G

Appendix G

Hydrology Documents

REFERENCE CONDITION - HYDRO

Maureen Campbell, Hydrologist

1995

Overview

The geology of the Western Cascades has determined the drainage network and water yield characteristics of the Watershed. This geologic character determines the rate at which water enters the groundwater and surface water systems. Modification of this interaction occurrs with a change in vegetation pattern.

Historically a change in vegetation occurred through natural fire and/or disease and bug infestation, all of which can result in reduced crown closure. Open areas with trees less than 35 years of age evapotranspire less water than do forests with full canopy closure, thus introducing more water into the soil. Open areas also accumulate greater quantities of snow than forests with full canopy closure. Snow accumulation and rain on snow events from warm precipitation fronts can cause rapid snow melt and high peak flows within the channel networks.

The historical range of hydrologically unrecovered forest land varies from 21% to 1%. The reduction of hydrologically unrecovered forest to 1% results from modern fire suppression that began in 1910. This is before Hills Creek Dam was constructed.

Table ___: Percent Hydrologically Unrecovered

Seral Stage	Years		
	1835-1855	1876-1915	1947
Stand Initiation Early Habitat	21%	17%	1%
Rock outcrops meadows unsuited	3%	4%	3%
Total Unrecovered	24%	20%	4%

Middle Fork Willamette River

The MFW River from Coal Creek to the Reservoir flows through a corridor defined by the local geology roughly a 1/4 mile wide. The MFW is an alluvial channel composed of sand, gravel and cobble-sized material. The average stream gradient is 2%. The 1946 air photos reveal a single thread channel

alternating back and forth from single to double thread as it flows from one bend to the next. The active floodplain width roughly 2 to 5 times the wetted channel width. Islands of mature timber are present within the active channel. The riparian area was dominated by mature timber. Large woody material was hard to distinguish on these high-altitude photos.

Drainage Pattern

The Middle Fork Willamette River enters the Watershed from the south and flows north toward Hills Creek. The major streams that flow directly into the MFW River parallel each other and have a secondary dendritic drainage pattern. Stream density for the entire Watershed is 3.1 miles per square mile. Stream densities for the Subwatersheds range from 2.7 at the south end of the Watershed to 3.4 at the north end of the Watershed. Table____ provides information on area, miles of stream by Class, and drainage density. Note that the intermittent Class IV streams have been delineated from air photos rather than from topographic crenulations.

Table Subwatershed Area, Stream Class, and Stream Density.

5TH/6TH FIELD			SQUARE	STREAM CLASS				TOTAL	STREAM
	SUBWATERSHED	ACRES	MILES	I	II	III	IV	MILES	DENSITY
21-1	Oakridge	10,671	16.7	5.0	4.1	13.3	34.3	57	3.4
21-2 west	Hills Creek Reservoir	25,247	39.4	0.0	15.6	30.7	92.4	139	3.5
21-2 east	Hills Creek Reservoir	14,600	22.8	0.0	9.2	16.3	34.1	60	2.6
21-2 all	Hills Creek Reservoir	39,847	62.3	0.0	24.8	47.0	126.5	198	3.2
21-3 west	MFW/Little Pine	22,275	34.8	9.8	18.7	26.4	74.0	129	3.7
21-3 east	MFW/Little Pine	16,254	25.4	5.8	16.8	15.6	25.8	64	2.5
21-3 all	MFW/Little Pine	38,529	60.2	15.7	35.5	42.0	99.8	193	3.2
21-4 north	Coal Creek	1,584	2.5	0.9	1.4	2.1	2.9	7	3.0
21-4 south	Coal Creek	14,957	23.4	1.6	9.6	22.7	29.6	64	2.7
21-4 all	Coal Creek	16,542	25.8	2.5	11.1	24.8	32.5	71	2.7
	TOTAL 21	105,590	165.0	23	75	127	293	519	3.1

Longitudinal Profiles

Valerie Rogers, Hydrologic Technician

Longitudinal stream profiles for the east and west sides of the Watershed can be seen in figures _____ and ____. The profiles show relative position of the streams within the Watershed, and their topographic relief.

Figure . Longitudinal Profile East Side of MFW River and Reservoir.

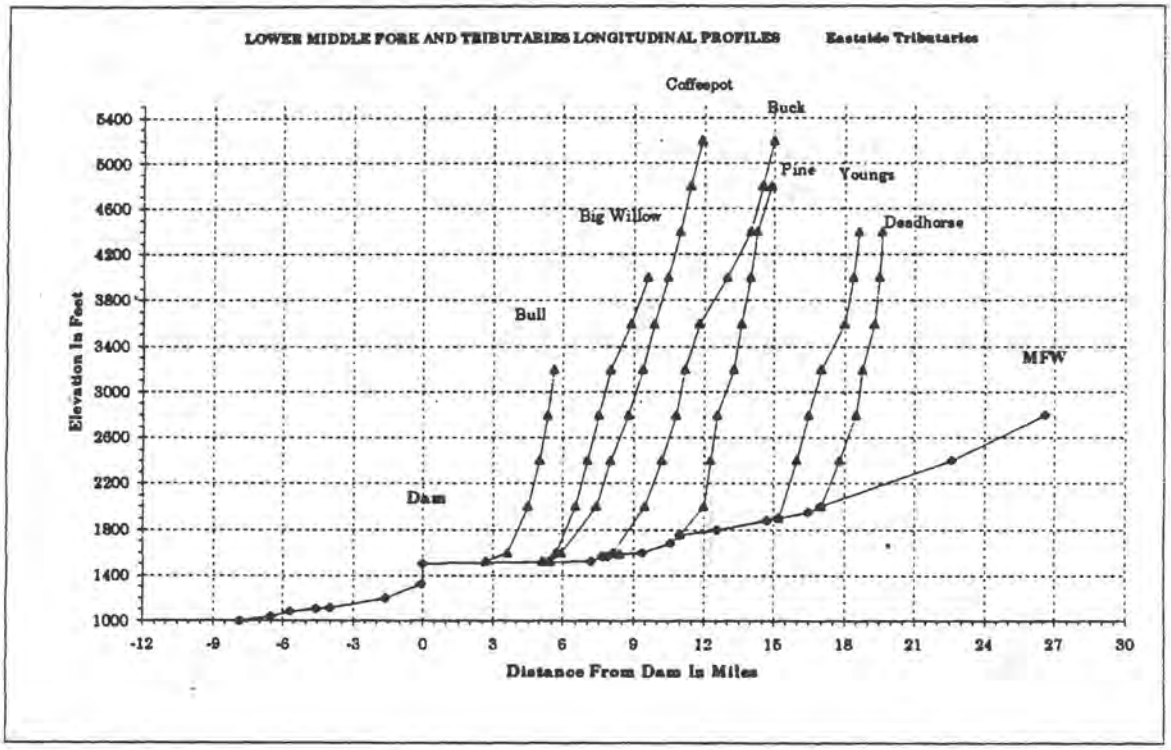
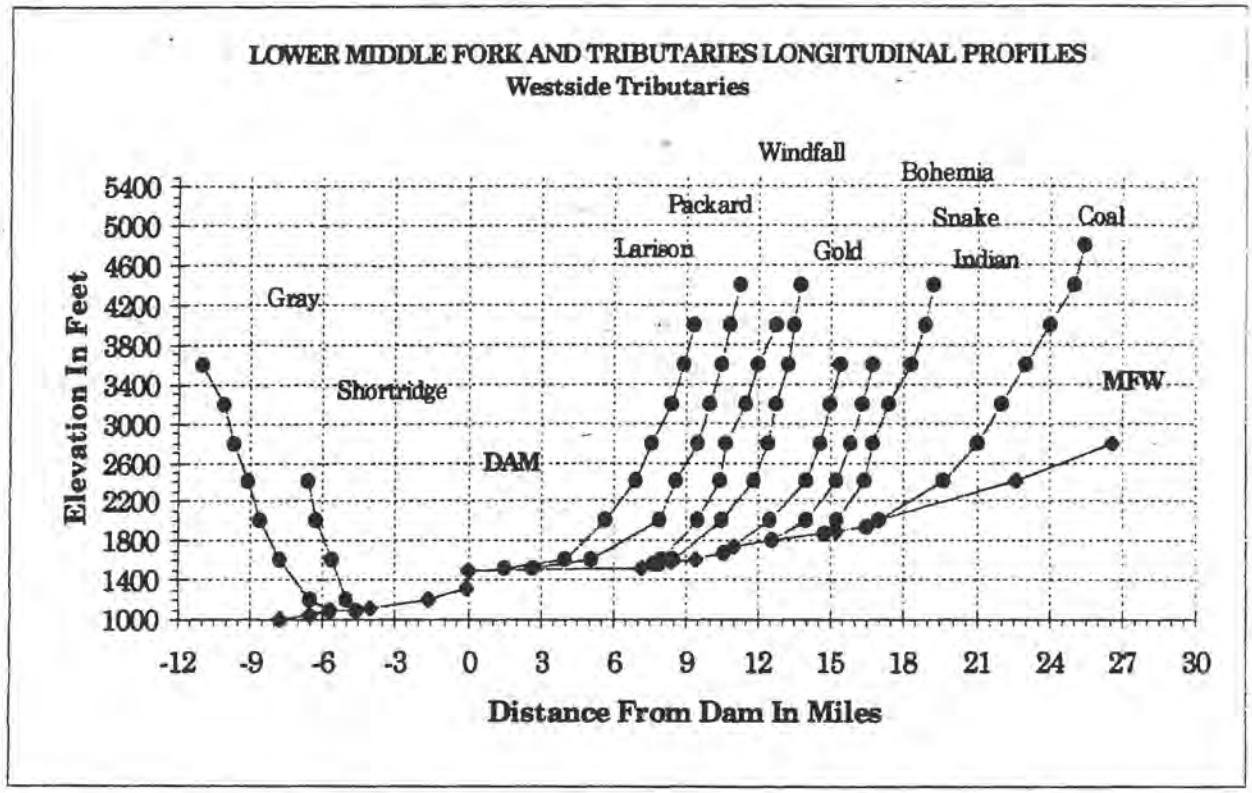


Figure . Longitudinal Profile West Side of MFW River and Reservoir.



Water Yield

Maureen Campbell, Hydrologist

Water Yield Class is an indicator of the rate at which water is transmitted through a particular soil profile to the stream system and into the groundwater. The water yield data is a character component determined for each SRI Landtype. The following definitions were taken from the Soil Resource Inventory GIS Data Dictionary, Willamette National Forest, 1994.

Water Yield Class I

Soils with a low runoff rate and a high water detention capacity, given that the soils are not saturated or frozen. Important in sustaining high base flow.

Assumption: 75% to Base Flow
25% to Storm Flow

Water Yield Class II

Soils with a moderate runoff rate and moderate water detention capacity. Water contributes to both peak flows and base flow.

Assumptions:	50% to Base Flow
	50% to Storm Flow

Water Yield Class III

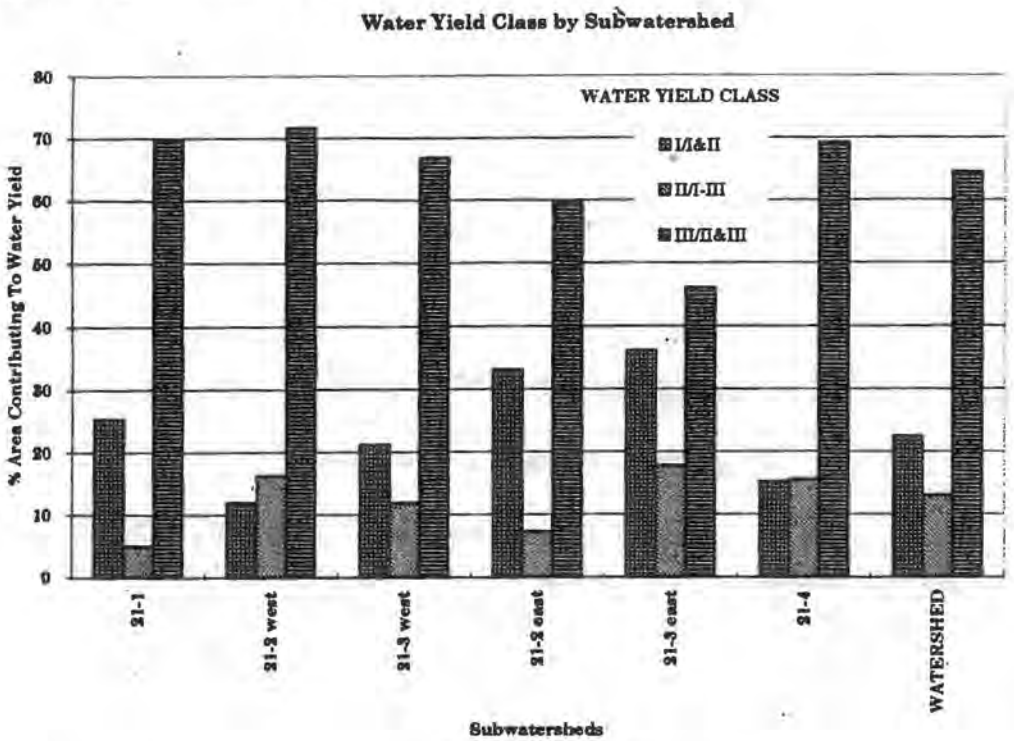
Soils with a high runoff rate and low water detention capacity. The storage capacity is low and easily exceeded with most of the water contributing to peak flow. Little water is yielded to sustain base flow.

Assumptions:	25% to Base Flow
	75% to Storm Flow

Water Yield Character

The MFWDT Watershed is dominated by landtypes with a Class III water yield indicating that streams are flashy and respond quickly to storm events , and less water is detained in the soils as groundwater for contribution to summer low flow. Only 22% of the area is represented by landtypes that have a high water detention and low peak flow response to storms given that soils are neither saturated nor frozen. Fourteen percent of the area provides water equally to groundwater and to the stream following storms. The eastern half of Subwatersheds 21-2 and 21-3, Hills Creek Reservoir and Middle fork Willamette /Pine Creek Subwatersheds, show a greater percentage of the area covered by Landtypes with a Class I water yield, indicating Landtypes with a greater clay content and water storage capacity. Comparatively 33 and 36% on the east and 12 and 21% on the west side of the Subwatersheds.

Figure ___. Water yield Class



This reveals that streams on the west side such as Larison, Packard, Windfall, and Gold Creeks will show a potentially greater peak flow response to storm events as compared to Bull, Big Willow , Coffeepot and Buck Creeks on the east side of the Reservoir. Nonetheless, all of the Subwatersheds within this Watershed are dominated by streams that respond quickly to storm events.

Rain On Snow - Characterization

Valerie Rogers, Hydrologic Technician

Rain on snow events are common in the Western Oregon Cascades. These precipitation events bring warm air and rain into the mountains melting snowpacks quickly and delivering great amounts of water to the drainage network in a short period of time. Rain on snow events take place within the transitional snow zone (TSZ) which ranges in elevation from roughly 1500 to 4000 feet. The TSZ also varies in elevation relative to aspect. The upper boundary of the TSZ can be approximated by the True Fir/Doug Fir transition zone. Approximately 78% of the MFWDT Watershed is in the TSZ. The remaining area above 4000 feet generally maintains a seasonal snowpack.

This process is significant in that harvest units that are less than 30 years old accumulate greater quantities of snow than adjacent timbered lands.
Due to the high percentage of area within the TSZ, rapid flood peaks and high flows associated with rain on snow events are a dominant hydrologic process in the MFWDT Watershed. These storm flows in turn are an important factor affecting fluvial sediment transport rates as well as transport of large and small organic material. These higher flows also provide access to side channels which play an important role in providing diverse, high quality aquatic habitat to the local fauna.

