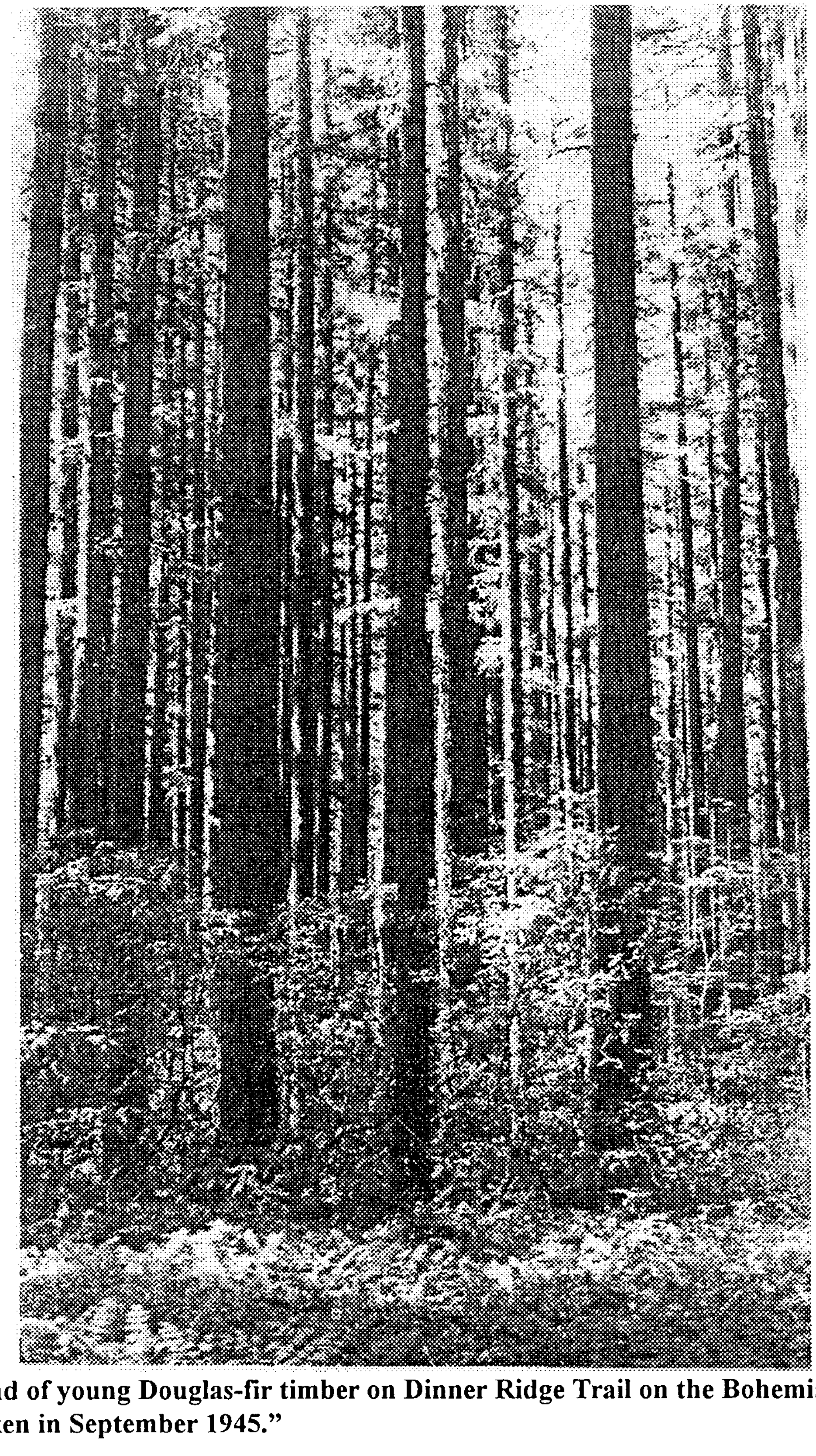
"Holland Point Lookout on Bohemia District. Photo taken on June 15, 1945."

