Little Applegate Watershed

Hydrology Report

Michael Zan
Hydrologist

April 1995

SECTION 1

LITTLE APPLEGATE RIVER HYDROLOGY

Mean Monthly Flows:
Except for some data collected from May through October 1913, and from June through October 1994, there is no known flow data for the Little Applegate River or its tributaries. With this in mind it was necessary to construct a hydrograph displaying mean monthly flows by utilizing records from nearby stations that have been published in USGS Surface Water Records and Open-File Reports. In constructing a hydrograph, a short discussion of low flows is first in order.

Since **low streamflows** have been identified as a key question pertaining to the **larger issues of water quantity/quality and fish populations**, the greatest need is to gain a reasonable estimate of seasonal low flows to help quantify the impacts of water withdrawals on instream beneficial uses. With this in mind, extreme caution must be used when extrapolating data from gaged to ungaged watersheds. This is particularly important in determining low-flow characteristics (Riggs 1972, Gallino 1994 personal communications). The principle terrestrial influence on low flow is geology and the primary meteorological influence is precipitation. Neither have been adequately used to describe effects on low flow using an index so that estimation of low flow characteristics of sites without discharge measurements has met with limited success. Exceptions are on streams in a region with homogeneous geology, topography, and climate, in which it should be possible to define a range of flow per square mile for a given recurrence interval. Again according to Riggs (1972), although estimates of low flow characteristics from basin characteristics are generally of low accuracy, the desire to estimate such characteristics for an ungaged watershed may justify development of regional relationships where conditions are favorable; namely that if all significant basin characteristics except drainage area in a region have extremely limited ranges, one would expect a good relation between low flow characteristics and drainage area.

Unfortunately, the gaged watersheds in southwestern Oregon in the vicinity of the Little Applegate River represent a wide range of geologic as well as meteorological characteristics. With this in mind, the records and watershed characteristics for the nearest gages which might be useful for extrapolating flows for the Little Applegate have been examined. These gages/watersheds are: Elliot Creek (USGS #14361600 - 51.8 sq mi - 10 years data), Middle Fork Applegate River (USGS #14361590 - 50.7 sq mi - 8 years data), Carberry Creek (USGS #14361700 - 68.9 sq mi - 10 years data), and Applegate River near Copper (USGS #14362000 - 225 sq mi - 41 years data). None of these streams were regulated for their periods of record, except for some minor winter storage at Squaw Lakes Reservoir and some minor diversions on upper Carberry Creek.

Elliot Creek is geologically distinctly different from the other gaged watersheds (and the Little Applegate) except that it is included in the larger watershed represented by the gage on the Applegate River near Copper. Elliot Creek is almost entirely underlain by schist parent material. Carberry Creek and the Middle Fork Applegate are similar to the Little Applegate Watershed in that they are underlain primarily by metasedimentary and metavolcanic rocks of the Applegate group; they all also have significant acreages in granitics. The watershed area above the Applegate River gage near Copper includes Carberry Creek, the Middle Fork Applegate. Elliot Creek. Squaw Creek and several minor facing streams. Portions of Squaw Creek and all of the facing streams are geologically similar to Carberry Creek, the Middle Fork Applegate, and the Little Applegate. Because of the obvious differences in geology, the Elliot Creek data was not used.

Although the Middle Fork Applegate is geologically similar to the Little Applegate, the weighted average annual precipitation for the watershed is substantially higher; it averages about 55 inches per year in the Middle Fork drainage verses 38 inches in the Little Applegate. For this reason the Middle Fork data was not used.

The geology and precipitation patterns of the watersheds tributary to the Carberry Creek and Copper gages were next compared to those features of the Little Applegate River Watershed. Geologically, Elliot Creek and a portion of Squaw Creek in schist parent material comprise about 25 percent of the watershed area above the Copper gage. The flows at this gage would thus appear to be most heavily influenced by the 75 percent of the Watershed that is in metasediments and metavolcanics.

Regarding precipitation, Carberry Creek watershed receives a weighted average of 45 inches of precipitation per year and the Applegate River Watershed above Copper receives about 42 inches per year, compared to the Little Applegate's 38 inches. Approximately 22 percent, 27 percent, and 17 percent of the Carberry, Applegate at Copper, and Little Applegate River Watershed areas, respectively, are in the zone above 5000 feet elevation dominated by snow. The corresponding percentages of those watersheds in the 4000-5000 foot transient snow zone are 33 percent, 30 percent, and 16 percent, respectively. The respective percentages in the zone below 4000 feet that is dominated by rain are 45 percent, 43 percent, and 67 percent. From this it appears that the distributions of types of precipitation are similar above the Carberry and Copper gages, both of which have proportionally more area in the snow and transient snow zone than found in the Little Applegate River Watershed. In this regard neither site has an advantage.

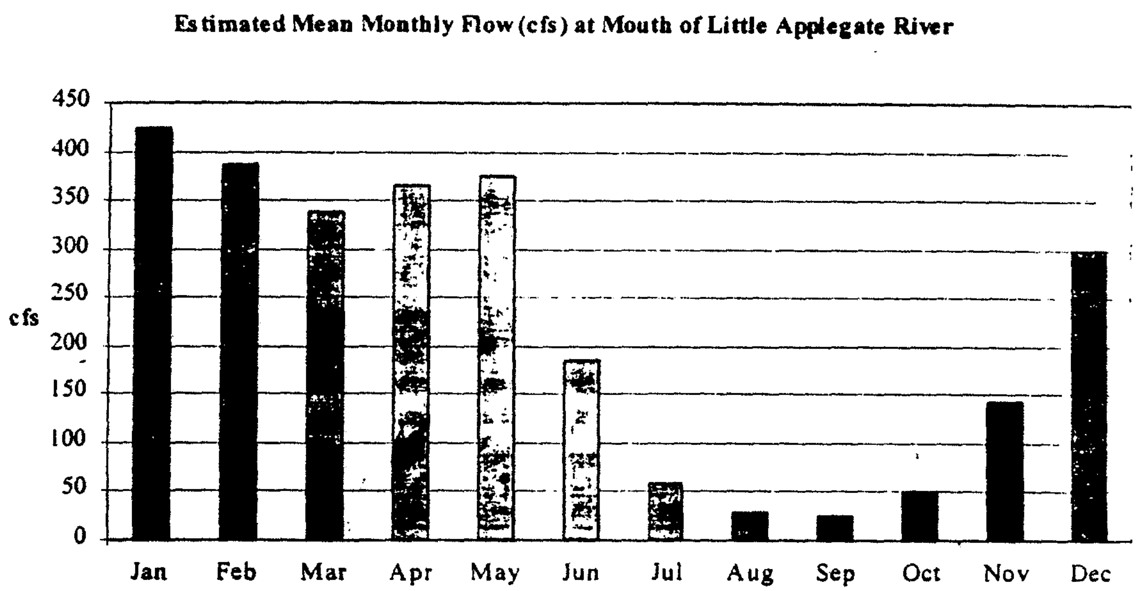
Based on both geologic and climatic factors, it was felt that data from either of these stations would be useful in determining an estimate of mean monthly flows in the Little Applegate. A comparison of normalized mean monthly flows displayed as CSM (cubic feet per second per square mile) was made between the two stations as summarized in Table #1. The numbers display a remarkable similarly between the two sets of data., particularly during the critical low flow period from July through October.