Spring Season Water Yield

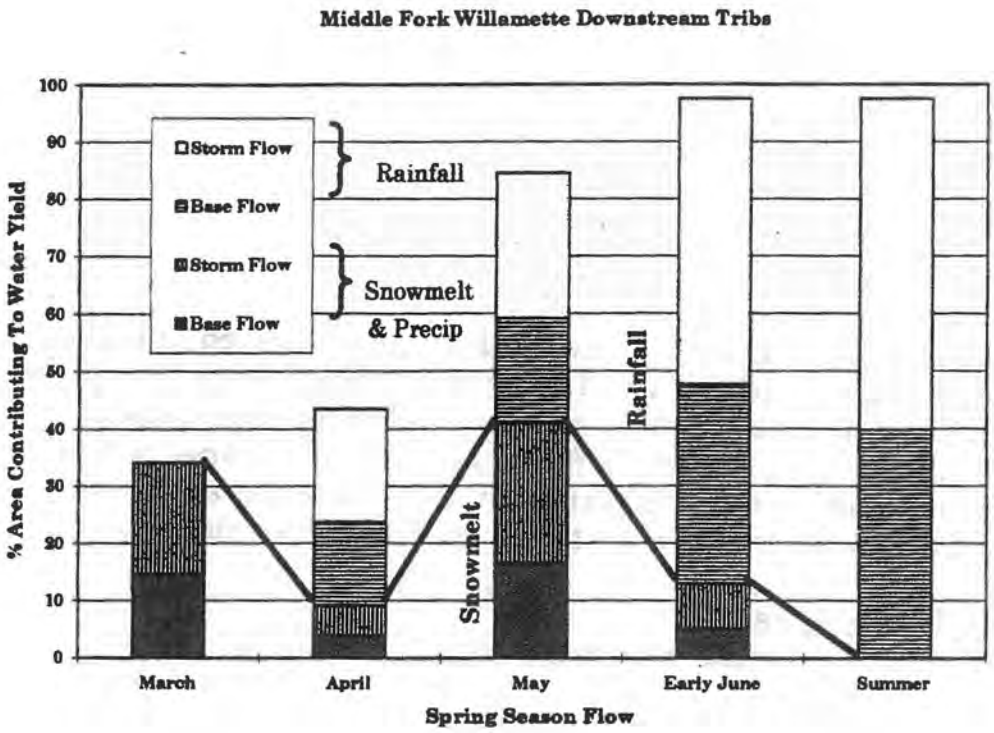
Maureen Campbell, Hydrologist

Based on aspect, elevation, water yield, and the expected timing of snow melt a flow regime was developed for the spring season. Assumptions were made on the percentage of water that would contribute to storm flow (peak flow) for a given water yield class. These values are shown below in Table_____. In general the timing assumption is that the snow pack will melt off earlier in the season on southerly aspects and at lower elevations first and higher elevations on northerly aspects last. Timing calculations are as follows: the drainage area of the water yield class multiplied by the percentage of water expected to contribute to storm flow and to base flow for a particular water yield class, given the aspect and elevation. The water yield analysis does not account for the quantity of precipitation, the status of groundwater storage, or vegetative condition. The influence of vegetation will be discussed under the chapter on Existing Conditions for Hydrologic Recovery.

Table . Assumptions for Snow Melt by Aspect and Elevation for Spring Season Flow

Aspect	Elevation	Snow Melt Off During
South Slope	X<4000 ft	March
South Slope	X>4000 ft	April
North Slope	X<4000 ft	April & May
North Slope	X>4000 ft	May & early June

Note: South Slopes include: west, southwest, south and east aspects.
North Slopes include: northwest, north, northeast, and east.


Middle Fork Willamette Downstream Tribs
Storm Flow
Base Flow
Storm Flow
Base Flow
Rainfall
Snowmelt
& Precip
Rainfall
Snowmelt
% Area Contributing To Water Yield
100
90
80
70
60
50
40
30
20
10
0
March
April
May
Early June
Summer
Spring Season Flow

CURRENT CONDITIONS - HYDRO

Maureen Campbell, Hydrologist

ISSUE VM VEGETATION MANAGEMENT

Riparian Habitat

VM5

Riparian area vegetation has been altered within this Watershed by harvest activities, road building, and wildfire. Impact of the Shady Beach Fire on the riparian area is included within the harvest acres. Stream temperature, channel stability, and the potential for future large woody material recruitment is a product of the geology, vegetation and climate. These characteristics are further modified by management activity within the riparian corridor.

Stream Temperature

Stands that are within the riparian area, younger than 35 years in age, in general do not provide adequate shade for the stream environment especially for wider streams. On the other hand smaller streams may be shaded before this time depending on the local geomorphology and elevation. The alteration of site character by harvest, such as elevating the water table or intensifying a frost pocket, can retard the rate of regeneration. The impact of vegetation manipulation on water temperature is presented relative to the miles of perennial stream harvested within the last 35 years (see Table_____).

Table____. Percent perennial stream harvested with max recorded stream temperature

Subwatershed	Stream	% Perennial Harvested	Max Water Temp (Fahrenheit)	Date
21-1	Gray	8.5		
21-1	Shortridge	0.0		
21-2 west	Larison	14.6		
21-2 west	Packard	56.2	77	1992
21-2 west	Stony	100		
21-2 west	Snow	14.5		
21-2 east	Modoc	20.8		
21-2 east	Bull	19.9	68	1994
21-2 east	Little Willow	0.0		
21-2 east	Big Willow	42.0	71	1994
21-2 east	Coffeepot	25.0	65	1994
21-3 west	Windfall	30.0	65	1992
21-3 west	Gold	26.6		
21-3 west	Bohemia	46.6	* 63	1993
21-3 west	Snake	28.6	* 64	1990
21-3 west	Spring Butte	46.9		
21-3 west	Indian	33.0		
21-3 east	Buck	23.9	76	1992
21-3 east	Estep	38.2		
21-3 east	Pine	26.6		
21-3 east	Youngs	16.7	64	1990
21-4 south	Coal	22.8	66	1993
21-4 north	Deadhorse	26.8		

Note: a) Stream miles harvested was hand measured from 1995 GIS map.
b) * indicates grab sample; otherwise water temperatures are from Max-Min thermometers.

Channel Stability

Vegetation manipulation of the channel bank and floodplain plays a significant role in maintaining the structural integrity of the channel and floodplain morphology. Harvest activity results in the loss of root strength that formerly held banks together creating banks vulnerable to erosion processes which are accelerated with storm events. Resultant influxes of sediment to the bedload can cause further erosion and deposition downstream, widening stream channels, elevating water temperatures, and deteriorating aquatic habitat. The impact of vegetation manipulation on channel stability is presented relative to the percent riparian buffer harvested for all stream classes within the last 35 years (see Table____, Riparian Vegetation).

Large Woody Material Recruitment

Managed and unmanaged stands within the riparian area older than 55 years of age are assumed to begin providing both the down woody and the large woody material component to the riparian area, stream channel and floodplain. Trees 55 years of age are generally around 15 inches in diameter, and vary according to site conditions and tree species The following table shows the percent riparian area by Subwatershed less than 35 years of age and those greater than 55 years in age.

Table____. Riparian vegetation less than 35 years old and greater than 55 years old.

Subwatershed	% Riparian Area X < 35 years	% Riparian Area X > 55 years
21-1	8	72
21-2	22	50
21-3	33	46
21-4	33	64
Total 21	26	53

Note: a) 4% of each Subwatershed is roaded (roads have a 40 foot buffer and include all mapped in GIS).
b) riparian buffer calculations are inclusive of Class I-IV streams.
c) riparian buffer widths are based on the President's Plan.

Hydrologic Recovery

VM3

As a whole, 37% of the MFWDT Watershed has been harvested since 1960 and is vegetated by trees less than 35 years old; roughly the age where stands are considered hydrologically recovered as related to crown closure. Traditionally hydrologic recovery is based on a transient snow zone with an upper elevation of 4,000 feet, but because the Rigdon Ranger District is in a position of transition between the northern wet and colder forests and the southern warm and dryer forests, the transient snow zone likely extends to a higher elevation band and is inclusive of the higher ridge tops of this Watershed around 5,500 feet. Hydrologic recovery using stands less than 35 years of age at all elevations is presented in Table ___, Hydrologic Recovery by Subwatershed. Subwatersheds will then be further described relative to the east and west sides of the Reservoir and MFW River. These descriptions will include stream watershed hydrologic recovery to further reveal harvest activity.

Table___. Hydrologic Recovery by Subwatershed.

	Inside Riparian	Outside Riparian	Private	All Elev X<35 yrs	Total Acres	% X<35 yrs	% Hydrologic Recovery
21-2 east	762	3,839	0	4,601	14,600	32	68
21-1	**161**	**1,075**	**431**	**1,668**	**10,672**	**16**	**84**
21-2 west	717	2,564	9,240	12,521	25,247	50	50
21-2	**1,479**	**6,403**	**9,240**	**17,121**	**39,847**	**43**	**57**
21-3 west	1,435	4,271	4,121	9,827	22,275	44	56
21-3 east	1,012	4,346	0	5,358	16,254	33	67
21-3	**2,447**	**8,616**	**4,121**	**15,184**	**38,529**	**39**	**61**
21-4 north	111	312	0	423	1,584	27	73
21-4 south	728	3,689	0	4,417	14,958	30	70
21-4	**839**	**4,001**	**0**	**4,840**	**16,542**	**29**	**71**
21	**4,925**	**20,095**	**13,792**	**38,813**	**105,590**	**37**	**63**

Note: all private land is assumed to be less than 35 years old.

Table.____ Percent Area and Acres Harvested for above 4,000 feet.

Stands X<35 yrs	% 21-1	% 21-2	% 21-3	% 21-4	% Watershed	Total Acres
X>4000'/north	37	43	53	32	42	13,947
X>4000'/south	30	45	37	25	35	9,891
Total X>4000'	36	44	46	29	39	23,837
Total Ac X>4000'	356	5,233	9,587	8,661	23,837	

Subwatershed 21-1

- most hydrologically recovered Subwatershed.
- moderately high potential for rain on snow events occur.

	Stream	% X<35 yrs	% Hydrologic Recovery
21-1	Gray	19	81
	Shortridge	21	79

Subwatershed 21-2 East

- moderately high potential for rain on snow events to impact the stream channel.
- east side of Reservoir slightly less flashy, more clays for suspended sediment, riparian vegetation better condition less channel/floodplain erosion.
- nearly half of the area above 4,000 feet within 21-2 has been harvested in the last 35 years.

	Stream	% X<35 yrs	% Hydrologic Recovery
21-2 east	Modoc	90	10
	Bull	43	57
	Little Willow	24	76
	Big Willow	24	76
	Coffeepot	31	69

Subwatershed 21-2 West

- moderately high potential for rain on snow events to occur and impact the stream channel.
- west-side of Reservoir - flashier streams, some have little to know riparian vegetation, greater potential for elevated water temperatures and channel/floodplain erosion.
- nearly half of the area above 4,000 feet within 21-2 has been harvested in the last 35 years.

	Stream	% X<35 yrs	% Hydrologic Recovery
21-2 west	Larison	33	67
	Packard	64	36
	Stony	88	12
	Snow	22	78

Subwatershed 21-3 East

- moderately high potential for rain on snow events to impact the stream channel.
- east side of Reservoir slightly less flashy, more clays for suspended sediment, riparian vegetation better condition less channel/floodplain erosion.
- nearly half of the area above 4,000 feet within 21-3 has been harvested in the last 35 years.

	Stream	% X<35 yrs	% Hydrologic Recovery
21-3 east	Buck	36	64
	Estep	33	67
	Pine	32	68
	Youngs	30	70

Subwatershed 21-3 West

- moderately high potential for rain on snow events to impact the stream channel.
- west side of Reservoir - flashier streams, some areas have little riparian vegetation, greater potential for elevated water temperatures and channel/floodplain erosion.

	Stream	% X<35 yrs	% Hydrologic Recovery
21-3 west	Windfall	28	72
	Gold	43	57
	Bohemia	39	61
	Snake	50	50
	Spring Butte	75	25
	Indian	49	51

Subwatershed 21-4

- most hydrologically unrecovered Subwatershed.
- moderately high potential for rain on snow events to impact the stream channel.
- majority of harvest within last 35 years.

	Stream	% X<35 yrs	% Hydrologic Recovery
21-4	Deadhorse	31	69
	Coal	29	71

Water yield remains the same as described in the Reference Condition. The majority of the MFWDT is composed of soils and geology that have a high runoff rate producing streams with a quick response to precipitation and snow melt events.

Issue TR **Existing Transportation System**

Increase In Drainage Density

TR3

Stream density and pattern determines the peak flow timing and duration within a channel and the system as a whole. Water yield is also an important factor determining the rate at which water is transported from the point of raindrop impact to the stream channel. Predominantly we have soils that transport water rapidly to the stream channel producing flashy flow responses to storm events and snow melt. Roading interrupts the subsurface and surface flow of water to the stream system, and channelizes the water in the ditches. These "pseudo" class IV streams effectively shorten the time it takes for water to reach the stream channel, further accentuating the flashy streamflow tendency. Within the Watershed, the road network effectively doubles the drainage density, thus decreasing the time it takes for the stream to respond to a storm event (see Table ____ for road and stream density values by Subwatershed). This causes greater peaks in flood flow, and consequentially a greater potential for floodplain and channel alteration.

Table____. Road and stream density.

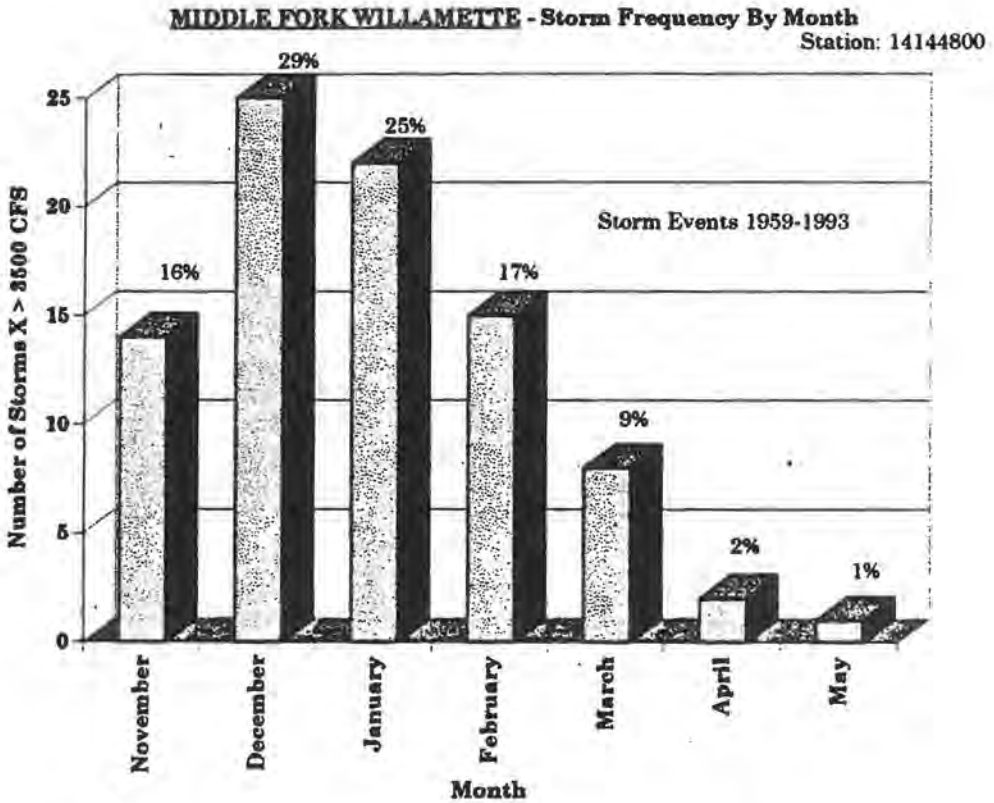
Subwatershed	Square Miles	Road Density	Stream Density	Road & Stream Density
21-1	16.7	3.3	3.4	6.7
21-2	62.3	3.6	3.2	6.8
21-3	60.2	3.5	3.2	6.7
21-4	25.8	3.0	2.7	5.7
Watershed Total	165	3.4	3.1	6.5

Streamflow

The MFW River above the Hills Creek Dam has one USGS Gauging Station which has been operational since 1959 recording both stream temperature and stream discharge. Station 14144800, named the "Middle Fork Willamette River Near Oakridge, OR", is located roughly 0.5 miles upstream from the Reservoir near Sand Prairie Campground. The drainage area of the station is 258 square miles and includes both the Upper Middle Fork Willamette Watershed and the MFWDT Watershed with the headwaters originating in the Diamond Peak Wilderness. Analysis of water years 1959 through 1993 provided the following insights and information.

Flood frequency by month reveals the number of streamflow peaks greater than 3,500 cubic feet per second (cfs) occurring within the watershed. The USGS has determined that 3,500 cfs represents a flood given the morphology of the channel. The period of record shows that more than half of the floods took place in December and January, and that roughly another one-third of the floods occurred in March and April as can be seen in Figure_____. The largest of the floods occurred in December 1964 where precipitation initially fell as snow, then temperatures warmed and were followed by heavy precipitation, melting snow below 5,000 feet(Waananen, Harris, and Williams, 1971).