Probably named for Lawrence Holland who established a homestead on the Willamette National Forest. Holland Meadows, just below the lookout, had a fire station and shelter.

Rujada Point Lookout - 1941

"Rujada Point Lookout was located on Rosehill, photo taken on June 31, 1941."

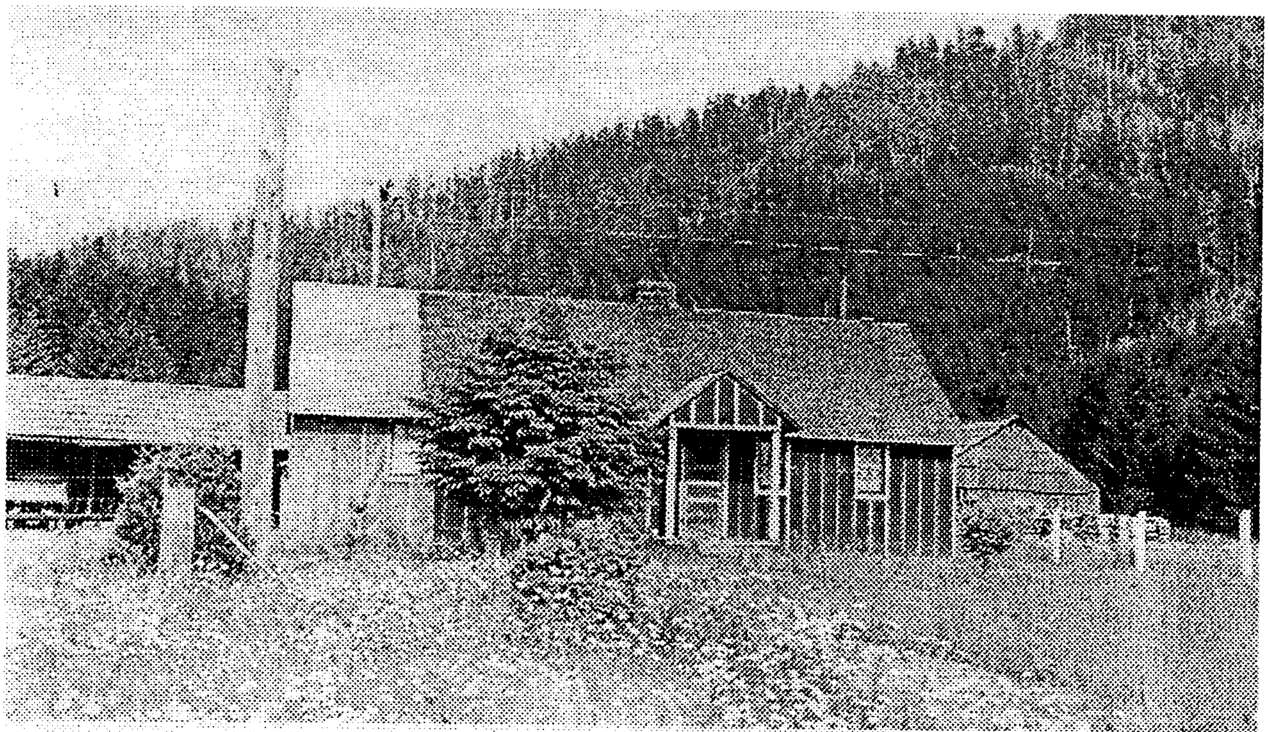
Dinner Ridge Trail - 1945



"Good stand of young Douglas-fir timber on Dinner Ridge Trail on the Bohemia Ranger District taken in September 1945."

The surface fuels are light with an undergrowth of brush growing up in the fuel model eight timber.

Layng Creek Ranger Station - 1947



"Scaler's residence at Layng Creek Ranger Station in 1947, converted Civilian Conservation Corps."