Since there are 41 years of data (1939-80) for the Applegate River gage near Copper, verses only 10 years (1977-87) for the Carberry Creek gage, the (CSM) data from the gage near Copper was selected to construct a hydrograph to represent the Little Applegate River flows at its mouth. The close similarity in geology and climate suggested that an adjustment factor was not needed; that is, a direct application of Applegate at Copper CSM data to the Little Applegate was deemed appropriate. The hydrograph (see Figure #1) displays mean monthly flow in cubic feet per second (cfs).

Table #1
Little Applegate River
Mean Monthly Flow
CFS per Square Mile (CSM)

	Carberry Creek	Applegate River near Cooper
January	3 40	3 76
February	5.07	3 44
March	4 00	2.99
April	3.44	3.23
May	2.91	3.33
June	1.35	1.65
July	0.46	0.52
August	0.24	0.26
September	0.24	0.22
October	0.40	0.44
November	1.67	1.27
December	3.72	2.66

Figure #1



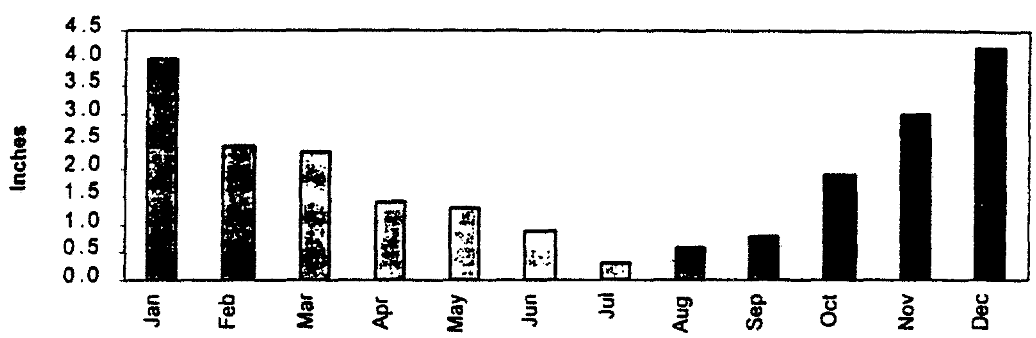
It is emphasized that this is only an approximation of long term mean monthly flows. It is considered reasonably close to natural, **unaltered** flows for purposes of this analysis. Although no adjustment factor was used, these values, particularly low summer flows, may be slightly liberal since the Little Applegate receives about 90 percent of the average precipitation received in the watershed above the gage at Copper, and since a greater percentage of the watershed above Copper lies within the predominantly snowfall zone above 5000 feet (27% verses 17%) which suggests greater delayed surface and subsurface flows. In reality, although there are no storage facilities in the Little Applegate

Watershed, there are numerous diversions which affect the amount of streamflow during the April through October irrigation season. This will be addressed in the following subsection on low flows.

The hydrograph (Figure #1) displays a pattern of natural runoff that is common to streams in the Siskiyou Mountain Range of the Klamath Mountain Physiographic Province. It is reflective of the Mediterranean climate of Southern Oregon. High mean monthly streamflows parallel the wet winter and spring months followed by a prolonged period of low flows during the droughty summer and early autumn. Figure #2 displays the pattern of annual distribution of precipitation in this region. Only about six percent of the annual runoff in the Little Applegate Watershed normally occurs from July through October; about 15 percent of annual precipitation occurs during the same four-month period (half of this coming in October).

Figure #2

Mean Monthly Precipitation (inches) at Buncom
(NOAA Sta Index No. 1149)



No attempt has been made to quantify the contributions of individual subwatersheds to the total flow within the Little Applegate Watershed. By observation though, it is obvious that the major contributing streams are McDonald Creek, Glade Creek, and Yale Creek. Other important sources are Split Rock Creek, Bear Gulch, Lake Creek, and Greeley Creek.

Background Low Flows and Human Processes Affecting Those Flows:

As previously mentioned, extremely low streamflows (due to water withdrawals) has long been identified as a concern contributing to the larger issues of water quantity/quality and fish populations. The negative effects this has had on the fishery in the lower Little Applegate were evident by the early 1900s; refer to the History Report for a discussion of irrigation development within the Little Applegate Watershed from 1852 to about 1915.

In order to estimate the magnitude of irrigation withdrawals on instream flows, flow data have been compared to known water use. Flow data that was used include extrapolations from records for the Applegate River gage at Copper, and streamflow data for the Little Applegate River that is available for 1913 and 1994. Information on water use is provided from the Oregon Water Resources Department's (OWRD) Water Rights Information System (WRIS) files (OWRD 1994).

According to the WRIS records there are valid rights to 71 cfs for mining purposes in the Little Applegate Watershed. Since mining uses normally occur during periods of high flow when instream flows are plentiful, and since actual withdrawals for mining purposes have been insignificant in recent years, mining uses are not currently a major factor contributing to decreases in instream flows.

The water use records also show that there are valid water rights to 69 cfs for consumptive uses including irrigation, domestic and livestock uses in the Watershed. Over 95 percent of this consumptive use is for irrigation. Since irrigation rights are exercised between April 1 and October 31, these demands have often exceeded the natural flows in the Little Applegate for significant portions of the summer and early fall. Figure #3 visualizes how demands for irrigation and other incidental consumptive uses compares with mean monthly flows during a normal irrigation season. The irrigation demand includes a total of 23 cfs from a number of diversions along the lower 10 miles of the main stem Little Applegate River and from tributaries such as Yale Creek (see WRIS records and History Report). These withdrawals are generally downstream of the Rogue River National Forest boundary and BLM lands. The other 46 cfs is Talent Irrigation District (TID) rights to water from McDonald Creek, which is high in the watershed within the National Forest boundary. Under this right, water is exported from the Little Applegate Watershed into Wagner Creek and the Bear Creek Watershed. Actual use has been short of the 46 cfs due to limitations of natural flows in McDonald Creek during the irrigation season and to superior downstream rights. The TID has a relatively low (1915) priority. In addition to valid water rights, concern has been expressed by the ODFW and by the Oregon State Police that additional water is being illegally withdrawn throughtout the entire Applegate River System including the Little Applegate Watershed: while these withdrawals may be individually minor, their cumulative effect exacerbates the impacts on instream flows from valid rights.

When comparing irrigation water allocations to available natural flows (Figure #3), it is evident why the lower main stem Little Applegate River has been observed to convey very low flows during the irrigation season. By late summer it is nearly dry at its mouth except for some seepage losses and/or return flows from irrigation withdrawals. This occurs even following winters of high precipitation. Although there is little data quantifying flows, many local residents and state and Federal employees, including ODF&W and the Water Master's office, have made these observations for many years.