Figure___. Flood Frequency Greater Than 3,500 cfs on MFW, 14144800



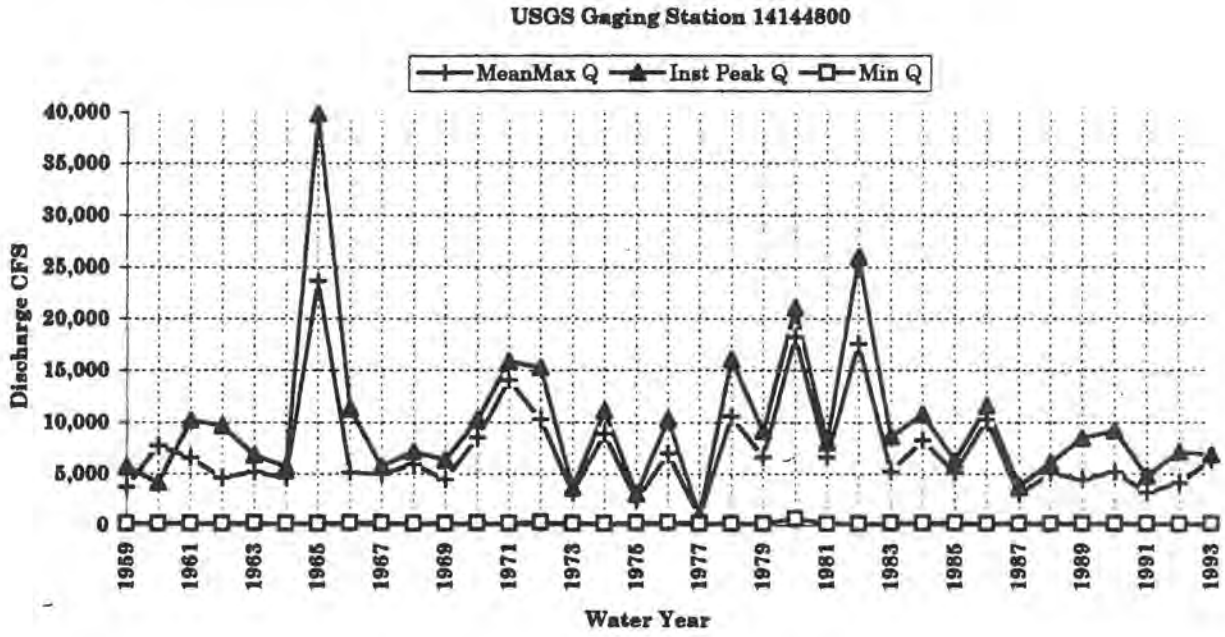
Instantaneous peakflows, mean daily maximum flows and minimum flows for the period of record are shown in Figure____. The maximum instantaneous peakflow for the period of record took place in water year 1965 on December 22, 1964 reaching an instantaneous peak flow of 39,800 cfs. The mean maximum daily discharge for that storm was 23,700 cfs. A recurrence interval (RI) was developed from the mean maximum annual flood events for the period of record using the Log-Pearson Type III Duration-Frequency Analysis. The RI for the <u>mean maximum flow</u> of the 1964 flood event is roughly 50 years (see Beilharz et al., 1991. <u>Instantaneous peak flow</u> recurrence intervals were developed for this

gauging station, 14144800, by Harris et al. in 1979 and include the following values:

Instantaneous Peak Flow Recurrence Intervals, 14144800

Recurrence Interval	Discharge (cfs)
2 year	8,140
5 year	13,700
10 year	18,300
25 year	24,900
50 year	30,600
100 year	36,900

Figure___. Hydrograph for the Period of Record, Station 14144800



Other notable flood events occurring in the Willamette River Basin prior to this period of record include: 1861, where the flood event exceeded the 1964 flood in magnitude; 1890, where the flood was of slightly lesser magnitude than the 1964 event; in addition floods of a smaller magnitude took place in 1923, 1945, and 1955 (Waananen, Harris, and Williams, 1971).

Hydrologic Character

Within this watershed the hydrologic character of the geology and soil combine with the climate to create the following:

- the greatest quantity of total monthly flow, as seen for the averaged period of 1964-1993, occurs from December to May, peaking in December and January (see Figure____, Average Total Discharge by Month for 1964-1993, MFW River).

- the greatest frequency of flood events, larger than 3,500 cfs, occurs in December and January (see Figure___, Flood Frequency Greater than 3,500 cfs on the MFW). And although the frequency of flood events is on the decrease from February to May, the total discharge for those same months remains fairly high and constant (see Figure___, Average Total Discharge by Month for 1964-1993, MFW River).

- Higher flows in March and May are likely in response to snowmelt occurring below 4,000 feet, on the south slope and north slopes respectively. See both the Spring Season Flow Figure and Table and the Figure ___, on Average Total Discharge by Month for 1964-1993, MFW.

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Figure____. Average Total Discharge by Month for 1964-1993, MFW River.

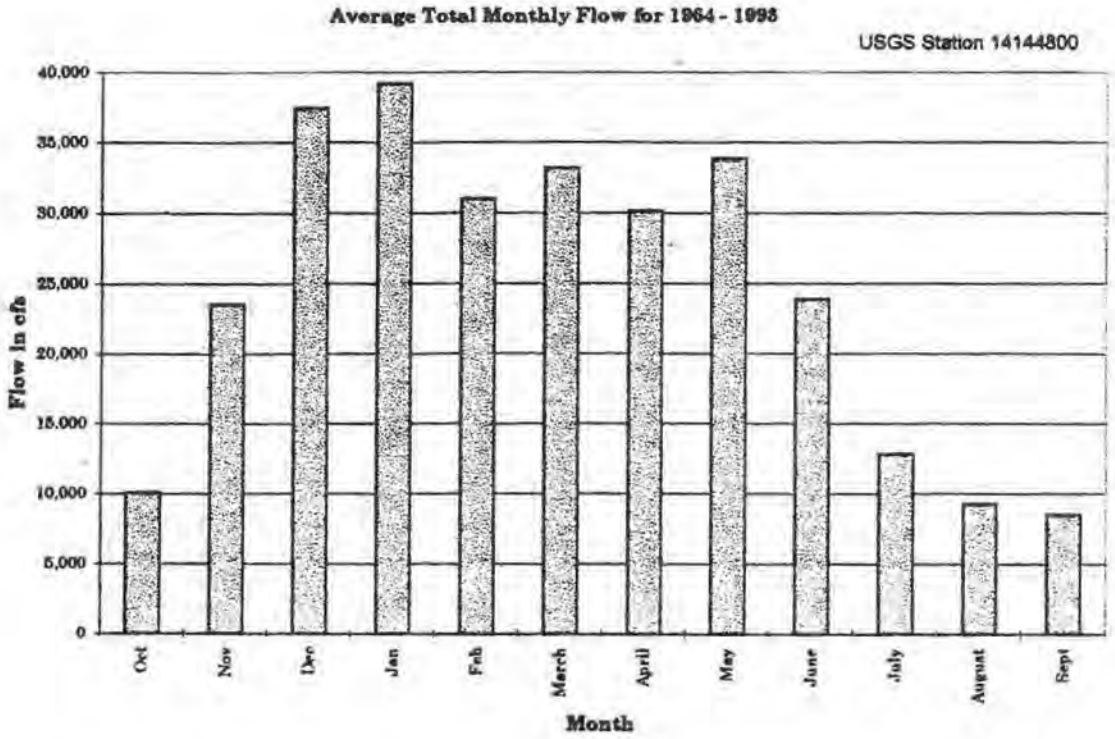
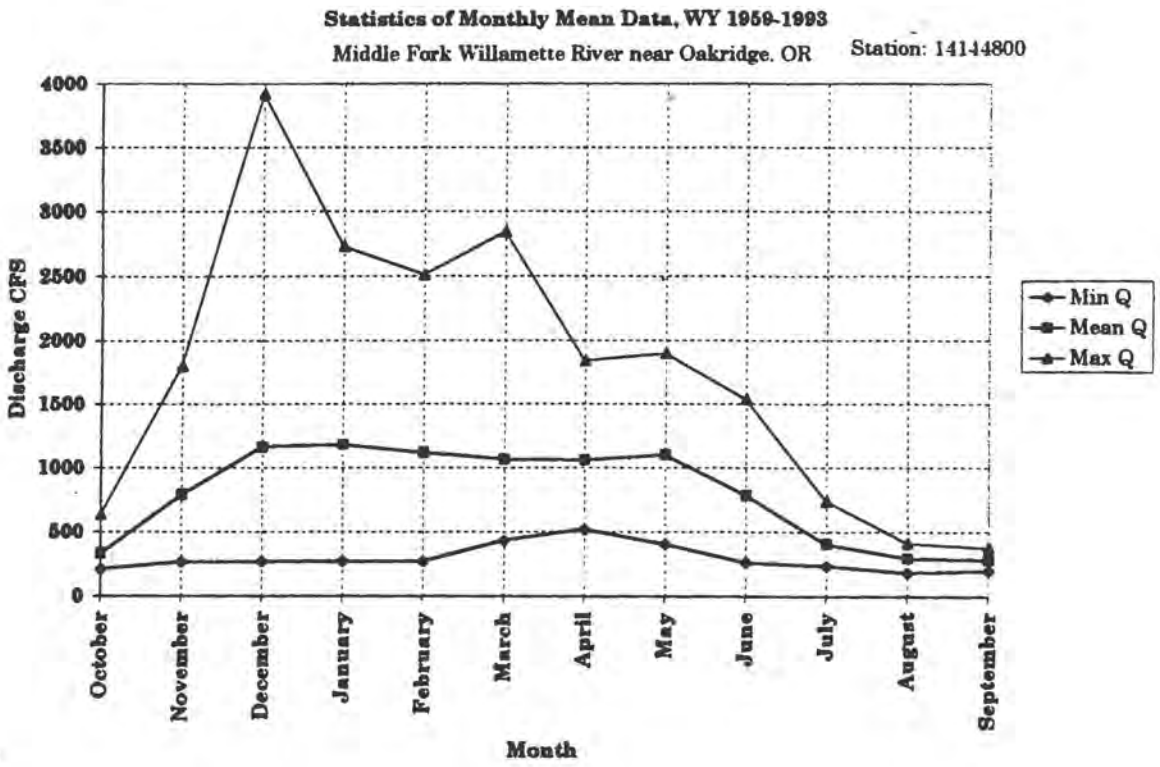


Figure____. Variance of Mean Discharge by Month for the period of record.



Temperature Regime

Valerie Rogers, Hydrologic Technician

Prior to timber management activities dominating the MFWDT Watershed, the MFW river was characterized by cool water temperatures year round. Temperature measurements taken during the 1937 US Bureau of Fisheries (USBF) survey reveal water temperatures ranging from 50 Fahrenheit (F) near Simpson Creek, immediately upstream of the Watershed boundary, to 58 F near Coffeepot Creek. Table ____ shows water temperature measurements, measurement time, and location of the readings by the USBF.

Table____. 1937 Water Temperatures MFW River

Location	Date	Time	Sky	Air Temp F	Water Temp F
MFW/Simpson	9/3	14:30	P.cloudy	67	50
MFW/Estep	9/2	16:10	Fair	68.5	56
MFW/Coffeepot	8/28	16:40	Fair	64	58
MFW/Modoc	8/31	17:00	Fair	62	57

The late afternoon/late summer timing of these measurements is past the usual peak summer temperatures which occurs from late July through mid August. Thus these values can be expected to be slightly lower than the maximum summer water temperature for 1937, but provide a good indication of the reference condition. In addition, some riparian harvest along the MFW may have occurred by 1937 influencing water temperatures and what we are considering to be the undisturbed condition.

It is likely the temperature of most tributaries was slightly cooler than the mainstem of the MFW due to the greater amount of canopy closure and the overall higher elevation of the tributaries. During the Bureau of Fisheries survey, temperatures were measured at the mouths of three tributaries spaced in the lower, middle, and upper sections of the Watershed (see Table___).

Table____. 1937/38 Water Temperatures in Tributaries of MFW River.

Location	Date	Time	Sky	Air Temp F	Water Temp F
Simpson Cr	9/12	na	na	70	52
Buck Cr	7/10	na	na	70	54
Hills Cr	9/11	14:30	Clear	70	57

These values average 54.3 F, one degree cooler than the mainstem at 55.25 F. The data suggest a general trend of increasing temperatures in the downstream direction for both the mainstem and tributaries.

MFW River Stream Temperatures 1959-1987

Natural disturbance processes such as fire, debris flows, windthrow, and disease have periodically altered the thermal regime in various parts of the drainage network, primarily through tree mortality. Temperature conditions in the Watershed overall however remained favorable for salmonids (~58) as evidenced by observations of "fair numbers" of rainbow, cutthroat, dolly varden (bull trout), and chinook reported in the 1937 USBF survey.

Temperature is a highly variable ecosystem element which can be characterized in many different ways. The following discussion of current temperature conditions is based primarily on a qualitative evaluation of available data.

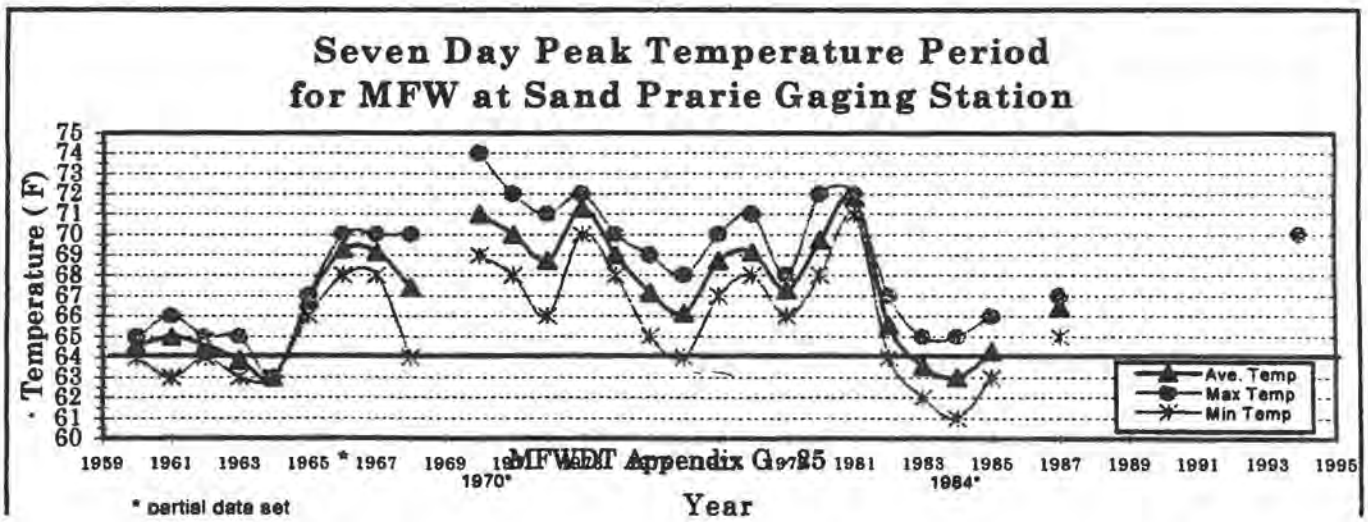
From an overall watershed perspective, temperature values in the mainstem MFW river are important to consider. Conditions in the mainstem reflect the integration of several factors which affect stream temperatures in the entire drainage network upstream of the sample location. These include broad scale factors such as elevation, air temperature, and seasonal solar radiation as well as fine scale factors such as flow, substrate, and canopy characteristics.

Data is available from a USGS gauging station located at Sand Prairie just above the upper extent of Hills Creek Lake. Temperature at this location is partially affected by temperatures in upstream tributaries outside the boundary of this watershed, and likewise is unaffected by temperatures in several downstream tributaries which drain directly into Hills Creek Lake. Daily max/min values have been recorded nearly continuously from 1960 to 1987. This period of record encompasses about half the period of intensive forest management.

Seven Day Peak Period

Figure_A_ displays the annual variation in the "seven day peak period", a temperature parameter of biological importance for cold water fish (DEQ 1994). The average, maximum, and minimum values for the peak period are shown for each year. The average values range from 63 degrees in 1964 to 72 degrees in 1980. The recommended maximum for the average value during the seven day peak period is 64 degrees. The data show only four years in which the average value has not exceeded this magnitude.

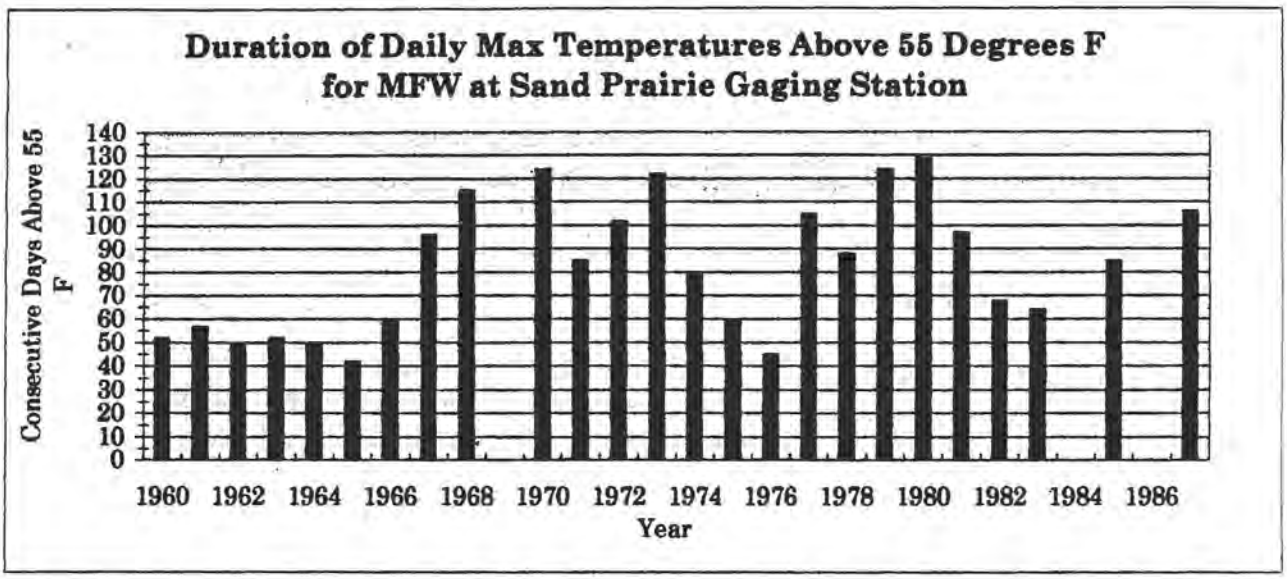
Figure_A._ Seven Day Peak Temperature Period for MFW at Sand Prairie Gauging Station.