Note the fire scar on the hillside in the background.

Appendix E

Geologic Background

Geologic Unit Legend

Tut Welded to unwelded ash flow tuffs, has a tendency to weather to zeolites and clays

Tub Basaltic lava flows associated with Western Cascades

Tib Intrusive basalts and andesites- originate as vents and flow sources sills, plugs and dikes that have been exposed by erosion.

Thi Hypabyssal intrusive hornblende, qtz diorites, small intrusions such as dikes and sills that have crystallized in near surface conditions, Between intrusive and extrusive.

Tu Undifferentiated tuffs and breccias with minor components of volcaniclastic sediments and extrusive flow rock. Locally very diverse and discordant. Makes up a large portion of Little Butte Group

Tsv Silicic vent complexes, large rhyolite and dacitevent complexes, associated with multiple intrusions and eruptive breccias and flow deposits.

Qls Landslide and debris slide deposits, undifferentiated deposit associated with Holocene and Pliestocene climatic regimes. The largest deposits occur when thick baslts overly clayey tuffaceous materials

A Method and Process for Aerial Photo Landslide Inventory and Geomorphic interpretation that resulted in a hazard classification for Layng Creek Watershed Analysis *prepared by Paul Uncapher, Geologist*

The landslide history of Layng Creek was developed using a series of aerial photographs to identify observable landslide features (primarily debris slides) that could be seen using stereo pair imagery. Tools included Topcon mirror stereoscope and mylar overlays with appropriate marking pens. Identified slide features were located as polygons on 1:24,000 registered overlays by flight year, with accuracy limitations relative to the existing scale. These polygons were digitized into LT-Plus and are subsequently available as unique layers in the forest GIS system.

During the interpretation phase, an attempt was made to identify the type or associated disturbance with each polygon. Three attributes were used to distingush between a normal , road, or timber related disturbance. Although it is difficult to distinguish, every attempt was made to support these interpretations.

A number of slide associated features were used to interpret the occurrence and spatial locations of mapped sites. These features include rockfall deposits, headwall scarps, unvegetated surfaces, vegetation differences and debris fans. In addition slide tracks not associated with stream channels were helpful in the identification of older failures.

There was limited opportunities to field verify these interpretation during the course of this project. The primary objective was to develop an understanding of the patterns and trends associated with landslide features.

Photo Series used included:

1966- coverage entire area

1988- coverage entire area

Geomorphic Interpretation

During the initial stages of the Watershed Analysis, information available identified the need to develop an understanding of the large earthflow features in Layng Creek. As a result, 1:70,000 black and white photos (1974) were used to delineate these large scale features. Indicators of these complexes such as headwall and lateral scraps, hummocky terrain, stream patterns, local sag ponds and active toe zones were field verified to refine the mapping units delineate the polygons. This was then incorporated into a geomorphic overlay as part of the GIS system. In addition to the earthflow terrain, an attempt was made to deuvease those areas where dibris sides were an inherent part of the landscape.

The aquatic issues developed during the analysis led to the creation of a geologic hazard map that incorporated the landslide information, geomorphic terrain's and slope classes. This layer was designed to respond to Cumulative Effects questions and should be considered a relative indication of geologic hazard

Layng Creek was stratified by earthflow/ non earthflow and subsequently divided into three slope classes:

0-30%, 30-60%, and over 60%. This was based on the assumption that there would be some distinguishing difference in landslide activity between these stratas. Upon completion of this map, the landslide layer was superimposed upon it and acres of slide by strata was summed. This was used to calibrate our assumption and organize these by strata, relative to landslide hazard. The stratification developed is as follows:

Hazard 1	Non-Earthflow	- over 60%
Hazard 2	Earthflow	- over 60%

The process descried above was developed to be used at the Watershed Analysis scale and information generated should be subject to change with additional field information..