The data that does exist was collected in 1913 and in 1994. Both sets of data support what has been visually observed for many decades. Figure #4 displays mean monthly discharge (cfs) measured at two locations on the main stem Little Applegate River in 1913. Data used to construct this graph are from US Geological Survey WSP-1318. One measurement station was at the mouth. The other measurement is for the main stem below Yale Creek, six miles upstream from the mouth; this measurement is actually the addition of flows measured on both Yale Creek and the Little Applegate River immediately above their confluence.

Figure #4 displays a reduction in main stem flows in the lower six miles. It should be noted that in addition to water withdrawals between these points, there were also numerous withdrawals farther upstream and on tributaries such as Yale and Sterling Creeks. Mining was also more active at this time so that ditches such as Sterling Ditch may have been diverting flows for a portion of the irrigation season. It is not possible to know what 1913 natural flows would been without diversions. The 1913 irrigation season did follow a winter which experienced 110 percent of normal precipitation (NOAA - National Weather Service Records, Medford, OR).

Figure #3

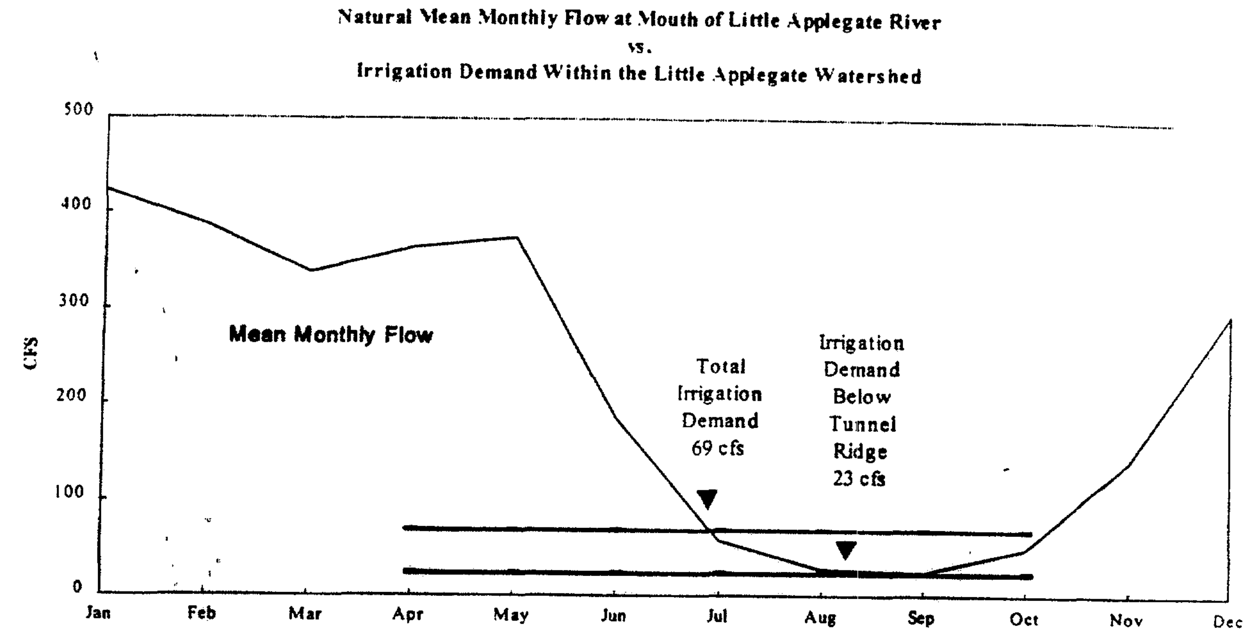
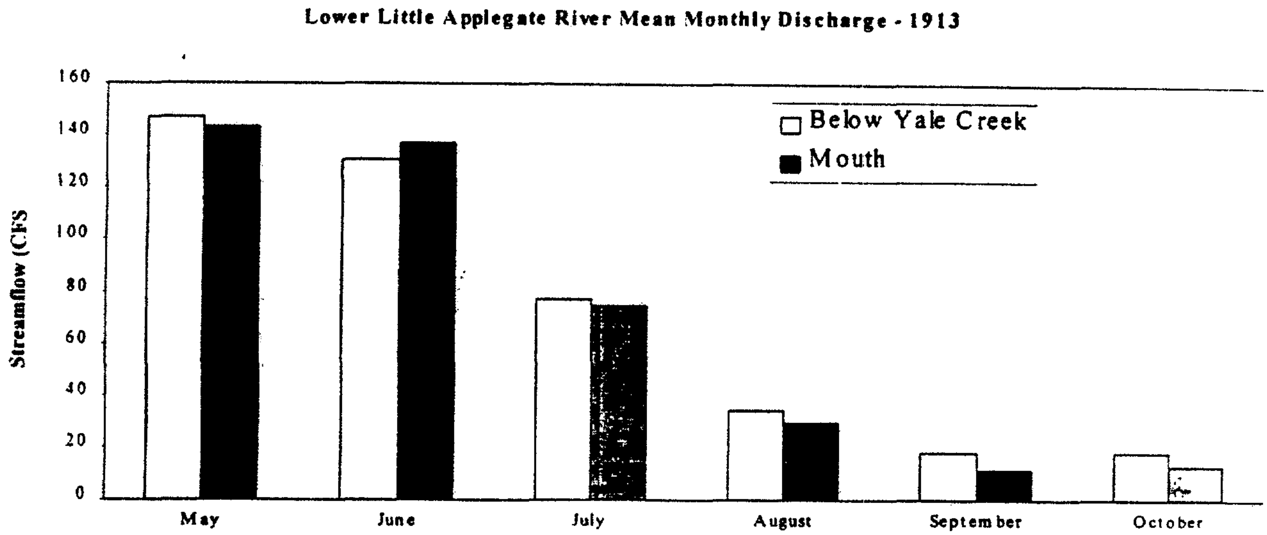


Figure #4



During 1994, instantaneous flows were measured on six dates during the irrigation season at six stations on the main stem Little Applegate River below McDonald Creek. The results are displayed in Figure 5. There was no measurable precipitation during this period except for a 1 1/2-inch storm in late September; the flow measurement below Yale Creek was actually taken following this storm and two days later than the other September readings, so that the reading for this station on that date should be ignored. The 1994 season followed a winter of near-record low precipitation and snowpack so that the flows displayed in Figure #5 essentially represent base flow for that time period (minus water withdrawals).