Number of Days With Stream Temperatures above 55F

Another view of the temperature regime of the MFW at this location is shown in figure_B_. For Chinook salmon, 55 degree is at the upper boundary of the range of satisfactory conditions for adults and near the middle of the range for juveniles (DEQ 1994). The number of consecutive days in which maximum temperatures were above 55 degrees ranged from 42 in 1964 to 128 in 1980. Although not tied to a specific water quality requirement, this view of the data reveals a potential biological concern related to the duration of low level temperature stress.

Figure_B_ Duration of Daily Maximum Temperatures Above 55 Degrees F for MFW at Sand Prairie Gauging Station.



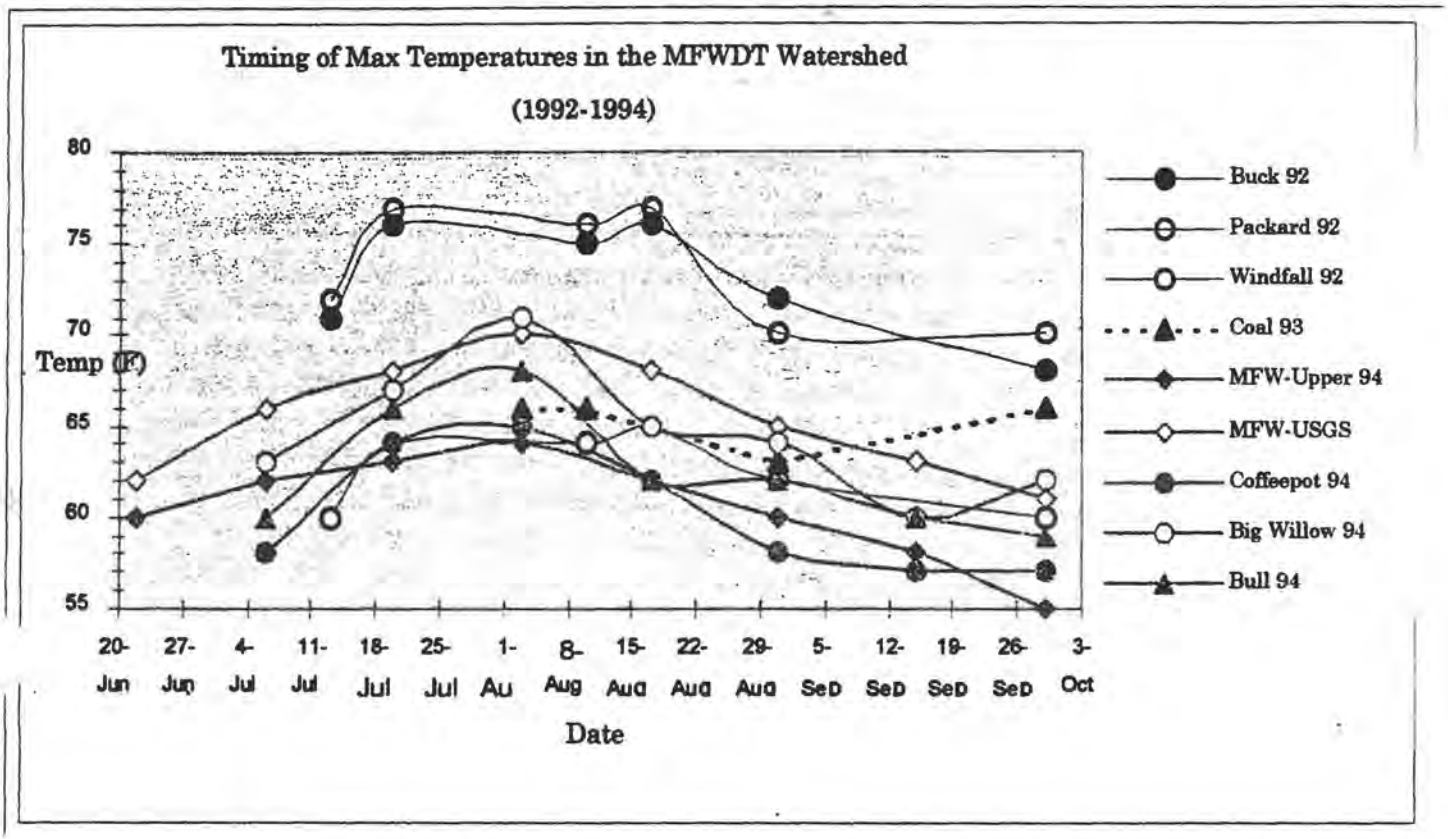
Together, figures _A_ & _B_ show some evidence of an overall increase after 1965 in both the magnitude and duration of seasonal high temperatures. The timing of these two measures however does not appear to be closely linked. For example, in 1979 the duration of daily maximum temperatures greater than 55 degrees was relatively long (124 days), while the magnitude of the average peak temperature was relatively low (67.5 degrees).

MFW River & Tributary Stream Temperatures 1992-1994

Additional data has recently been collected for several tributaries in the MFWDT watershed. Temperature was monitored with min/max thermometers placed near the mouth of each tributary. Two locations in the mainstem MFW were also monitored, including the original USGS gauging station site and a site near the upper watershed boundary. Figure _C_ presents a summary of the monitoring results. Although displayed collectively, direct comparison is valid

only for locations sampled with the same interval in the same year. These groups are indicated by different linetypes in the figure.

Figure_C Timing of Max Temperatures in the MFWDT Watershed



Overall the data shows seasonal maximum temperatures tend to occur between late July and late August basin-wide. This timing is consistent with the 27 year period of record from the USGS gauging station and reflects the influence of regional climatic patterns. The type of data does not allow computation of the seven day average peak temperature, however it is reasonable to expect this standard is often exceeded throughout the watershed. The combined monitoring results show single maximum temperatures greater than or equal to 64 degrees have occurred in all locations and years for periods of up to eight weeks although not necessarily continuously.

Extremely high temperatures were recorded at two sites monitored in 1992. Maximum temperatures ranged from 76 to 68 degrees in Buck Creek and from 77 to 70 degrees in Packard Creek. During the latter six weeks of the season, different types of cooling trends developed in the two creeks as shown by the different slope of the lines in figure _C_. The pattern of maximum temperatures in Windfall Creek in 1992 was similar to Buck Creek but the range of values

was much lower, between 65 and 60 degrees. This difference likely reflects differences in factors operating at a sub-basin scale.

Five other sites were monitored in 1994 including the USGS gauging station site. In the context of the entire period of record, the seasonal maximum temperature recorded at this site in 1994 is one of the higher values (see figure_A_ above). Thus the monitoring data from 1994 represent temperature conditions in a comparatively warm year. The range of values among these sites was less extreme than among the 1992 sites. This difference could be explained by the change in location or the change in year or a combination of these factors.

The widest range of maximum temperatures for a single location in 1994 occurred in Big Willow Creek. Maximum temperatures ranged from 60 to 71 degrees and a warming trend of 2 degrees occurred in the last two weeks of the season. A similar warming trend of 3 degrees occurred in Coal Creek during the last four weeks of the 1993 summer season. This trend did not occur at the other sites monitored in 1994. Between the two sites on the MFW river, the overall pattern of seasonal maximum temperatures is similar reflecting broad scale influences, but the range of values is different, reflecting fine scale influences. Between the two locations, the river is likely receiving inputs of relatively warm water from tributaries. The channel drops 400 feet in elevation and also increases in width and thus is less shaded.

Canopy Closure and Stream Temperature

The relationship between canopy closure and stream temperatures has been extensively studied and reported in the scientific literature (Brown and Krygier 1970, Beschta and Taylor 1988). Results have tended to show a positive correlation between reduced canopy closure and increased temperature. However, the magnitude of change can vary widely depending on site-specific characteristics. Table _1_ presents a sub-basin summary of the percentage of perennial stream miles directly impacted by harvest in the past 35 years along with recently recorded temperature data. Intermittent streams were not included because they are unlikely to contribute to seasonal maximum water temperatures since they generally do not flow above the surface during summer.

Table_1_ Percent perennial stream harvested with max recorded stream temperature.

Subwatershed	Stream	% Perennial Harvested	Max Water Temp (Fahrenheit)	Date
21-1	Gray	8.5		
21-1	Shortridge	0.0		
21-2 west	Larison	14.6		
21-2 west	Packard	56.2	77	1992
21-2 west	Stony	100		
21-2 west	Snow	14.5		
21-2 east	Modoc	20.8		
21-2 east	Bull	19.9	68	1994
21-2 east	Little Willow	0.0		
21-2 east	Big Willow	42.0	71	1994
21-2 east	Coffeepot	25.0	65	1994
21-3 west	Windfall	30.0	65	1992
21-3 west	Gold	26.6		
21-3 west	Bohemia	46.6	* 63	1993
21-3 west	Snake	28.6	* 64	1990
21-3 west	Spring Butte	46.9		
21-3 west	Indain	33.0		
21-3 east	Buck	23.9	76	1992
21-3 east	Estep	38.2		
21-3 east	Pine	26.6		
21-3 east	Youngs	16.7	64	1990
21-4 south	Coal	22.8	66	1993
21-4 north	Deadhorse	26.8		

The available data seems to shows no consistent relationship between the two parameters. However, the data is inadequate to meaningfully assess the relationship as the maximum sample size for any year is three. The relationship also may be obscured and difficult to detect at this intermediate scale.

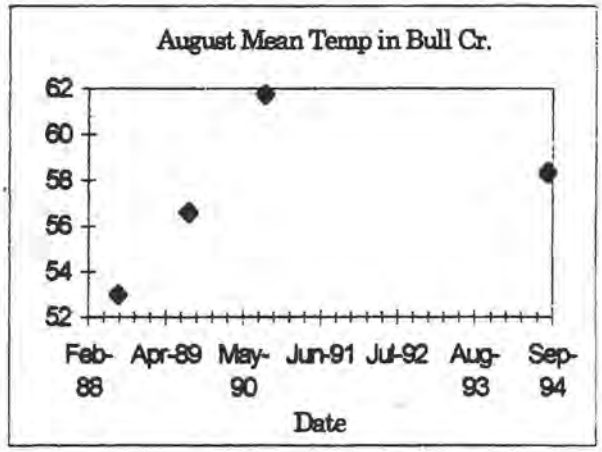
A review of available data for Bull Creek provides some indication of how temperature conditions change in a small tributary after a major disturbance (1988 Shady Beach fire and subsequent salvage logging). The August mean temperature in Bull Creek prior to disturbance was estimated to be 53 degrees. An increase of 1.5 degrees was predicted to occur after the fire and logging activity (Shady Beach Fire Recovery Project Final EIS 1989). Table_2_ and figure_2a_ show the August mean temperature for Bull Creek in 1989, 1990, and 1994. Although some samples are quite small, the data indicates August mean temperatures have increased as much as four times the predicted amount

but may be decreasing. Bull Creek provides habitat for tailed frogs which are sensitive to temperatures above 66 degrees.

Table_2_ August Temperatures in Bull Cr.

Bull Creek Summary						
DATE	TIME	TEMP	MAX T	MIN T	MEAN	SAMPLE
1988					53	estimate
Aug-89	from hourly data				56.6	n = 120
8/6/90	1340	64				
8/13/90	1240	62				
8/20/90	1200	61				
8/27/90	1235	60			61.75	n = 4
8/4/94	945	58	68	55		
8/18/94	1120	56	62	55		
8/31/94	1105	55	62	54	58.333	n = 9

Figure _2a_ August Mean

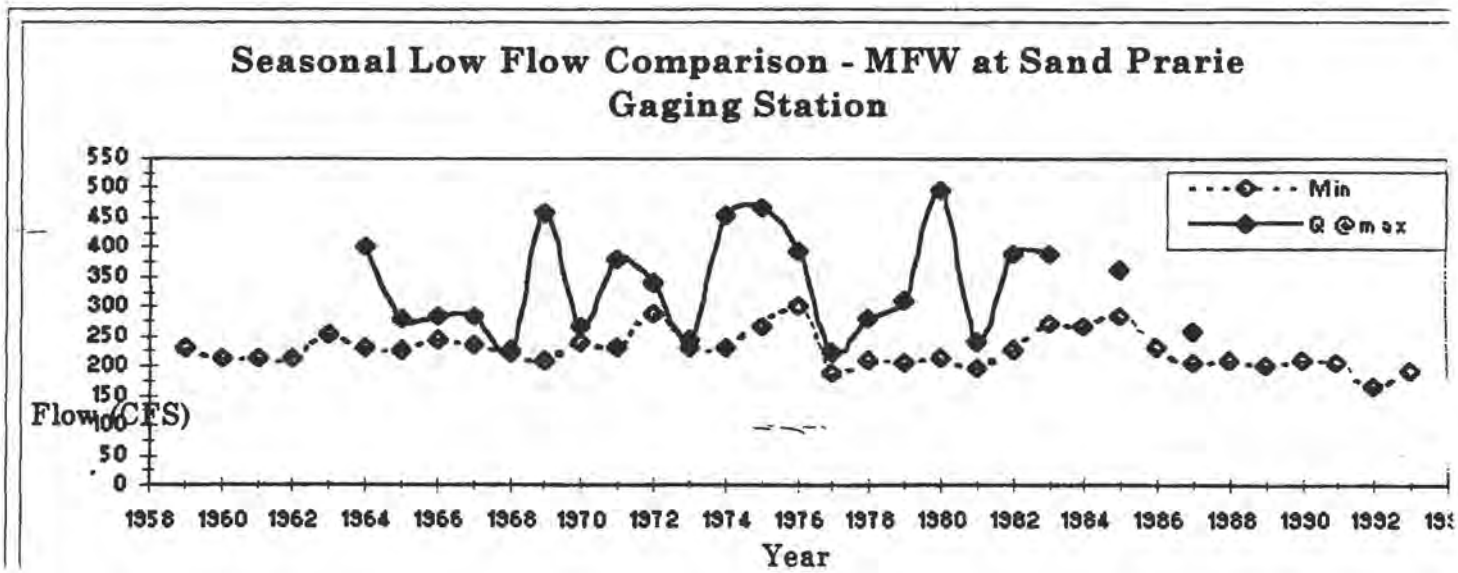


Temperatures in Bull Cr.

Temperature Interpretations

Seasonal variations in flow, air temperature, and solar radiation have a combined influence on summer stream temperatures. Suitable air temperature data was not readily available for this analysis. However an examination of seasonal low flows in conjunction with seasonal maximum temperatures was made. Figure _D_ compares the volume of discharge which occurred on the date of maximum temperature to the minimum discharge for the year.

Figure _D_ Seasonal Low Flow Comparison for MFW at Sand Prairie Gauging Station.



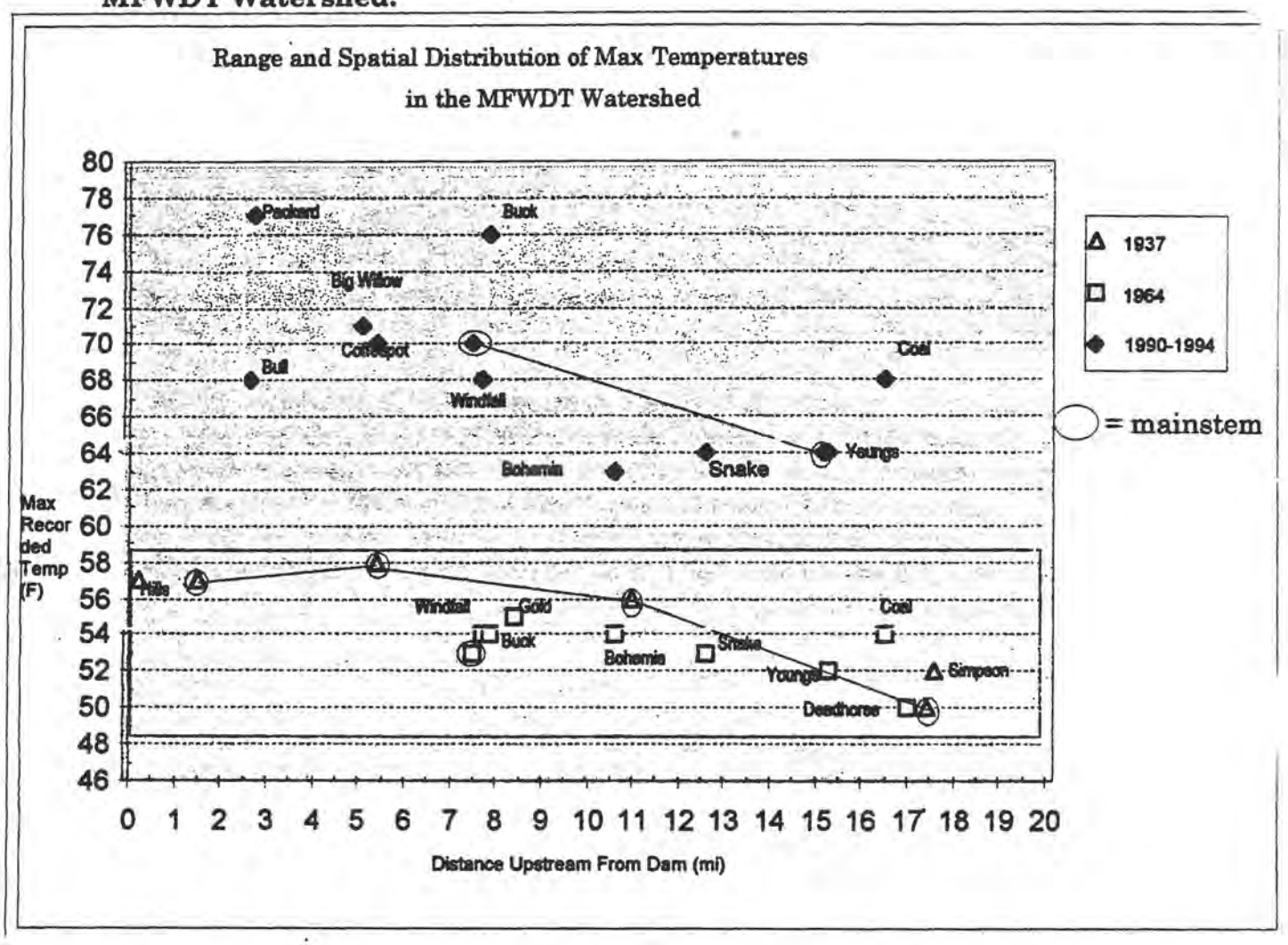
In some years, such as 1968, 70, 73, 77, and 81, the timing of seasonal low flows and seasonal maximum temperature was fairly concurrent. In other years such as 1964, 69, 74, and 80, the seasonal maximum temperature was attained when flow was approximately double the seasonal minimum. A review of Figure _A__ in the Current Conditions chapter reveals that in most of the years when low flow and high temperature occurred concurrently, the average seven day peak period temperature was relatively high. On the other hand, in 1980 when the timing of these two factors was not at all concurrent, the seven day average perk period temperature was not particularly low. Concurrent low flow may tend to increase peak temperatures, but higher flow may have a comparatively smaller effect on reducing peak temperatures, especially in a wider mainstem channel naturally exposed to solar radiation.

Yearly variation in weather patterns and corresponding fluctuations in stream temperature occur naturally. Likewise, both natural and human-related variation in characteristics such as canopy closure and substrate material occurs across the landscape and is reflected in different temperature conditions. Aside from the influence of long term climatic change however, the overall range of variability across a watershed tends to remain relatively stable through time, both with respect to the spread and to the center of the range.

Comparison and Extrapolation

Comparison and extrapolation of maximum stream temperatures from late summer/early fall stream temperatures was done using the 1990 to 1994 stream temperature data set. Figure _E_ was constructed from limited available data from three decades to portray the range of variability in temperature conditions of the MFWDT watershed. Data for 1990-1994 is the same as that found in Table _1_ and represents the maximum recorded temperature at a given location during that time period. It was necessary to aggregate the values in order to have a data set to reasonable size and to include as many of the same locations as possible from previous decades. Most of this data is from min/max thermometers and thus represents true maximum temperatures. Data from the other two decades is entirely grab samples. Only samples taken at a time of day and season as close as possible to the usual timing of seasonal maximum temperatures were included in the graph. Nevertheless these data points are almost certainly below the true seasonal maximum. They were collected during the first week of September when air temperatures were considerably lower than summer highs. (See appendix __ for relevant raw data). The shaded area of the graph which highlights the range of these values should therefore be adjusted upward, perhaps by approximately six degrees F as seen in the center of the graph. This would put the upper boundary of the range at 64 degrees which is generally consistent with the temperature tolerance of salmonids.

Figure_E_ Range and Spatial Distribution of Max Temperatures in the MFWDT Watershed.



With these considerations in mind, rough comparisons can be made. The upper end of the range from earlier decades slightly overlaps the lower end of the range in the 1990's. This suggests the center of the range has shifted upward significantly. The range of recorded temperatures is 14 degrees in the contemporary decade and 8 degrees in the earlier decades which suggests the amount of variability has increased. In terms of the spatial distribution of maximum temperatures, there is a slight general pattern of decreasing temperatures in the upstream direction in earlier decades for both the mainstem and tributaries. In the 1990's, the pattern is present for the mainstem but is scrambled for many tributaries.

Buck Creek shows the <u>single most extreme change in maximum</u> recorded temperature, an increase of 22 degrees. Stream temperatures are thought to reach a theoretical upper limit near the maximum average air temperature for a given region and elevation (MacDonald, Smart and Wissmar 1991). In the

Western Cascades, maximum average air temperatures at 2000 feet (the elevation at the mouth of Buck Creek) were found to be around 74 degrees. Thus the high value recorded in 1992 may be near the theoretical maximum at this location. In contrast, in 1937 the stream temperature in Buck Creek was 54 degrees when the air temperature was 70 degrees. This suggests there has been a substantial decline in the moderating influence of the riparian zone on the thermal regime of Buck Creek.

Life History Stages - Spring Chinook and Bull Trout

The following figures F and G present a view of the range of temperatures required during different life history stages for Spring Chinook salmon and Bull Trout along with a plot of daily min/max temperature recorded in 1973-1974 at the Sand Prairie gauging station. These years were chosen because they are the most recent two years without a temperature data gap. A review of figure A in the Current Conditions chapter shows these to be relatively though not uncommonly warm years. Life stage indicators were redrawn from originals created by Dave Buckanan (DEQ 1994).

Figure F Annual Temperature Regime of MFW at Sand Prairie with Temperature Requirements of Spring Chinook Life Stages

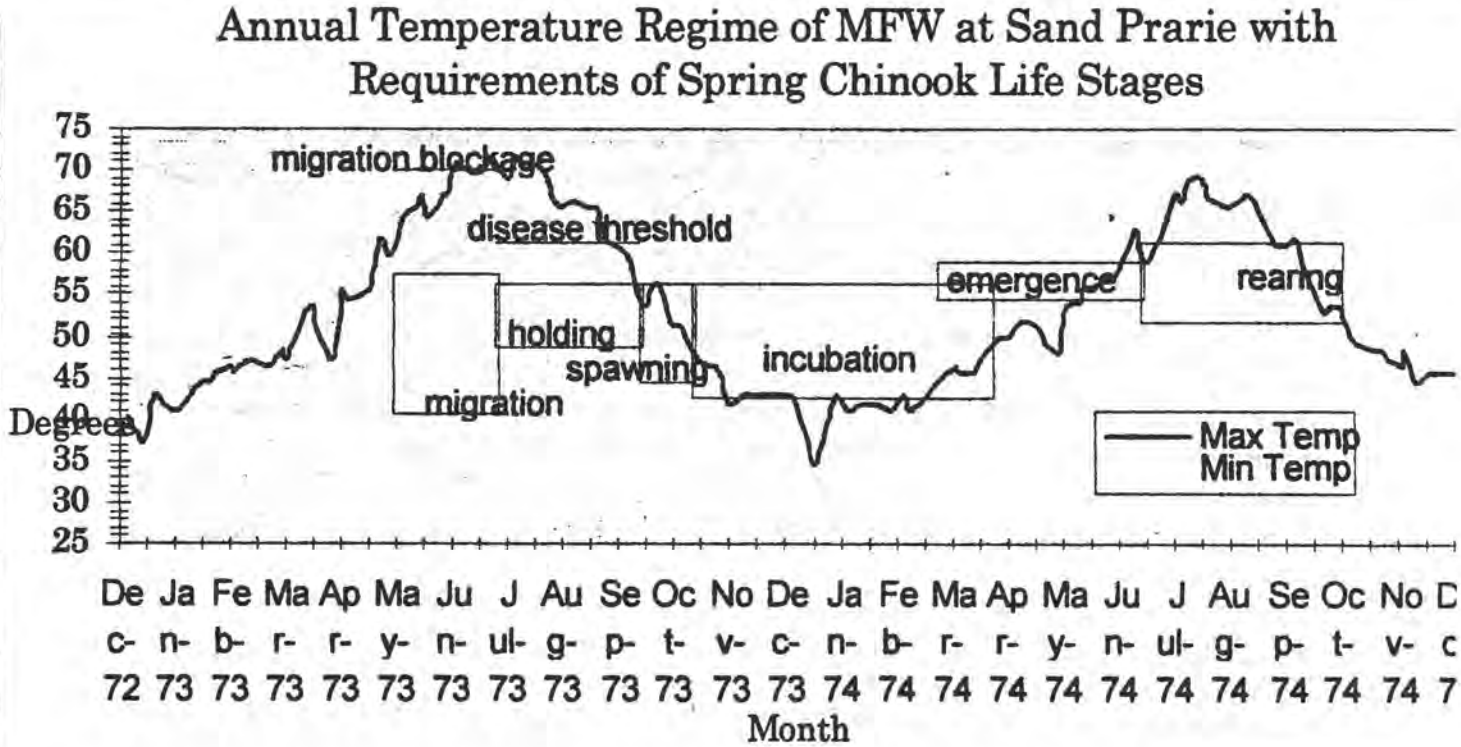
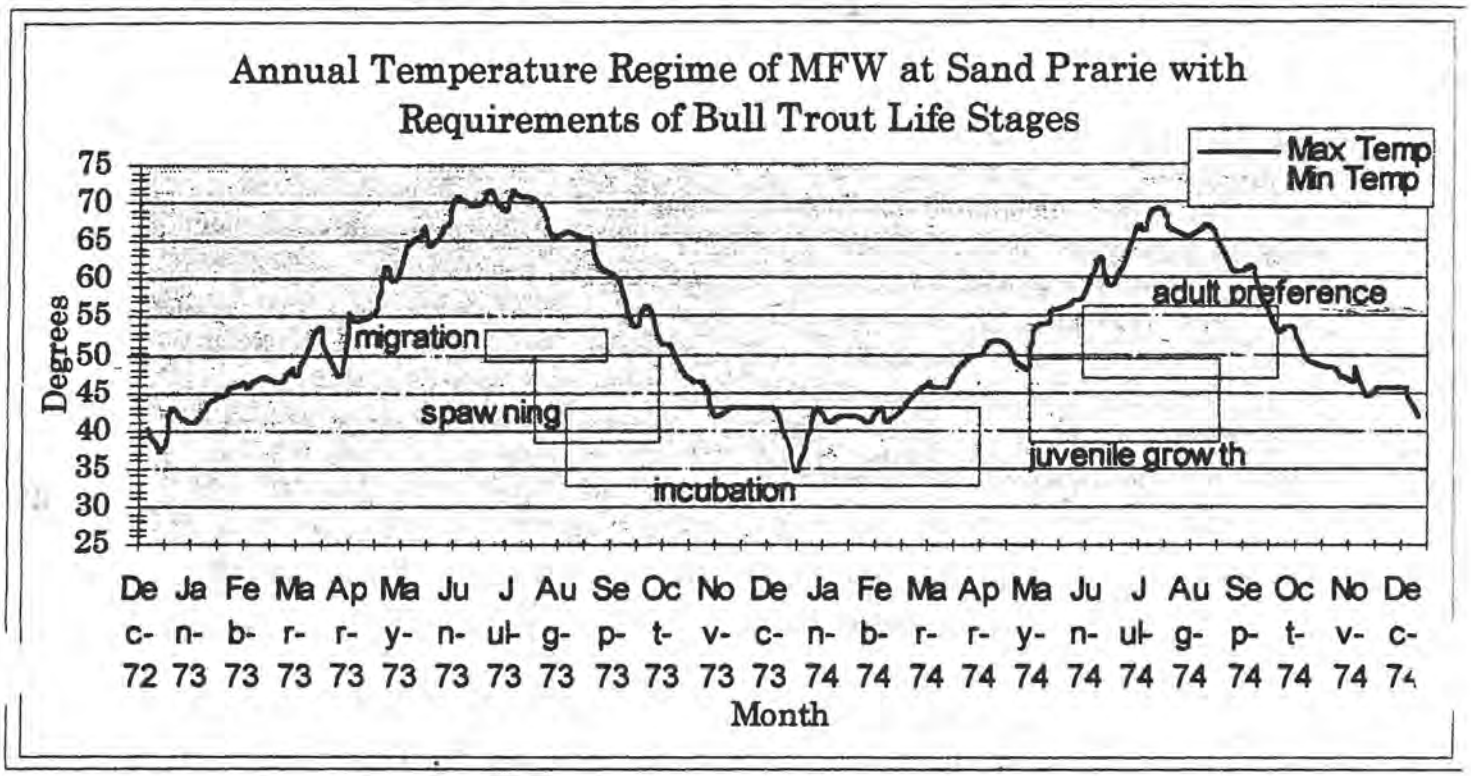


Figure G Annual Temperature Regime of MFW at Sand Prairie with Requirements of Bull Trout Life Stages



It is clear that summer maximum temperatures are well outside the suitable range for adult and juvenile summer life stages of both species. The situation is acute for adult Chinook salmon during the holding stage when even daily minimum temperatures approach the threshold at which common diseases become more virulent. The minimum temperatures are also above the suitable range for Bull Trout migration, spawning, and juvenile growth. In the case of Chinook, cooler than optimum temperatures also occur at other times of the year. This is perhaps not surprising since this part of the MFW was historically near the upper part of the species' range. However an estimated 750-1000 spawners were observed in this part of the river in September 1937 so temperature conditions were not entirely unsuitable.

Concepts of natural selection imply that the range of environmental conditions will not frequently be far outside the range of suitable conditions for species which have naturally adapted to that environment. Thus the range of biologically suitable conditions for naturally adapted organisms is a conservative approximation of the natural range of variability in environmental factors for a given place and time. This biological evidence of intolerable conditions for several life stages of two historically present species provides strong support for

the claim that the temperature regime in this part of the MFW is outside the previous range of natural variability.

Temperature Conditions Conclusion

There is enough evidence of potentially frequent widespread occurrence of abnormally high summer temperatures to warrant concern, investigation, and corrective action. Vegetation manipulation is a likely causal factor, but available data is inadequate to determine the magnitude of its direct impact and interaction with other factors.

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Brown, G. W. and Krygier, J. T. 1970. Effects of clear-cutting on stream temperature. Water Resources Research, 6: 1133-1139.

MacDonald, L. H., Smart, A. W., and Wissmar, R. C. 1991. Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska. Environmental Protection Agency and Center for Streamside Studies. Seattle, Washington. EPA 910/9-91-001.

USDA Forest Service Pacific Northwest Region. 1989. Shady Beach Fire Recovery Project Final Environmental Impact Statement. Rigdon Ranger District. Oakridge, Oregon.

DEQ Oregon Department of Environmental Quality 1994. Temperature Draft Issue Paper. 1992-1994 Water Quality Standards Review. Portland, Oregon.