Figure #5

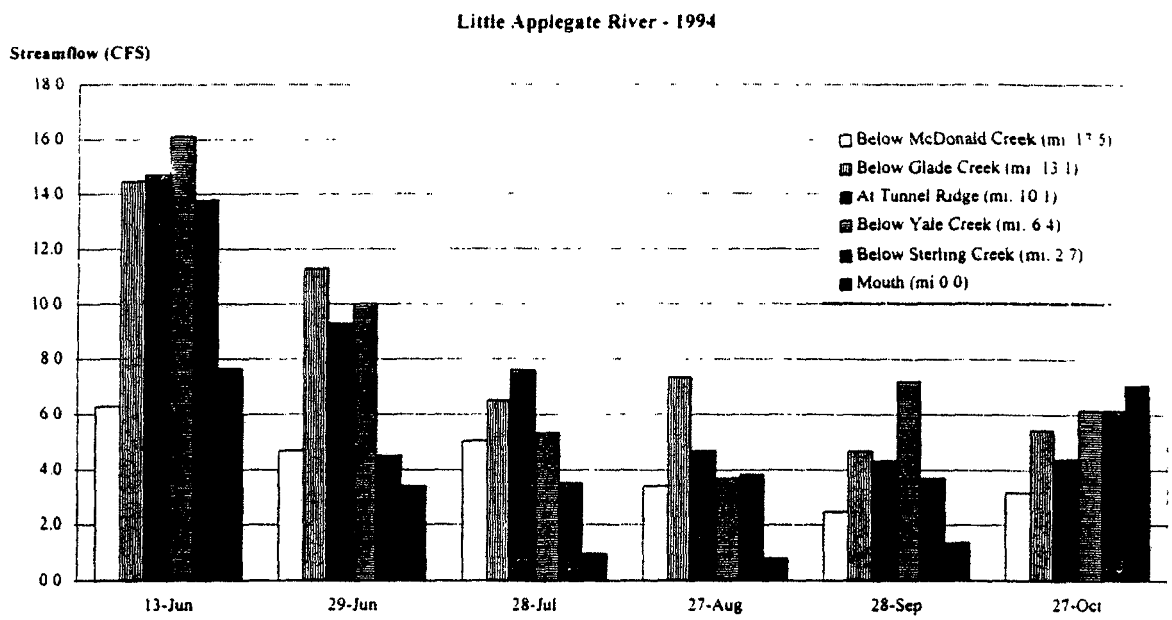


Figure #5 displays the normally expected increase in streamflow progressing downstream from McDonald Creek (M.P. 17.5) to Glade Creek (M.P. 13.1). There are no valid water rights in this reach of the river except for the Sterling Ditch which has not conveyed water in recent years. Flows below Glade Creek are shown to progressively decrease toward the mouth of the Little Applegate River during the irrigation season. The decrease between Glade Creek and Tunnel Ridge (M.P. 10.1) is unexplained but may be attributed to seepage lose since there are no known valid water rights in this reach. The 23 cfs demand for irrigation and associated consumptive uses occurs below Tunnel Ridge on the main Little Applegate and its lower tributaries, notably Yale Creek. The last measurement was at the end of the irrigation season and shows a return to the normal progressive downstream increase in flows typifying undiverted streams. The 0.8 to 1.4 cfs measurements at the mouth of the Little Applegate River from July through September are typical even in summers following winters of normal or high amounts of precipitation, as noted earlier.

Another way to understand the current demand for water on instream flows is to compare this demand with the non-exceedance values developed in a low-flow analysis. Non-exceedance probability is the probability (or chance expressed as a percent) that, in any given year, the annual minimum mean flow for a given duration will be less than the stated magnitude. Table #2 for the Little Applegate River was extrapolated from statistical data for the Applegate River near Copper gage #14362000 (USGS Open-File Report 93-63). It displays magnitude and probabilities of non-exceedance of (natural) low flows in nine duration classes for the Little Applegate River at its mouth. The tabulations show annual-minimum mean flows (cfs) for averaging periods of 1, 3, 7, 14, 30, 60, 90, 120, and 183 consecutive days (n-days mean flows) for recurrence intervals of 2, 5, 10, 20, 50, and 100 years. Associated annual non-exceedance probabilities are 50, 20, 10, 5, 2, and 1 percent. For example, in any given year there is 50 percent chance (or once in every two year probability) that the annual minimum mean flow for 90 consecutive days duration, which is 26 cfs, will NOT be exceeded at the mouth of the Little Applegate River. Stated another way there is a 50 percent chance each year that flows at the mouth of the Little Applegate will average less than 26 cfs for 90 consecutive days. Again, these flow rates assume unregulated natural flows and no upstream diversions. To build on this example, when the irrigation demand of a near constant 69 cfs from April through October is compared to the 26 cfs (50 percent chance 90 consecutive day) non-exceedance value for a given year, it is again evident why the lower Little Applegate River experiences extremely low flows for long periods.

Table #2
Magnitude and Probability of Annual Low Flow

Period (Consecutive days)	Discharge, in CFS, for indicated Recurrence Interval, in years, and Annual Non-exceedance Probability, in Percent					
	2 yr 50 %	5 yr 20 %	10 yr 10 %	20 yr 5 %	50 yr 2 %	100 yr 1 %
1	18 cfs	14 cfs	12 cfs	10 cfs	9 cfs	8 cfs
3	18 cfs	14 cfs	12 cfs	11 cfs	10 cfs	8 cfs
7	19 cfs	14 cfs	13 cfs	12 cfs	10 cfs	9 cfs
14	20 cfs	15 cfs	14 cfs	12 cfs	10 cfs	9 cfs
30	20 cfs	16 cfs	14 cfs	13 cfs	12 cfs	11 cfs
60	23 cfs	18 cfs	16 cfs	14 cfs	13 cfs	12 cfs
90	26 cfs	21 cfs	18 cfs	17 cfs	15 cfs	14 cfs
120	31 cfs	24 cfs	22 cfs	19 cfs	17 cfs	16 cfs
183	57 cfs	40 cfs	32 cfs	28 cfs	23 cfs	20 cfs

Owing to high demand for water in the Little Applegate Watershed during the low flow period, the OWRD has placed constraints on applications for surface water rights in this basin. Applications are only accepted for domestic, livestock, power development, and instream uses, for irrigation of non-commercial gardens less than one-half acre, and for storage from November 1 through March 31. This does not guarantee a water right for specific applications but initiates an availability study to determine if there is water available for said applications. There are no constraints on wells in the Little Applegate beyond the normal permitting restrictions required by Jackson County.

Effects of decreased summer flows on water temperatures, habitat structure and fish populations are discussed in the Water Quality Section of this report and in the Stream Ecosystem Report.

High Flows and Human Processes Affecting Those Flows:
High flow information, including peak discharges, is not available for the Little Applegate River or its tributaries. Data from nearby gages reveal that the 1974 flood was the greatest known event for most streams in this region. The Applegate River gage near Copper registered its maximum discharge during the 1974 flood, which was greater than a 100-year event; peak events were also recorded there in 1950, 1955, and 1964.

Although there are no flood control structures in the Little Applegate Watershed, available information is that past floods, particularly since the late 1900s, did not result in extensive damage to private property (structures). Even in earlier years most documented structural damage involved mining improvements such as flumes and reservoirs, and mining equipment; other than that most damage was erosion of and deposition on agricultural land. Most recent damage has been to public roads and bridges (see History Report). The lower Glade Creek bridge and the Little Applegate River bridge at Yale Creek were reportedly washed out in 1964. During most large floods, it was also common for huge log jams from logging debris to form; upon breaching they would cause damage to the downstream riparian zone. There is no record of any homes being swept away by flooding except that the Smith property at the mouth of Yale Creek reportedly experienced some damage during the 1964 flood which some residents say was greater than the 1974 event. Since structural damage to private property has not been a major or recurrent problem, this has not to date been identified by the public as a major issue. But since the last major flood was in 1974, it is unknown to what extent, if any, that urbanization since that time has encroached into floodprone areas.