H

Appendix H

Vegetation Documents

Appendix H1
Blowdown Patterns
in the Middle Fork Willamette Downstream Tributaries of the Willamette River

Jerry English, Forestry Technician

1995

Blowdown disturbance to timber stands predominantly comes from two types of windstorms. One is an East wind pattern. This occurs when a low pressure area develops near the Oregon coast, when there is a high pressure area located East of the crest of the Cascade Mountains. As the two systems try to equalize air pressure, the air moves from the East side to the area West of the Cascades. This air flow readily follows east to west water drainages, that have cut through the mountains. The velocity of this wind increases as it drops in elevation. The elevation drop is from approximately 5,000 feet at the crest to approximately 1,500 feet near Hills Creek Lake. Where there are no drainages, the air tends to flow westerly across the top of the landscape. As the air moves to the west, it slows down the closer it gets to the low pressure area. Therefore wind velocities are generally highest in the westerly oriented drainages and along the tallest ridges, in the areas nearest the crest of the Cascades. The Middle Fork Willamette Downstream Tributaries area is somewhat insulated from these wind patterns as Diamond Peak (8,744 feet), Groundhog Mountain., Logger Butte, and Warner Mountain. (all near 6,000 feet) are high enough to block most of the airflow from moving directly down to the Middle Fork in this analysis area. Only extreme weather patterns have high enough winds to affect the lower elevations of this area and cause extensive blowdown. The last time this occurred was on December 23, 1983. Most of the blowdown from all but the extremes of this type of wind pattern has been near the Groundhog Mountain., Logger Butte, and Warner Mountain. areas. Some blowdown from this wind pattern has occurred along the higher elevations of the Calapooya Divide on the west side of this analysis area. However the impact from this airflow pattern is not as high as it is further from the crest of the Cascades and the winds are not as strong. The high winds of the storm in 1983 blew down some patches of timber near twenty acres in size in the Young's Creek Drainage of this analysis area. Approximately 2,000 MBF of timber was salvaged from this area as a result of that storm.

The other type of windstorm that occurs is from winds circulating around low pressure systems moving inland from the Pacific Ocean. Wind velocities from this type of storm range from low to very high, depending on the strength of the system. As with the East wind pattern, wind velocities tend to be highest near the tops of the ridges. Wind direction is usually from the south or west, but can be from any direction. This can happen because the winds are always circulating around the

center of the low pressure system. Wind direction depends on where your location is in relation to the center of the system. Winds from these systems generally are not as strong in the Middle Fork Willamette Downstream Tributaries as they are on the coast because the systems tend to lose energy as they leave the Pacific Ocean and move inland. In the area of the Middle Fork Willamette Downstream Tributaries the strongest winds usually come from the west or south because winds from other directions occur when the system has moved farther inland and lost some of its strength.

Some of the blowdown that occurs happens in very localized areas. The winds in this area are much more intense than in most areas of the general storm. This results in blowdown in a small area, whereas the winds over the rest of the forest were not strong enough to blow trees down. The winds in these storms also occasionally seem to swirl, blowing down trees in one area and then skipping over part of the forest to blow down trees in another location. This swirling action sometimes blows the trees down in directions different than the prevailing wind pattern, resulting in a crisscrossed jumble of trees.

Blowdown patterns from both of these windstorms usually occur along the edges of new openings. Most of the new openings in this analysis area are from timber cutting units. The trees in timber stands in this area grow up close together and their crowns tend to support each other, keeping the trees from getting bent over very much. One of the functions of the roots of a tree is to hold the tree upright. These root systems develop partly in response to the stresses put on the upper part of the tree, so the roots only develop to support the tree for the stresses it normally experiences. During timber harvest the trees left within the cutting unit and the trees along the edges of the cutting units lose the support of the adjacent trees. Until they can develop a larger and stronger root system in response to the increased wind stress, they are susceptible to being blown down during a windstorm event. It usually takes at least 5 years for a tree to become more windfirm.

Trees are susceptible to being blown down in two ways. One is when the root system is not capable of holding the tree upright from the force of the wind. Trees that have bigger crowns intercept more wind and have a higher chance of being blown down. Trees are also blown down when there is a weakness in the stem of the tree. During a windstorm the bole of a tree can break, with the root system still holding the lower portion of the tree below the break upright, while the upper portion falls to the ground. Most of the weaknesses in the trees in this analysis area are from various rotting fungi that weaken the wood in the bole of the tree, although there are a small number that attack the roots of the trees. Trees with smaller crowns, sound stems and root systems have a better chance of withstanding a windstorm.

Soil conditions also affect the ability of trees to withstand wind. In areas where the soil is shallow, a trees roots can not grow down to a sufficient depth to provide the support necessary to keep the tree upright. Soil moisture content also affects the strength of the root system. The higher the soil moisture the lower the root holding strength of the soil. Soil moisture is normally higher during the winter and spring, the moisture usually coming from the storms off the Pacific that also have high winds. There are also some wet soil areas that collect water and are not well drained, where soil moisture is high for most of the year.

Blowdown also occurs within undisturbed stands of timber. In the Middle Fork Willamette Downstream Tributaries analysis area this is usually isolated trees or very small patches of trees that are defective or located on shallow or wet soils. This type of blowdown is continuous and a natural part of the forest. No larger blowdown areas have been observed in the remaining undisturbed stands (reviews of 1990 photos of area).

The amount of blowdown a stand experiences during a strong wind ranges from only a few trees to almost all trees being blown down. A stand is seldom completely blown down. There are usually a few pockets of trees or scattered individual trees remaining standing, although these have usually suffered some damage to their crowns or boles from the falling of the adjacent trees. Most of the smaller trees and understory are crushed under the larger trees as they fall.

Some of the blowdown salvage sales by subdrainage

SUBDRAINAGE	SALE NAME	YEAR
21 1 Oakridge	Gray Cr. Salvage	1952
	Highway 58 Blowdown	1960's
21-2 Hills Creek Reservoir	Willow Creek Salvage	1952
	Bohemia Creek Salvage	1953
	Little Willow Cr 16A Salvage	1955
	High Noon BD	1968
	Umpqua BD	1968
	Slapdown	1976
	Twist	1977
	Little Rock Salvage	1978
	Bambi Salvage	1985
	Ash Salvage	1988
	Boulder Salvage	1993
	Pot Salvage	1993
	Spiral Salvage	1993
	Knoll Salvage	1994
21-3 Middle Fork Willamette/Little Pine	Buck Creek Salvage	1953
	Buck Cr 4A Salvage	1955
	Strip Salvage	1965
	Tea Creek Salvage	1966
	Umpqua BD	1968
	High Noon BD	1968
	Tally	1977
	Noon Tea	1977
	Flat	1979
	Joe Blow	1979
	Young's Creek Salvage	1984
	High Stew Salvage	1993
	Low Stew Salvage	1993
21-4 Coal Creek	Dumpty	1976
	Day Salvage	1981

Appendix H2
Harvest Treatments by Decade
Middle Fork Willamette Downstream Tributaries

Ginny Tennis, 1995

Decade	Clear-cut 110's Acres		Prep Cut 120's Acres		Shelterwood 130's Acres		Shelterw Remov Overst Remove 141,143 Acres		Selection Cut 150 Acres		Partial Removal 160 Acres		Salvage 230's Acres		Special Harvest 240's Acres	
	NRRA*	RRA*	NRRA	RRA	NRRA	RRA	NRRA	RRA	NRRA	RRA	NRRA	RRA	NRRA	RRA	NRRA	RRA
1930 -	20	5	0	0	0	0	0	0	0	0	161	128	8174	2883	15	0
1940-1949	34	1	0	0	0	0	0	0	0	0	0	0	50	8	0	0
1950-1959	1888	624	0	0	0	0	0	0	0	0	235	53	326	59	326	0
1960-1969	5177	1128	0	0	18	15	40	15	0	0	54	2	123	11	0	0
1970-1979	4460	1349	80	29	199	32	120	0	0	0	16	0	19	1	0	0
1980-1989	6453	1465	0	0	244	32	287	67	0	0	497	193	270	30	0	0
1990-1995	3405	315	0	0	111	13	54	0	0	7	665	150	15	25	0	0
Sub-total Acres	**21,437**	**4,887**	**80**	**29**	**572**	**92**	**501**	**82**	**0**	**7**	**1,628**	**526**	**8,977**	**3,017**	**341**	**0**
Total Acres	**26,324**		**109**		**664**		**583**		**7**		**2,154**		**11,994**		**341**	

NRRA - Non-Riparian Reserve Area
RRA - Riparian Reserve Area

The main portion of the harvest in the MFWDT Watershed started in the late 1940's. with the way the GIS year of origins have been put into the data base the early harvest does not show up until the 1950's.

Clearcutting in the lower elevation Douglas-fir forests was the preferred harvest system. Approximately 63% of the harvest acres were broadcast burned based on GIS data. The 1950's showed the first large harvest of 2512 acres. By the 1960's this had increased to a cut of 6305 acres. A slight decrease to 5809 acres occurred in the 1970's. The peak of harvest quantity was in the 1980's with 7918 acres of removal. From 1990 to present 3720 acres have been removed from the MFWDT. With the present riparian definitions, from the 1950's to 1995 the riparian impacts are shown in the 1970's and have decreased to 9% in the early 1990's.

Sixth field Subwatershed 21-3 was the major clear-cut harvest area from the 1950's until 1990 until a shift to Subwatershed 21-2 was made. Harvesting proceeded from the northern end of the Watershed along the original Road 23 and gradually expanded up the easily accessible areas first. Over a dozen units were harvested in the Willow Creek area in the late forties. Buck and Groundhog had heavy harvest in 1950's and this brought roads up to the eastern boundary of the MFWDT. In the 1950's, harvest started extending up Coffeepot Creek. Grays Creek had 4 units that were harvested in the early 1950's. The lower part of Coal Creek was harvested in the late 1950's and the upper reaches in the early 1960's.

Shelterwood harvesting was initiated in the 1960's with 33 acres treated. The largest number of acres was shown in the 1980's with 276 acres of shelterwood. Shelterwood removal and overstory removal started in the 1960's and peaked in the 1980's with 354 acres of removal. No shelterwood treatments were done in sixth field Subwatershed 21-1.

Partial removal was shown in the 1930's at 289 acres and has varied up to a high of 815 acres in 1990's.

Salvage has taken place but there is no verification on why the pre 1930 acreage is so high. A special harvest was done in the pre-1930's and 326 acres in the 1950's. What the special harvest treatment was is unknown.

Appendix H3
Matrix/LSR Current Conditions
Ginny Tennis, Forester
1995

In response to the timber issue the following information show acreage by GIS stand age, by Management Area Allocation, that may have commodity removal. Acreage do not include allocations closed to commodity removal.

The following chart depicts the terrestrial acres that may be utilized for PSQ. Acreage is given by Subwatershed and by an age range. This does not show the acres from other allocation that may have commodity removal following a catastrophic event. These acreage's will be further reduced by the 15 percent retention area associated with each harvest unit other than thinnings, suitability, buffers for TE&S Species or special habitat protection and any modifications in management along the proposed Wild and Scenic River Corridor and other resource protection needs as identified in the future. The scenic disturbance restrictions given to give a sense of the appropriateness of entering those allocations for commodity removal.

I. Matrix stand acres outside of Riparian areas and outside of 100 acre owl circles.

Land Management Plan Designation	Disturbance Restriction	Stand Age from GIS Year of Origin (Rounded Available Acres >1 ac) by years							Total Acres by LRMP
11a Scenic Modification Middleground	**<24% disturb =<4.5' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	**81-200**	**200+**	
Sixth field 21-1		0	0	0	0	0	0	0	0
Sixth field 21-2		164	380	137	683	254	6	310	1934
Sixth field 21-3		72	141	222	344	221	36	733	1769
Sixth field 21-4		0	11	0	15	0	0	0	26
Total Acres for MFWDT and Tributaries		**236**	**532**	**359**	**1042**	**475**	**42**	**1043**	**3729**
11c Scenic Partial Retention. Middle	**<20% disturb +<15-20' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	**81-200**	**200+**	
Sixth field 21-1		0	0	0	0	0	0	0	0
Sixth field 21-2		843	332	23	127	16	51	665	2057
Sixth field 21-3		74	153	50	38	86	35	439	875
Sixth field 21-4		0	26	0	16	2	69	46	159
Total Acres for MFWDT and Tributaries		**917**	**511**	**73**	**181**	**104**	**155**	**1150**	**3091**

Land Management Plan Designation	Disturbance Restriction	Stand Age from GIS Year of Origin (Rounded Available Acres >1 ac) by years							Total Acres by LRMP
11d Scenic Partial Retention. Foreground* * contains Proposed Wild And Scenic River Portion	**7% 1st 10 years of plan <14% disturbance=<10-15' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	**81-200**	**200+**	
Sixth field 21-1		0	0	0	0	0	0	0	0
Sixth field 21-2		0	0	0	0	0	0	79	79
Sixth field 21-3		33	84	77	58	268	52	894	1466
Sixth field 21-4		15	11	36	42	0	56	153	313
Total Acres for MFWDT and Tributaries		**48**	**95**	**113**	**100**	**268**	**108**	**1126**	**1858**
11e Scenic Retention Middleground	**7% 1st 10 years of plan <10% disturbance=<15-20' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	**81-200**	**200+**	
Sixth field 21-1		0	34	17	0	0	10	16	77
Sixth field 21-2		0	0	0	0	0	0	0	0
Sixth field 21-3		0	0	0	0	0	0	0	0
Sixth field 21-4		0	0	0	0	0	0	0	0
Total Acres for MFWDT and Tributaries		**0**	**34**	**17**	**0**	**0**	**10**	**16**	**77**
Land Management Plan Designation	**Disturbance Restriction**	**Stand Age from GIS Year of Origin (Rounded Available Acres >1 ac) by years**							**Total Acres by LRMP**
11f Scenic Retention Foreground	**5% 1st 10 years of plan <10% disturbance=<10-15' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	**81-200**	**200+**	
Sixth field 21-1		0	51	40	23	0	114	248	476
Sixth field 21-2		74	69	38	81	0	87	1206	1555
Sixth field 21-3		0	0	0	0	0	0	0	0
Sixth field 21-4		0	0	0	0	0	0	0	0
Total Acres for LMFW and Tributaries		**74**	**120**	**78**	**104**	**0**	**201**	**1454**	**2031**
14a General Forest Intensive Timber Mgt.	**Probable Sale Quantity programmed**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	**81-200**	**200+**	
Sixth field 21-1		0	0	0	0	0	0	0	0
Sixth field 21-2		404	683	585	1020	522	113	1609	4936
Sixth field 21-3		1015	2226	1667	2865	1187	317	6000	15277
Sixth field 21-4		41	318	312	237	164	265	180	1517
Total Acres for MFWDT and Tributaries		**1460**	**3227**	**2564**	**4122**	**1873**	**695**	**7789**	**21730**
matrix acre total by age		**2735**	**4519**	**3204**	**5549**	**2720**	**1211**	**12578**	**32516**
Percent of non Riparian Matrix by age		**8%**	**14%**	**10%**	**17%**	**8%**	**4%**	**39%**	

II. LSR LANDS FOR POTENTIAL COMMODITY REMOVAL

The following chart displays acres by age classes for some Land Management Allocation by sixth and fifth field watershed. This chart will allow the user to see potential acreage in various size classes in order to assess by sixth field Subwatershed where potential vegetation manipulation projects for habitat improvement or to meet other objectives can be done. Other acreage may be available in other allocations where no commodity removal is allowed.

Land Management Plan Designation	Disturbance Restriction	Stand Age from GIS Year of Origin (Rounded Available Acres >1 ac) by years					Total Acres by LRMP
11a Scenic Modification Middleground	**<24% disturb =<4.5' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	
Sixth field 21-1		106	129	76	409	149	869
Sixth field 21-2		2	56	0	53	0	111
Sixth field 21-3		0	0	0	0	0	0
Sixth field 21-4		0	0	0	0	0	0
Total Acres for MFWDT and Tributaries		**108**	**185**	**76**	**462**	**149**	**980**
11c Scenic Partial Retention Middleground	**<20% disturb +<15-20' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	
Sixth field 21-1		26	2	0	57	0	85
Sixth field 21-2		21	8	0	4	0	33
Sixth field 21-3		0	0	0	0	0	0
Sixth field 21-4		0	0	0	0	0	0
Total Acres for MFWDT and Tributaries		**47**	**10**	**0**	**61**	**0**	**118**
11f Scenic Retention Foreground	**5% 1st 10 years of plan <10% disturbance=<10-15' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	
Sixth field 21-1		1	9	1	17	47	75
Sixth field 21-2		0	0	0	4	0	4
Sixth field 21-3		0	0	0	0	0	0
Sixth field 21-4		0	0	0	0	0	0
Total Acres for MFWDT and Tributaries		**1**	**9**	**1**	**21**	**47**	**79**
14a General Forest Intensive Timber Mgt.		**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	
Sixth field 21-1		19	83	150	131	3	386
Sixth field 21-2		260	1026	512	359	337	2494
Sixth field 21-3		133	376	285	572	0	1366
Sixth field 21-4		522	946	595	748	0	2811
Total Acres for MFWDT and Tributaries		**934**	**2431**	**1542**	**1810**	**340**	**7057**

Appendix H4
Vegetation Description
MFWDT
Ginny Tennis
July 1995

The Willamette National forest has 5 major conifer series, Douglas-fir series, Grand fir series, mountain hemlock, Pacific silver fir series, and the western hemlock series. Classification is based on the Plant Association and Management guide for the Willamette National Forest, 1987.