The exact changes in timing and quantity of runoff, including the magnitude of increased peak flows, that are due to human processes or management activities in the Little Applegate is unknown. The primary human processes influencing runoff (and attendant sediment loads) are roading and the alteration of vegetation through timber harvest, man-caused wildfire, fire exclusion, and conversion of sites to agricultural use. Urbanization is having an increasingly greater influence, particularly owing to its concentrated close proximity to streamcourses. Roads affect runoff in that they act as ephemeral or intermittent streams by serving as conduits in intercepting surface and ground water, and transporting this water more efficiently to streamcourses. This usually results in increasing the magnitude of peak flows. This effect is more pronounced in areas with high road densities and where roads are in close proximity to streamcourses. Peak flows may also be influenced by vegetative removal and logging practices which contribute to soil compaction and/or removal of ground cover with consequent increases in surface runoff. The degree to which long-term fire exclusion has offset timber harvest and type conversion to agricultural uses, and the significance this may have on timing and magnitude of runoff, is not known. The combination of intensive roading and regeneration harvest over the past 30 years suggests that there is a net increase in runoff and peak flows over historic levels. However, these human processes have more of a noticeable effect in smaller headwater drainages and on the smaller magnitude but more frequent flows of two, five, and 10 year return intervals. Large catastrophic events such as in 1964 and 1974, which occur once in 50 to 100-plus years, are due to combinations of extreme climatic events involving high-intensive long-duration tropical storms on heavy snowpacks and saturated ground conditions (Rothacher 1973, Harr 1975, Harr 1976, Harr and Frediksen and Rothacher 1979). These catastrophic events are not influenced by harvest and roadbuilding.

Flow Condition Trends:
High flows are not expected to change much from current conditions based on current human processes operating within the Watershed. Urban development may result in some increase in smaller peak flows of five to 10 year return periods in tributaries such as in lower Yale Creek and Sterling Creek. The remaining subwatersheds are largely in public ownership. It is expected that any increase in management intensity that may apply to private land in these subwatersheds will be offset by decreases on public lands. That is, there will likely be no substantial change in magnitude in the smaller flood events in those subwatersheds because overall future timber management will be less intensive and current regeneration units will be allowed to hydrologically recover under the ecosystem management concepts adopted with the President's Forest Plan. Larger flood events on the lower Little Applegate

River will not change; as noted earlier, these events are not noticeably influenced by management activities.

Low flows will continue to be below levels needed to support healthy fish populations and other instream values. This assumes a continuation of water withdrawals under existing rights, and no commitment to augment these flows by other means.

Options to Alleviate Low Flow Impacts:
Several concurrent actions are appropriate if habitat for anadromous and resident fish in the Watershed is to be improved. Restoration of the riparian zone and treatment of sediment sources are two of those actions that are discussed elsewhere in this report under the sections on Riparian Transition Zones and Water Quality. Potential for direct stream habitat improvement actions are discussed in the Stream Ecosystem Report.

Another action, addressed here, is the consideration of options to increase instream flows in the main stem Little Applegate and lower McDonald and Yale Creeks during the irrigation season.

One option is to construct a reservoir on the upper main stem Little Applegate or possibly one of its higher tributaries, most likely Glade Creek. A maximum reservoir capacity of 9580 acre feet would be required to store the entire 23 cfs under permit for consumptive uses from April 1 through October 31 in the lower 10 miles of the Little Applegate and its lower tributaries. A smaller structure of about 6000 acre-feet capacity would likely be required since there is usually sufficient natural flow in the Little Applegate to support consumptive and instream needs during April and May of all but the most extreme drought years. An even smaller structure would be required if continued low flows in the lower two or three miles of Yale Creek were accepted so that only Little Applegate River flows were augmented. If replacement water was to be provided to Yale Creek, then a delivery system would need to be included. This option would not benefit the lower one mile of McDonald Creek, below the TID diversion, since a water storage facility would most likely not be located in this subwatershed due to extremely high sediment loads (see Watershed Condition and Water Quality Sections of this Report). The chief benefit of a structure would be the ability to capture surplus winter flows for later use using gravity release, thus maintaining instream needs for fish. Another benefit is that existing diversion ditches could be used. Besides the high investment costs, other negatives might include adverse effects on resident fish habitat, wildlife habitat, and sediment deposition and associated high reservoir maintenance costs if the structure is located downstream of the main sediment sources (see Water Quality Section). Another concern is that temperatures of water released by a storage facility must be maintained at optimal levels for salmonids. Also, a structure might accelerate urbanization in the lower Watershed by being designed to hold additional water for that purpose.

A second option is to import water by pumping from the Applegate River near its confluence with the Little Applegate. Benefits again include an ample supply of water during the irrigation season while maintaining natural flows in the lower Little Applegate. Negatives include high capital investment costs, maintenance of pumps and main and lateral delivery systems, and the potential to accelerate urbanization in the lower Watershed should additional pumping capacity be designed for that purpose. There is also the need that temperatures of water pumped from the Applegate River are optimal for salmonid needs in the Little Applegate.

A third option is to purchase early (high priority) irrigation rights from willing sellers and devote thi. water to instream values. Assuming there are enough willing sellers to provide adequate instream flows for fish, the initial cost may or may not be in the range of a structural option. Benefits are that there should be no maintenance costs such as are associated with structural options, there is no additional water being made available which would encourage additional urbanization in the watershed, and there would be no negative impacts to wildlife habitat. The major negative would be a change in the way of life of those traditional users of irrigation water. A variation of this option is to encourage the use of more efficient irrigation systems. The State of Oregon offers incentives to convert from less efficient systems (e.g. flood irrigation) to more efficient systems (e.g. sprinkler) with the stipulation that a portion of the savings be retained in the stream to benefit aquatic resources. The same benefits are realized as with purchase of water rights, and there would be less impact to the traditional agricultural use of the valley bottoms. However, in order to acquire adequate instream flows for fish values, some combination of purchase and increased efficiencies of use might be needed.

Another option to explore is importation of water by gravity from Applegate Reservoir (assuming there is enough elevation) or from Squaw Lakes. Some of the benefits and negatives identified in the first two options apply here also.

Use of vegetation management to augment summer flows is not a viable option; research has found that such practices may slightly increase total yield and delay runoff for several weeks into the summer, but the magnitude of these responses is not sufficient to meet existing demand and maintain summer flows. In addition, the practices needed to augment flows, such as regeneration cutting, may not always be compatible with direction in the President's Plan.

None of the above options address the low flows in the lower mile of McDonald Creek. If fishery values there are considered valuable enough to preserve, the only apparent cost effective way to do so is to purchase TID water.

All options should incorporate a cooperative effort, possibly coordinated by ODFW, to identify and eliminate illegal diversions from the Little Applegate and its tributaries.

These and/or other options would need to be analysed in the NEPA process.

SECTION 2

WATERSHED CONDITION

Cumulative Effects (Current Condition):
An overall current watershed condition rating was obtained for subwatersheds in the Little Applegate Watershed by using a process for determining risk of cumulative watershed effects (CWE) from multiple activities. An "overall condition rating" is obtained by combining a "watershed risk rating" and a "channel condition rating" which are developed from various physical parameters analysed for each subwatershed. The watershed risk rating is an integrated index of the current degree of human activity (processes) within a watershed, and the consequent potential to contribute adverse impacts to aquatic resources. The channel condition rating is an index of current channel and fish habitat conditions and is based on indicators believed to limit fish populations. The variables and rating procedures are described in detail in the document "Determining the Risk of Cumulative Watershed Effects Resulting from Multiple Activities" (US Forest Service - February 1993).

Subwatersheds that were analysed are shown in Figure #6.

Figure #6 - Little Applegate Subwatersheds

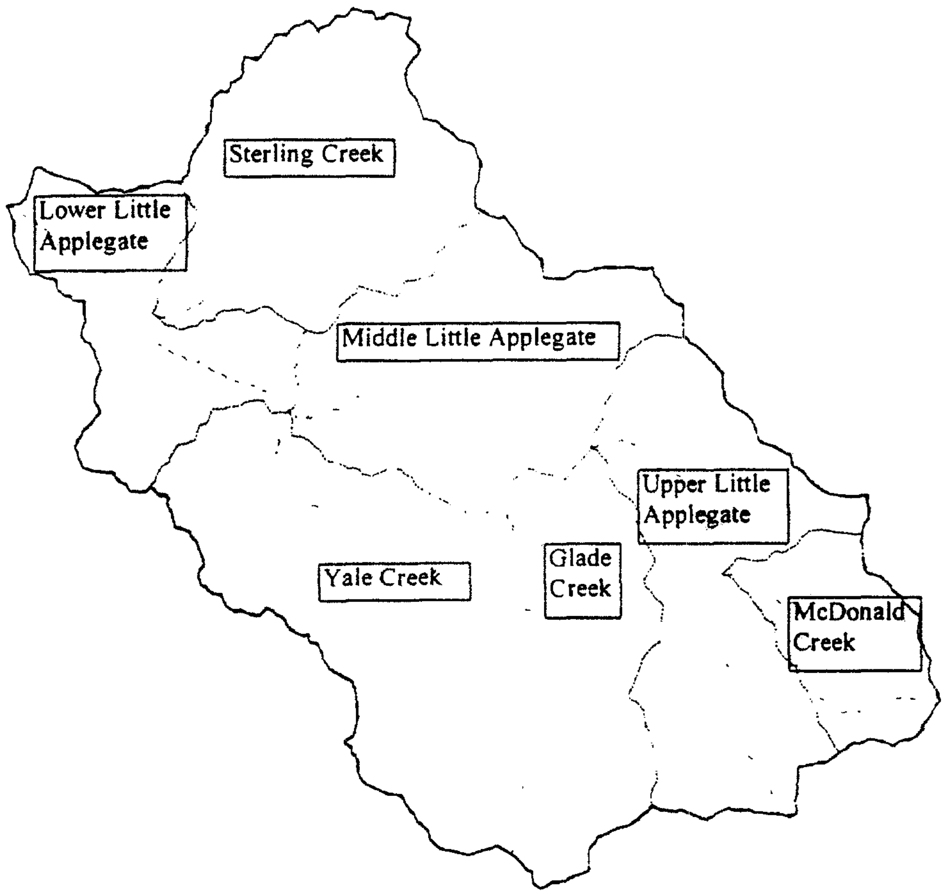


Table #3 summarizes data for variables used to derive current watershed risk ratings and identifies the rating for each subwatershed. The variables used to assign watershed risk ratings are road density and "hydrologic recovery" which, in short, is an expression of the proportion of the watershed converted to early succession stage.

Table #3
Watershed Risk Rating
Little Applegate Subwatersheds

	Area		* Watershed Area Considered NOT Hydrologically Recovered		Roads	Density	Watershed Risk
Subwatershed	Acres	Sq.Mi	Acres	% Subwatershed	Miles	Mi/Sq mi	Rating **
McDonald Creek	4,650	7.3	1,050	23%	26.8	3.7	High
Upper Little Applegate	12,200	19.1	2,410	20%	57	3	High
Glade Creek	8,730	13.6	2,020	23%	39.7	2.9	High
Middle Little Applegate	11,960	18.7	1,540	13%	55.8	3	Moderate
Yale Creek	15,230	23.8	4,440	29%	99	4.2	High
Sterling Creek	11,890	18.6	1,890	16%	88.6	4.8	High
Lower Little Applegate	7,600	11.9	360	5%	29.5	2.5	Moderate
Totals	72,260	113.0	13,710		396.4	3.5	

* Defined as Forest Types that are less than 30 years old.
** Determined using Figure 1 in US Forest Service CWE Process (February 1993).

Table #4 summarizes information for variables used to derive current channel condition ratings and identifies the rating for each subwatershed. The variables used for this analysis are water temperature and embeddedness.

Table #4
Channel Condition Rating - Little Applegate Subwatersheds

	Variable Ratings		Channel Condition
Subwatershed	**Temperature	**Embeddedness	***Rating
McDonald Creek	Good	Poor	Poor
Upper Little Applegate*	Fair	Poor	Poor
Glade Creek	Good	Fair	Fair
Middle Little Applegate*	Fair	Poor	Poor
Yale Creek	Fair	Poor	Poor
Sterling Creek	Poor	****Poor	****Poor
Lower Little Applegate*	Poor	Fair-Poor	Poor

* These "subwatersheds" are influenced by conditions within other upstream subwatersheds.
** Temperature and embeddedness ratings presented here are a summary of information included in the Water Quality section of this report and in sections of the Stream Ecosystem Report including BLM Benthic Macroinvertebrate Survey.
*** Determined using Figure 2 in US Forest Service CWE Process (Feb 93)
**** No values for Sterling. This rating is a subjective judgement based on personal observation of this heavily altered channel.

Table #5 is derived by combining the watershed risk and channel condition ratings. This rating is one of the main criteria used for determining the risk of cumulative effects to fish populations. All seven subwatersheds rated "poor." Subwatersheds rated "poor" have a relatively high probability of incurring additional risks to fish habitat and populations based on existing conditions and potential project effects within those watersheds. Additional projects may not appear likely to individually adversely affect fish production; however, when viewed cumulatively with other projects and depending on their position in a watershed relative to sensitive areas, it might present additional risk. Whether and how much additional risk is incurred by a project proposal is determined in an individual project risk assessment as part of the NEPA process. Part of that process is to identify mitigation measures, such as watershed restoration, which may negate or reduce additional risk.

Table #5
Overall Condition Rating
Little Applegate Subwatersheds

Subwatershed	Rating **
McDonald Creek	Poor
Upper Little Applegate*	Poor
Glade Creek	Poor
Middle Little Applegate*	Poor
Yale Creek	Poor
Sterling Creek	Poor
Lower Little Applegate*	Poor

* These "subwatersheds" are influenced by conditions within other upstream subwatersheds.
** Determined using Figure 3 in US Forest Service CWE Process (Feb 93).