A series is based on the physically largest tree specie(s) that would dominate at climax which are those species that would remain on site after a long disturbance free time period. The Lower Middlefork of the Willamette watershed has 4 of the 5 major conifer series within its boundaries. Mountain hemlock is fond as a minor component in stands at the highest elevations in the Lower Middlefork Willamette Watershed. Within each series the plant associations, or potential natural vegetation, is a group of species that can most effectively occupy sites with similar, moisture light and nutrient availability. The plant associations are recurring collections of groups of plant species which can grow and reproduce in competition over a long time period. Plant association is a group of species that could be climax. Climax forests rarely occur due to the longevity of the pioneer species, which are the first plants on any disturbed ground. Douglas-fir common to this area is a long lived pioneer species and may reach 1000 years old. Catastrophic fires or any other disturbance may not allow climax to be reached.

The series found in this watershed in the western 1/3 of Rigdon Ranger District sites occupy different areas of different environmental conditions. Delineations between different series tend to be blends of plants from adjacent series.

The following vegetation description, by series, is based on the Willamette National Forest Plant Association and Management Guide, personal observation, ecoplots, select tree data and silvicultural prescriptions from areas within the watershed.

Additional associations may be present but not documented on ecoplots.

DOUGLAS-FIR

The Douglas-fir series occurs on warm, relatively dry sites at lower elevations on south and west slopes. This is the driest environment capable of supporting a closed forest canopy. Incense cedar and grand fir are major climax species, but Douglas-fir dominates the canopy and regeneration layers. On the hot dry slopes at the lower elevations Douglas-fir will be the major climax species.

From ecoplot data vegetation on mature stands shows Douglas-fir is the primary component of the overstory, with a range of 20% to 95% cover. Incense cedar follows with minor to 40% cover and then ponderosa pine with minor to 20% cover. The stands with more ponderosa pine are located from Little pine openings to campers Flat along road 21 on the south and west slopes and on the lower end of Coal Creek. The ponderosa pine band follows along a lower precipitation band that goes up the Middlefork of the Willamette. Grand fir and white pine show up to 15 % cover. White pine is located on mid-upper elevation moist slopes as slopes east of Holland Meadows. Elevations on the ecoplots ranged from 1750 to 3150 feet in elevation.

The regeneration layer was nonexistent in 2 even-aged, fire regenerated stands with Douglas-fir as the only species in the canopy at an age of 100-130 years old. With multiple species in the canopy the regeneration layer consisted of Douglas-fir, incense cedar and minor amounts of western red cedar and Douglas-fir in the wettest areas.

The shrub layer includes vine maple, Oregon grape, salal, oceanspray, trailing snowberry, whipplevine and poison oak.

The herb, grass and fern layers tends to be light or under 10% cover and include species as twinflower, bluntleaf sandwort, fairybells, snowqueen, western starflower, pathfinder and strawberry.

Grasses include poas, bromes, and fescues.

Ferns include Sword fern, bracken fern and licorice fern.
Bigleaf maple was the most common hardwood with madrone and chinquapin present and alder on the streambanks.

Stand structures identified were even-aged single story, older remnant fire resistant Douglas-fir with an even-aged understory and stands that had 4 age classes on an 80 year fire disturbance regime.

Plant associations included are Douglas-fir/oceanspray/dwarf Oregon grape, Douglas-fir/oceanspray/grass, Douglas-fir-western hemlock/salal, Douglas-fir/oceanspray/whipple vine, Douglas-fir-western hemlock/dwarf Oregon grape and Douglas-fir/snowberry.

GRAND FIR SERIES

The Grand fir series tends to be on relatively well drained and dry slopes from 1800 to 4500 feet. Species in this series tend to a mix from the Douglas-fir, western hemlock and Pacific silver fir series. The grand fir series is between the

drier Douglas fir series and the wetter western hemlock series. This description is based on stands from 160 - 300 years old.

Mature vegetation found on local ecoplot data includes an overstory of grand fir with 7-50% cover, Douglas-fir with 0-60% cover, with smaller quantities of incense cedar, Pacific silver fir, sugar pine, western red cedar and western hemlock. The regeneration is mainly grand fir from 5-20% with lesser amounts of sugar, white pine and western hemlock.

Bigleaf maple was present at lower elevations in minor amounts and may be a transitional stand to the western hemlock series. No other hardwoods are documented in these stands.

Shrub species present in the stands included Oregon grape, baldhip rose, trailing snowberry, vine maple, salal and oceanspray.

Typical herbs are vanilla leaf, three-leafed anemone, fairybells, starry solomonseal, and redwoods violet. The herb layer is very diverse.

Plant associations are grand fir/dwarf Oregon grape and Pacific silver fir-grand fir/false solomonseal

PACIFIC SILVER FIR SERIES

Pacific silver dominates the upper slopes above 4000 feet. Locations that have Pacific Silver fir include the Warner Mountain-Ground Hog area, Bulldog Prairie, Gertrude lake area and Steeple Rock. On slopes that are hotter and drier this series will be replaced by either Grand fir or Douglas-fir series. This description is based on stands from 130 years old to 600 years. Stands had from 2-5 age classes represented.

Overstory species included in this series include Douglas-fir with 10-80% cover, western hemlock with 5-45% cover, Pacific silver fir with 1-40% cover and noble fir with 1-40% cover. Associated species as mountain hemlock, Alaska yellow cedar, white pine , yew and western red cedar may be found in the stands. Hardwoods are not commonly found in this series.

Regeneration species include grand fir, western hemlock, white pine, yew and western red cedar.

Shrub species include rhododendron, vine maple, princes pine, dwarf bramble and big huckleberry, and Oregon grape.

Herbs include vanilla leaf, starry solomon seal, green pyrola, inside-out flower, ginger, queencup, fairybells, coolwort, montia, viola, beargrass.

Plant associations include Pacific silver fir-grand fir/false solomonseal, Pacific silver fir/coolwort foamflower, Pacific silver fir/rhododendron/dwarf Oregon grape, Pacific silver fir/rhododendron/beargrass, Pacific silver fir/dwarf Oregon grape, Pacific silver fir/vine maple/coolwort foamflower and Pacific silver fir big huckleberry/queencup beadlily.

WESTERN HEMLOCK SERIES

This series is located throughout the entire subdrainage from low to 4600 foot elevations. Douglas-fir is the predominant species in the western hemlock series. This description is based on information from stands ranging in age from 82-500 years old. Cohorts include western hemlock and western redcedar. Minor amounts of incense cedar, grand fir, sugar pine, white and ponderosa pine can be found in these associations. Bigleaf maple is the predominant hardwood with madrone and chinquapin found on west slopes.

Regeneration is mainly western hemlock and western red cedar. Drier sites have incense cedar and Douglas-fir regeneration.

The shrub layer is fairly well developed with vine maple, rhododendron, Oregon grape, princes pine and salal. The herb layer is diverse but with low covers of individual species as oxalis, twinflower, scoulers bluebell, montia and sword fern.

Plant associations found in this watershed for the western hemlock series include western hemlock/dwarf Oregon grape, western hemlock/dwarf Oregon grape/salal, western hemlock/dwarf Oregon grape/vanilla leaf, western hemlock/rhododendron-dwarf Oregon grape, western hemlock/rhododendron/twinflower, western hemlock/salal , western hemlock/rhododendron-salal, western hemlock/twinflower,

MOUNTAIN HEMLOCK SERIES

This series is located on the upper ridges above 4000 feet. The dominant tree species are mountain hemlock and silver fir and their regeneration. This is one of the harshest sites west of the Cascade crest. A short growing season, multiple frosts and high summer temperatures make for a difficult growing site.

Big huckleberry, princes pine, beargrass and dwarf bramble are common plants on the mountain hemlock/big huckleberry and beargrass sites.

Hemstrom, M.A., Logan, S.E. Pavlot, W. 1987. Plant Association Management Guide and associated plot data. USDA-Forest Service, Pacific Northwest Region. Eugene, Oregon

Appendix H5
MFWDT
Ginny Tennis, Forester
July 1995

INTERPRETIVE COMMENTS FOR GROUP #I - Western Hemlock/Douglas-fir Series

In this group the stand initiation and stem exclusion developmental stages has increased by timber harvest removal.

FACTORS PERTAINING TO TRENDS IN GROUP #I - Western Hemlock/Douglas-fir Series

Disturbance Events

The main disturbance events in the Western Hemlock/Douglas fir group has resulted from timber harvest activities over the past 50 years and man and lightening caused fires. This converted multicohort(unevenaged) stands and single cohort stands, found on dry site Douglas fir, to younger evenage stands or further developed the complexity with additional age classes added and the retention of overstory Douglas-fir and ponderosa pine.

Vegetative Succession.

The portion of the wetter western hemlock stands which have not had regeneration harvest activities currently have structures of multiple layers with a multiple species composition. On north slopes that have been burned an even-aged 100 year old western hemlock stands may be found under scattered Douglas-fir. The fire occurrence is variable but ecoplot data documents stands up to 500 years old with some underburning occurring in the stands.

The cool dry upper ridges or lower valley bottoms may have a grand fir climax. Fire occurrence based on existing stand ages is from 153-282 years. The stands have a mainly Douglas fir and grand fir overstory with white pine as a minor associate. Regeneration is limited to grand fir and western hemlock understory.

On the dry site Douglas fir there is a tendency to hold for many years in the stem exclusion stage even up to 150 years old and typically be of pure Douglas-fir. The exclusion of fire has contributed to the development of complex fuel bed as trees regenerate, creating a fuel ladder. The regeneration may cause a loss of tree vigor due to overstocking on moisture limited sites.
Fires have been noted to have 80-120 year regimes from ecoplot data. With a high periodicity in the past stands have developed with scattered large old

growth, Douglas-fir with younger old small sawlog size Douglas-fir and poles and saplings and seedlings underneath. Stand ages may be quite variable due to frequent, low intensity fires.

The dry site Douglas-fir contains ponderosa pine and sugar pine and rarely will have western hemlock in the stand. The dry site is approximately one third of the watershed running mainly on the east side of the watershed from Hills Creek to Coal Creek. The ponderosa band with its associated grasses is found from Little Pine Openings to the bottom of Coal Creek.

Disturbance processes and succession

Early harvest activities used single species planting at a close spacing tending to modify species composition, stand structure in relation to natural stands. Snag felling due to the hazards of logging and broadcast burning eliminated a future nutrient input source and a wildlife habitat component.

Natural stands with lower initial stocking tend to stay in the stand initiation stage longer and have a greater herb and shrub growth.(Oliver et al 1990) Diversity in managed stands tends to increase greatly as other species seed in from adjacent areas. In the past decade increased use of more species adapted to specific sites has been utilized to develop diversity. Animal damage from stocking loss due to gophers or mountain beaver or height growth loss or form damage does allow stands to stay in the stem initiation stage longer. Removal of competing vegetation may allow faster development into the stem exclusion stage.

With the presence of the large number of trees per acre in the managed stands the available space is soon utilized and the stands may stagnate or slow in growth of height and diameter. Thinning or removal of trees allowed increased growth on the remaining trees and allow some ingrowth of shrub and herbs dependent on the amount of stocking removal. Stands that were not precommercially thinned or are overstocked natural stands from fire may stay in the stem exclusion stage for a much greater time frame. On the hot dry Douglas-fir and ponderosa pine sites grass is a severe competitor for the moisture available.

Fire occurrence causing tree mortality, or insects, disease and other damage mechanisms caused openings to develop and allowed ingrowth of trees. A 1993 survey of insect damage done by the USDA Forest Service in Cooperation with the Oregon Department of Forestry identified in this watershed identified 1) 10 sites of Douglas-fir bark beetle up the bottom of the Middlefork of the Willamette, Packard Creek and Coal Creek. Douglas-fir bark beetle occurs in endemic levels in downed, weakened, or diseased trees as occurs in small blowdown pockets or fires or disease center. Green trees are not preferred but

will be attacked if populations are high. Small trees are not large enough for breeding purposes and down trees in full sunlight are not utilized since the phloem dries out prior to completion of the bark beetle breeding cycle. 2) 1 site of the mountain pine beetle south of Estep Creek in a ponderosa pine stand. The mountain pine beetle dendroctonus ponderosae, will attack both sugar and ponderosa pine. It is associated with stress trees brought on by overstocking or mistletoe infections. A 1994 Survey mapped an infection center of Oregon Pine Ips southeast of Little Pine Openings and western pine beetle in the lower section of Dry creek.

Four common root diseases found in Oregon include Laminated Root rot, Phellinus weirii, Armillaria root disease, armillaria obscura, annosus root disease, and black stain root disease. Laminated root rot infection centers are normally less than one acre in size. Black stain is found in plantations along roads or in soil compaction areas and in overstocked stands and results ingrowth loss and tree killing. Most infections of these common rots are small scattered areas but to act as a disturbance mechanism allowing light in due to trees blowing down due to loss of root strength or bole integrity or trees dying in an upright position.

Westside Douglas-fir is severely damaged by laminated root rot and black stain root disease and is moderately damaged by armillaria up to age 25 and then susceptibility decreases. Western redcedar tends to be less susceptible to root diseases except for armillaria.

Ponderosa pine is moderately damaged by armillaria centered around infected stumps and annosus which is spread by spores in the wind and infects through fresh stumps and infects other trees by root contact.

Incense cedar is seldom damaged by the common root diseases.
Sugar pine and white pine are moderately damaged by armillaria.

Grand fir can be severely damaged by laminated, armillaria and annosus.
Pacific silver fir is severely damaged by annosus root disease and moderately affected by laminated root rot and armillaria.

White pine blister rust will cause individual tree mortality and create small openings.

Small openings in Douglas-fir stands are created from small areas of harsh sites or where one plant species is inhibited from growing near or beneath another by allelopathic chemicals. Rhododendron may inhibit the growth of Douglas-fir and allow white pine to be introduced in the openings.

The openings allow understory reinitiation of Douglas-fir due to the increased light as well as retention of brush and hardwoods.

Control of fire has allowed the less fire resistant young trees as Douglas-fir and grand fir to remain in these stands especially on the driest sites.

The oldgrowth stage may show varied layers of mixed age and species stand with scattered large residual Douglas-fir. On the sites where moisture is more prevalent multiple canopy structures tend to be the ingrowth of shade tolerant species as western hemlock and grand fir as individuals and less well defined fire layers as fires tend to less frequent but more a stand replacement event due to the build up of woody material on the forest floor.
GROUP 2 Pacific Silver Fir/Mountain Hemlock/Grand fir Series

The makeup of this group from GIS data by major species is 80% Noble fir, 10% mountain hemlock, 5% white pine, 4 % silver fir and 1% Alaska yellow-cedar.

FACTORS PERTAINING TO TRENDS IN GROUP 2-Mountain Hemlock/Silver Fir

Disturbance Events

The main disturbance event in the Pacific silver group has resulted from timber harvest activities over the past 45 years. Conversion of older multicohort(unevenaged) stands to young evenage stands has been the largest change in the subdrainage. Early units had no riparian areas buffered and early attempts at tree retention were inadequate leaving a 1 or two tree deep protection area which won't provide suitable shade immediately after harvest. Minor blowdown has taken place on unit boundaries as in the head of Deadwood Creek and increase large woody material on unit edges. Small stand replacement fires are infrequent but have occurred within the last 100 years and break up the typically large areas of older stands. Soil movement will delay stand development along Coal Creek and tend to make some stands stay in the stem initiation stage longer.

Vegetative Succession.

The majority of the silver fir stands which have not had regeneration harvest activities currently have multi-layered structures with 2-5 age classes present in stands. At lower elevations Douglas-fir and western hemlock are the most common associates. At upper elevations mountain hemlock and Alaska yellow-cedar tend to be codominant.

The younger stands tend to have fewer layers. The Steeple Rock area has stands of Douglas-fir, Silver and western redcedar that are fire originated in 1861. West

of Juniper Mountain 2 stands of a large component of western hemlock and Douglas-fir in the overstory with the silver fir have years of origin of 1459 and around 1643. Along Coal Creek a stand with 40 percent silver fir in the overstory with 64" in diameter Douglas - fir was fire originated over 500 years ago. From these stand ages the fire-return interval can be estimated at 120 to over 500 years. Silver fir forests are characterized of infrequent fires of high severity and may occur under unusual conditions of summer drought and east winds.(Agee,1993).

The Lower Middle fork stands are primarily not at climax due to presence of large quantities of seral species as Douglas-fir, western hemlock, noble fir and minor amounts of white pine. A minor climax of mountain hemlock has occurred at the highest elevations as Balm Mountain. Droughty areas will retain a higher proportion of Douglas-fir stocking.

Disturbance processes and succession

Early harvest activities used single species planting at a close spacing. Broadcast burning and PUM and YUM yarding removed down woody from the site. Snags were removed for logging safety and by broadcast burning. This tended to modify species composition, stand structure and different from natural stands. Natural stands with lower initial stocking tend to stay in the stand initiation stage longer and have a greater herb and shrub growth.(Oliver et al 1990) Diversity in managed stands tends to increase greatly as other species seed in from adjacent areas. In the past decade increased use of more species adapted to specific sites has been utilized to develop diversity.