Channel Structure/Morphology and Human Processes:
A sampling of channel types (Rosgen 1993) was done for several streams in the Little Applegate Watershed. This was done for general descriptive purposes and to help understand channel processes (e.g. sediment transport) occurring within the Watershed. The typing was done using data acquired in ODFW fish habitat inventories (ODFW 1994, ODFW 1995) in conjunction with several random field determinations. The ODFW inventories contains detailed information on channel entrenchment, substrate, width, depth, gradient, habitat type/group, and bank erosion. Sinuosity measurements are lacking but use of 1-inch-to-400-foot photos and personal familiarity with the streams were used to give reasonable estimates.

General Description of Channel Types - The stream channels of the Little Applegate and its main tributaries are predominantly "A2","A3" and "B3" types as defined by Rosgen (1994). The "A" channels are steep gradient (4-10 percent), well entrenched, cascading, step/pool streams; they have a low sinuosity (1.0-1.2) and width/depth ratio less than 12. The "B" channels are moderate gradient (2.0-3.9 percent), moderately entrenched, riffle dominated channels with infrequently spaced pools; they have moderate sinuosities greater than 1.2 and a width/depth ratio greater than 12. The "2" channels have a boulder dominated substrate and the A2 channels are characteristically headwater channels; they have very low sensitivity to increases in streamflow magnitude and/or sediment increases, have a high natural recovery potential, and have a very low streambank erosion potential. The "3" channels have a cobble dominated substrate. The A3 channels are generally located in the middle and upper reaches of the Little Applegate tributaries; they are highly sensitive to increases in stream magnitude and sediment, have a poor natural recovery potential, and have high streambank erosion potential. The B3 channels are generally in the middle and lower reaches of the main Little Applegate and its major tributaries; they have a low sensitivity to increases in streamflow magnitude and sediment, have a high natural recovery potential, and have a low streambank erosion potential.

Human Processes Affecting Channel Morphology - While it is recognized that factors such as ocean productivity, over fishing, and diversions all have affected fish populations, some human activities (processes) have contributed to the decline by their direct and indirect impacts to stream channels (fish habitat). These are discussed here.

Of all human processes affecting stream morphology, **hydraulic mining** in the late 19th and early 20th centuries was the most direct and most dramatic. There was extensive alteration of channel structure in the six miles of the Little Applegate River below Yale Creek and in much of Sterling Creek (see History Report). Hydraulic mining was practiced to a lesser extent in other streams so that direct impacts to channel structure from mining are less evident elsewhere.

Declines in fish populations in the Rogue River Basin parallel the period of intensive hydraulic mining (History Report), and they have never recovered to historic levels. It is probable that this cause-effec relational also applied to the Little Applegate River. What this suggests is that degradation of habitat from mining in the lower Little Applegate is probably one of the causes of the declines of anadromous and resident fish in the Watershed. Mining resulted in the removal of streamside vegetation, notably oak and pine, which provided shade, stabilized banks, and provided large wood for channel structure and habitat. It also simplified fish habitat by shaping or filling small side channels; this affected coho salmon habitat more than chinook and steelhead habitat (see Stream Ecosystem Report).

Another human process that had direct impacts to channel morphology was the removal of wood and channelizing and grading that accompanied conversion of oak and pine sites to **agricultural** use along the Little Applegate and lower Yale Creek.

The impacts from **grazing** have occurred mainly along portions of the lower Little Applegate and in the headwaters of the Little Applegate and tributary streams such as McDonald Creek and Glade Creek. Grazing impacts along the lower Little Applegate primarily involve isolated instances where cattle congregate along streams resulting in removal of streambank vegetation, compaction, and bank erosion. This contributes to local addition of sediments as well as nutrient loading.

Up to 5000 sheep and 2000 head of cattle grazed the Upper Little Applegate and adjacent areas from Grouse Gap to Jackson Gap as late as World War I (History Report). Currently about 200 head of cattle and no sheep graze this area. The impacts to channels from past and current grazing have mostly been "indirect" in that the result has been continued accelerated erosion in the highly erosive granitics which cover most of these headwaters; this in turn has resulted in a constant deposition of decomposed granite in McDonald Creek, Greely Creek, and the Little Applegate River. Since the channels here are mainly steep-gradient high-energy A2s and A3s as discussed earlier. most of the sand-sized sediment is ultimately transported downstream into the lower Little Applegate and Applegate Rivers. While much of the channel sediment may be "flushed" downstream in large flow events. the denuded and gullied headwaters provide a continuous source of sediment to the channels. This constant deposition of sediment in pools and riffles reduces their capacity to provide cover and rearing habitat for fish. and also probably reduces spawning success of salmonids. "Direct" grazing impacts to channels is localized and is generally found where cattle congregate on A3 channels. The impacts of grazing and other human processes on the granitics is discussed further in the Water Quality Section of this report as well as in the Stream Ecosystem Report.

Intensive **timber harvest** and **roading** within the Watershed did not begin in earnest until the 1950s and continued through the 1980s. The influence of these processes on timing and quantity of flows. including peak flows, and thus on channel structure of the middle to lower reaches of the Little Applegate River is likely negligible (see Hydrology Section in this Report). Any influences this recent activity may have on low-frequency high-magnitude peak flows and channel structure in headwater tributaries isn't yet evident since there has not been a major storm/runoff event in 20 years: the impacts are likely to be negligible in the A2 and B3 channels but may result in some streambank erosion on A3 channels. To date the major effect of roading on channel morphology has been from accelerated erosion, particularly in the granitics. As with certain yarding practices (primarily on private lands) and grazing (discussed above), this has contributed to excessive sedimentation in McDonald Creek and the Little Applegate River; this is evidenced by filling of pools by decomposed granite and as embeddedness in riffles. This is discussed in more detail in the Water Quality section of this Report.

Other contributions to this problem include failure of slopes below the **TID ditch** that became saturated during extreme precipitation events, and **natural events** such as the Sheep Creek slide.

Channel Condition Trends:
It is expected that overall watershed condition as evidenced by channel structure and quality of fish habitat will remain the same or eventually improve in subwatersheds with substantial public lands (particularly adjacent to major streams). The condition will remain the same or decline in subwatersheds with substantial private lands and where public lands are restricted to the headwaters and smaller streams.

The above conclusions assume implementation of the President's Forest Plan on public lands where watersheds are allowed to recover and are less intensively managed in the future, where Riparian Reserves are managed to meet riparian goals. and where streamside and possibly instream restoration projects would also be implemented. The result will be reduced aggradation and an upward trend in large conifers on public lands to provide streambank stabilization and a continuous source of coarse woody debris (CWD) for channel structure. The overall watershed condition trend will be upward in the subwatersheds with substantial public lands where aggradation from coarse granitics is not severe. that is, Glade Creek and upper Yale Creek. Watershed condition in Upper Little Applegate and McDonald Creek Watersheds will at best remain the same; while implementation of the President's Forest Plan will result in improvement on public lands. activities on private lands (see management assumptions below) will continue to contribute to the substantial sediment loading of these channels.

The other assumption is that current practices on private lands will be continued. Streamside zones that are currently devoted to agriculture will not be converted to forest, and private forest lands will be managed under current State forest practice regulations. In subwatersheds whose public lands are concentrated in the headwaters, the result will be maintenance of the current simplified channel structure and habitat conditions that are evident in the middle and lower Little Applegate River, Sterling Creek and lower Yale Creek. (Stream Ecosystem Report).