Animal damage from stocking loss due to gophers or mountain beaver or height growth loss or form damage does allow stands to stay in the stem initiation stage longer. Removal of competing vegetation may allow faster development into the stem exclusion stage but on harsh sites it should be retain to provide site shade for seedling germination and protection from frost. On the harsh higher elevations desired stocking levels may be hard to achieve and stands may never close as in the high elevation True fir mountain hemlock zones.

Some recent managed stands in Coal Creek have spotty, low stock with heavy brush competition. These stands will tend to be clumpy, mixed with open grown trees. Stocking problems are associated with poor burns, duff and rock inclusions and seedling establishment under droughty conditions. These stands will take much longer to reach and may never reach the stem exclusion stage or require density management. Adjacent to these stands are older managed stands with large number of vigorous trees per acre and no brush problems. This vigorous growth will soon occupy available space is soon utilized and the stands may stagnate or slow in growth of height and diameter. Thinning or removal of trees allowed increased growth on the remaining trees and allow some ingrowth

of shrub and herbs dependent on the amount of stocking removal. Stands that were not precommercially thinned or are overstocked natural stands from fire stay in the stem exclusion stage for a much greater time frame and the trees may stay small in diameter and become spindly with small crowns.

As the stands age, disturbance as disease, windthrow and small fires allow openings to develop in the stands. A 1993 survey of insect damage done by the USDA Forest Service in Cooperation with the Oregon Department of Forestry identified four sites of the true fir engraver in the Dome Rock and upper Coal Creek area. Small openings are created with the death of the trees.

Four common root diseases found in Oregon, that develop small openings in stands include Laminated Root rot, Phellinus weirii, Armillaria root disease, armillaria obscura, annosus root disease, and black stain root disease. Laminated root rot infection centers are normally less than one acre in size. Black stain is found in plantations along roads or in soil compaction areas and in overstocked stands and results ingrowth loss and tree killing. Most infections of these common rots are small scattered areas but to act as a disturbance mechanism allowing light in due to trees blowing down due to loss of root strength or bole integrity or trees dying in an upright position.

Westside Douglas-fir is severely damaged by laminated root rot and black stain root disease and is moderately damaged by armillaria up to age 25 and then susceptibility decreases. White pine is moderately damaged by armillaria. Pacific silver fir is severely damaged by annosus root disease and moderately affected by laminated root rot and armillaria.

With the openings coming in a transition from stem exclusion to understory reinitiation takes place.

In this Understory reinitiation phase the more shade tolerant species come in and start development of understory layers of different age trees. As the trees mature the seral species die out and a mature stand is developed and climax species, silver fir may become predominant on the site. With Douglas-fir being so long lived and fire interrupting succession climax of silver fir is not often seen. This is the late successional or old growth stage where trees start dying out due to age. The older high elevation portion of these stands has a high snag component in the mountain hemlock zone.

EXISTING LONG TERM MONITORING

Two Shady Beach Fire Recovery Monitoring Plots are located in the LMFW and Tributaries watershed. Ecology Reconnaissance plot #6399 from 1982 is located in T.22 S., R. 3 E., Section 13 and is a PSME/HODI/WHMO association. MOM Inventory plot #5012, from 1988 is located in T.22 S., R. 3 E., Section 1 and is a PSME/TSHE/BENE
plant association. The 50-100 monitoring is for a long-term study of fire effects on the plant associations. Monitoring consists of a cross-section of the 1988 burned areas that will provide a photo and quantitatively measured record of change from permanent points. Monitoring is designed to examine the following:

1. Native species performance based on fire intensities and plant association
2. Interim species performance(exotics introduced to stabilize the site.
3. Time frames required for healing to pre-fire successional status.
4 Documentation of vegetative recovery on salvage logged versus unlogged sites.

Installation was done in 1988. Monitoring schedules vary and can be found in the District file

Appendix H6
Vegetation Manipulation Issue VM6
Ginny Tennis, July 1995

Management activities and fire have set the stage for what is available for timber, special forest products or what is needed for vegetation management to meet the objectives of the Willamette National Forest Land and Resource Management and the Northwest Forest Plan.
Harvest takes a mature stand back into a stand initiation phase. Other disturbances include insect and disease, floods, wind and mass movement. Appendices 1 & 4 describes the past blowdown projects and some stand processes.

A chart showing the treatment acres by decade starting from the 1930's for the Lower Middle Fork of the Willamette and Tributaries is found in Appendix 2.

THE VEGETATION CURRENT CONDITION FOR THE MIDDLE FORK WILLAMETTE DOWNSTREAM TRIBUTARIES AND TRIBUTARIES
IN ACRES

Seral Stage	Acres
Stem Initiation Early Habitat	34,046
Stem Exclusion Pole, Small Timber	14,708
Understory Reinitiation Mature Timber	6,512
Mature, Old-growth Timber	44,003
Unsuited Non-forest**	1,759
Meadows	1,128
Water	3,017
City	930
Other*	3,897
Total	110,000

**Change due to private land conversion
*Roads, Administrative and Special Use areas

The current seral condition for forested lands including private is 31% in stem initiation, 13% in stem exclusion, 6% in understory reinitiation and 40% in mature/old growth. Of the 110,000 acre watershed over 90% is forested. Private lands are mainly in the stem initiation stage, with only a few in stem exclusion due to harvest activities.

The Forest Service forested lands are 21% in stand initiation, 11% in stem exclusion, 6% in Understory Reinitiation and 40% in the mature/Old Growth Stage. Appendix ***** is the vegetation description by series.

Clearcutting in the Douglas-fir forests was the preferred harvest system with over 26,000 acres harvested since 1940. The 1950's showed the first large harvest of 2512 acres. By the 1960's this had increased to a cut of 6305 acres. A slight decrease to 5809 acres occurred in the 1970's. The peak of harvest quantity was in the 1980's with 7918 acres of removal. From 1990 to present 3720 acres have been removed from the Lower Middle Fork of the Willamette.

The major clear-cut harvest area from the 1950's to 1990 was sixth field watershed 21-3 and then a shift was made to sixth field 21-2.
Harvesting proceeded from the northern end of the watershed along the original road 23 and gradually up the easily accessible areas first. Over a dozen units were harvested in the Willow Creek area in the late forties. Buck and Groundhog had heavy harvest in 1950's and this brought roads up to the eastern boundary of the LMFW. In the 1950s harvest started extending up Coffeepot Creek and into lower Coal Creek.

Shelterwood harvesting has been done on a small portion of the watershed.

Harvesting removed down woody material from streams and units in early harvests. Snags were all removed also in early sales. Present management leaves 15% green tree retention areas in removal areas except thinnings to provide micro-site, structure, future large woody material and snags. Early reforestation tended to plant a single species on a set spacing. Planting was done at heavy enough level to assist in meeting stocking level guidelines and unless stock was poor, weather or handling was too severe plantation survival was good leaving some overstocked stands.

The discussion of vegetation manipulation and commodity availability is organized by the by Record of Decision Designations. I. Matrix Lands II. Late Successional Reserves and Managed Late Successional Reserves and III. Riparian areas.

I. MATRIX LANDS

The Desired Future Condition for Matrix land is to increase diversity and ecological function while providing timber and other commodity production while maintaining moderate levels of old-growth components as snags, logs, and relatively large green trees.

The Current Condition of the Matrix lands on allocations that provide for timber production and associated riparian lands is:

CURRENT MATRIX CONDITION

	Stand Age (Terrestrial Acres, >1 acre)							Total
	0-5 yrs	**6-15 yrs**	**16-25 yrs**	**26-50 yrs**	**51-80 yrs**	**81-200yrs**	**200+yrs**	**Acres**
Non-Riparian Matrix Acres	2735	4519	3204	5549	2720	1211	12578	32516
Associated Riparian Acres	452	1092	918	1327	427	104	766	5086

INTERPRETATION FOR MATRIX

The change from the overall watershed reference, to current condition shows harvest of stands in the Understory Reinitiation and Mature/Oldgrowth stages and those and a large increase in the stem initiation stage and an increase in the stem exclusion stage. A higher percentage of these stands are in stem exclusion than shown in the numbers. This is the result of coding in the GIS year or Origin being delayed due to early natural reforestation.
Due to high reforestation success, at a close planting spacing, stand density management will be required to produce large trees and maintain health and vigor of stands. Without treatment stands will stagnate at an early age and tree diameter growth will be slowed.

Non-riparian matrix acres in stands 80 years or older by six field watershed are: 1)sixth field 21-3,8506 acres, 2)sixth field 21-2, 4126 acres, 3) sixth field 21-4769 acres and 4)21-1 388 acres. The 13789 matrix acres may be reduced 2000 acres by Special Habitats and buffers and reduced by 532 acres in Slinky, Stonepot, Boulderdash and Weeping Projects and a further reduction from 15% green tree retention. The available matrix acres for PSQ are 9569 and are primarily in sixth field watersheds 21-3 and 21-2. See Appendix ****** Matrix Current Condition for watershed detail.

Matrix acres in stands between 26-50 years are assumed to be managed stands near commercial thinning age or if not precommercial thinned and overstocked may be suitable for post and poles. Acres in this age class by sixth field watershed are: 1) sixth field 21-3, 3305 acres, 2) sixth field 21-2, 1911 acres, 3) sixth field 21-4, 310 acres and 4) sixth field 21-1, 23 acres for a total of approximately 5549 acres. Volume removal may also
be appropriate in stands 50-80 years old. Stand Density management and pruning are needed to increase product quality, size and tree vigor.

With many acres in younger age classes reforestation activities will be done including replants, release and animal damage control.

RECOMMENDATIONS FOR MATRIX

*The majority of the acres available for PSQ will come from sixth field 21-3, and 21-2. To maintain diversity, harvest will maintain the early successional stage. Harvest will occur in a range of habitat types and prescriptions from commercial thinning to regeneration harvest on matrix lands. Marking prescriptions should reflect diverse species, forms and conditions of vegetation. Windfirm boundaries between LSR and matrix lands are desirable and can be facilitated with "feathering" of harvest boundaries.

Commercial thinning and post and pole opportunities are found mainly in watersheds 21-3 and 21-2. Exams to the regional standards should be
done to facilitate project scheduling and facilitate data entry into GIS for all stands.

Vegetation management activities may be appropriate on all acreage shown above and may be needed and done in non-harvest allocations to meet specific objectives.

Opportunities for treatments to enhance function or to meet commodity productions include but are not limited to:
1) develop snags for structural diversity and future nutrient input for large woody debris

2) stand density management to meet objectives of diversity in species composition and stocking, structure and promote health vigor and size or meet other objectives and commodity needs.

3) pruning to increase product quality and improve tree vigor or to meet other objectives

4) vegetation treatments to reduce risk of fire, insects, disease or animal damage.

5) release or removal of vegetation to promote vigor, tree size, stocking protection, or forest user safety

6) reforestation for establishment, stocking level maintenance, stand diversity development or to meet other objectives. Cone and other vegetative collections may be utilized.

7) use of prescribed fire and fuel management to promote, health and vigor of vegetation, fuels reduction or meet other objectives as
habitat maintenance.

8) Roads restoration may be planted with a variety of vegetation, native collections may be utilized

9) Fertilization to promote, healthy and vigorous vegetation on all lands

10) Removal of special forest products will be done under current direction

11) Salvage and harvest will provide commodities from allocations where appropriate.

II. Late Successional Lands and Managed Late successional lands

Desired Future Condition for LSR,s or unmapped Late Successional areas, is the development and protection of late successional and old growth characteristics including: 1)Multi-species and multi-layered assemblages of trees of variable spacing 2)Moderate-to-high accumulations of large logs and snags, 3)Moderate-to-high canopy closures, 4)Moderate-to-high numbers of trees with physical imperfections as cavities, broken tops, large deformed limbs and lean 5)Moderate to high accumulations of fungi, lichens and bryophytes 6)Gap development from minor disturbances is allowed to continue.

Development of these characteristics in Late-Successional Reserves should focus on stands, under 80 years of age, that have been regenerated following timber harvest or stands that have been thinned. Treatments should be done in any stands that are prone to insect, fire, wind or fire disturbances, to prevent large-scale disturbances.

The following chart displays a summary of acres by age classes for the LSR Lands. The LSR Current Condition chart with individual watershed acres is found in Appendix ****. The summary shows some of the potential acreage where potential vegetation manipulation projects for habitat improvement can be done and commodity removal may be a result of the treatment. Treatments may be done in other allocations and LSRS.

CURRENT LSR CONDITION	Stand Age (Terrestrial Acres, >1 acre)				
	0-5 yrs	**6-15 yrs**	**16-25 yrs**	**26-50 yrs**	**51-80 □**
Non-Riparian Lsr Acres	1090	2635	1619	2354	536
Associated Riparian Acres	175	631	509	555	49
Total	1265	3266	2128	2909	585

INTERPRETATION FOR LATE SUCCESSIONAL RESERVE

The change from the overall watershed reference to current condition shows a harvest of stands in the Understory Reinitiation and Mature/Oldgrowth stages and those and a large increase in the stem initiation stage and an increase in the stem exclusion stage.
Over 24 % of the Late Sucessional Reserve for scenic and previously general forest allocations is under 80 years of age. About 4531 acres are in age classes 0-15 years and may be suitable for release and precommercial thinning. A portion of these may have already been treated. About 5622 acres are in age classes 16-80 and may be suitable for post and pole or commercial thinning. Some small acreage in special habitats might have vegetation treatment opportunities.

RECOMMENDATION FOR LATE SUCCESSIONAL RESERVE

Consider implementing precommercial thinning program on the 3266 acres in the 6-15 years of age. This will minimize the loss of tree vigor due to

overstocking and maintain full crowns and improve diameter and height growth. The increased vigor will reduce the risk of insect and disease
problems. Delaying the precommercial thinning will cause a loss of crown size and cause the trees to be of small diameter and increase the
post treatment fuel loadings and residual stand damage. The tall spindly trees may break under heavy snow loads. The desired future condition should be designed in at the precommercial thinning stage in order to not preclude options. The decline in health and vigor due to overstocking and
and poor crowns is not recaptured and will slow the development of large diameter trees. In riparian areas design the precommercial thinning based on desired future condition for the individual stream reach or riparian habitat. This is an opportunity to develop the species composition and set the stage for desired tree diameters for down woody material through the use of stocking level control.

An assessment of approximately 5307 acres of managed stands in the 16-50 year age class and approximately 585 acres in the 51-80 year age class should be done to identify habitat conditions and design vegetation manipulation projects to meet wildlife or other objectives.

Vegetation management along the reservoir should promote the health of stands, minimize fire hazards, and provide for the habitat needs of T and E species like nest sites and promote visual diversity for the recreationist and maintain roadside safety.

Verification and update of the GIS data is necessary to provide an accurate picture of stand conditions in the LSR.

Treatments are limited to those that are beneficial to and maintain late-successional forest conditions, forest health, user safety and reduce risk in all stands include but are not limited to:

1) development of snags

2) development of coarse woody debris, by snags development and tree felling

3) stand density management to produce large trees, develop structure, modify species composition, provide gaps and modify spacing or meet other objectives.

4) reduce risk from fire, insects, diseases or other environmental variables

5) release advanced regeneration of conifers, hardwoods or other plants

6) underplanting and modifying understory vegetation to begin development of multistory stands or retain desired stocking level

7) reforestation for establishment or other treatments for stocking level maintenance, stand diversity or to meet other objectives such as hydrologic recovery.

8) Roads may be restored to a natural state within LSR's and may be planted with a variety of vegetation and may use native collections.

9) Fertilization to promote, health vigor and vegetation establishment.

10) Seedling protection projects as animal control

11) Removal of snags and logs to reduce hazards and use for salvage where appropriate or provide restoration materials

12) special forest products may be collected under the current direction guidelines

III. Riparian Reserve Areas

Past management and natural processes have changed the condition of the riparian areas by increasing the quantity of stand initiation and stem exclusion
exclusion stages while reducing the understory and old growth stages. Snags and down woody material were removed during harvest.

The Desired Future Condition for Riparian Reserves is to sustain a physically complex and stable riparian and wetland vegetation in Riparian reserves along with restoring large conifers. Activities to facilitate this or that may be appropriate under current direction include:

1)Release young conifers in riparian areas from overtopping hardwoods.

2)Plant unstable areas as landslides.

3)Stand density management or pruning to encourage development of large conifers or modify species composition

4)Reforesting shrub and hardwood dominated stands with conifers or vice versa

5)Collection of vegetation or reproductive materials to facilitate site conversions or rehabilitation reforestation or revegetation projects or restoration projects.

6)Removal of salvage or other vegetative material to meet the Desired Future Condition or provide for user safety and commodities that are appropriate

Prescribed widths of the Riparian Reserves may be modified and be given a prescribed width based on slope distance or multiple of a site tree potential after a site specific analysis is conducted and described and the rational for the boundaries is presented through the appropriate NEPA process. Programmed timber harvest is prohibited.