Options or Actions to Improve Watershed Condition:
If the desired future condition is to improve the anadromous and resident fishery where conditions are currently unfavorable, several actions must be considered concurrently. These actions must be taken on private as well as Federal land since most of the potential highly productive anadromous fish habitat is on private land. The options or actions to restore instream flows and to control sediment sources are addressed in the Hydrology and Water Quality Sections, respectively, of this report. Another action is the long term need to restore and protect riparian transition zones for the many riparian values, including streambank stability and recruitment of CWD to streams; this is adddressed under the section on Riparian Transition Zones. Where there is a described need for short and intermediate term improvement in habitat (e.g. adding CWD, creating plunge pools or side channels, etc.), care must be taken to first identify the morphology and type for the section of stream being considered for improvement; this will aid in the proper selection of effective habitat improvement structures (Rosgen 1993, Rosgen and Fittante 1986). This requires site-specific analysis and should be done as part of the project NEPA process.

Application of the above actions will gradually contribute to improvement in the "poor" channel conditions found in six of the seven subwatersheds ("fair" for Glade Creek). However, to improve the overall "poor" watershed conditions found in the seven subwatersheds, road densities should be decreased in all subwatersheds, and hydrologic (vegetative) recovery should be allowed to improve over current levels, except Lower Little Applegate Subwatershed which historically exhibited largely early successional stage characteristics (grass, shrubs, oak).

SECTION 3

WATER QUALITY

Current Condition:

DEQ Findings - Pursuant to requirements of the Clean Water Act, the Oregon Department of Environmental Quality (DEQ) Statewide Assessment of Nonpoint Sources of Water Pollution (Oregon DEQ 1988) identified irrigation, stockwater, coldwater fisheries, other aquatic, wildlife, water recreation, and aesthetics as impacted beneficial uses in the Little Applegate River Watershed. Domestic and mining are additional beneficial uses there, although the DEQ did not identify them as impacted.

According to the DEQ Assessment, the 16 miles of the Little Applegate River from about Greely Creek to its mouth, and the lower four miles of Yale Creek, exhibit moderate to severe water quality conditions and affects on fish. The same report identifies moderate problems of aquatic habitat as affected by stream quality conditions. Figures #7-9 are from the DEQ Assessment.

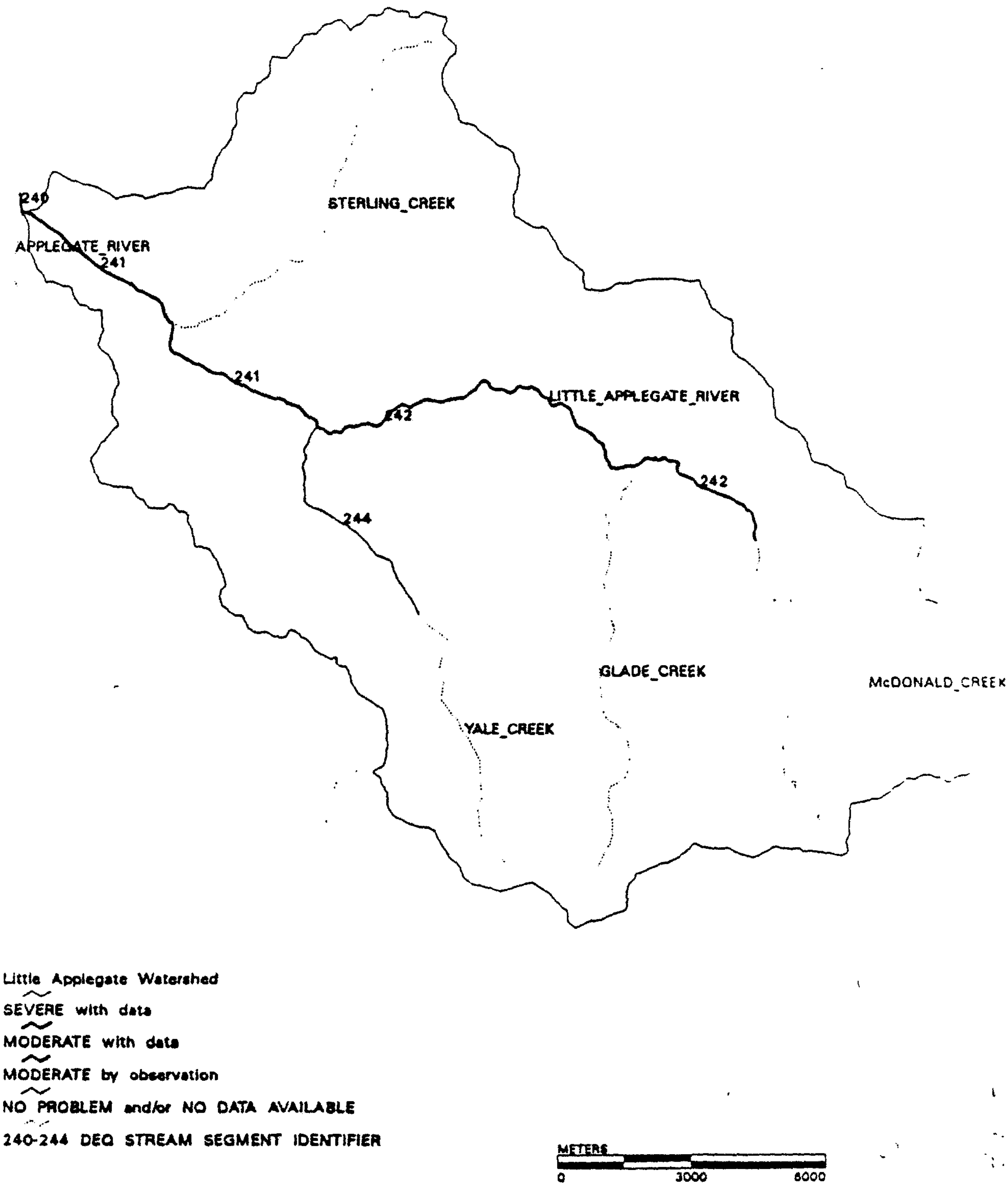
The DEQ found the six miles of the Little Applegate below Yale Creek to be so severely affected that it was listed as a "Category A1" stream; these are waterbodies in which serious nonpoint source (NPS) pollution problems are known to exist or have been reported without challenge. While "A1" streams are high priority for remedial action, it should be noted that this designation is not the same as the "water quality limited" (WQL) designation defined in Section 303 of the Clean Water Act. A Category 1 water body requires additional scrutiny before the WQL designation can be made.

The State identified the following types of, or contributors to, pollution in the Little Applegate River turbidity, low dissolved oxygen (DO), nutrients, sediment, erosion, low flow, and insufficient stream structure. Interestingly, high water temperature was not listed as a pollutant in that report. That may have been due to lack of sufficient data, or it may have been implied by low flows. Neither did the State identify toxics such as heavy metals (associated with certain mining processes) as a pollutant, erosion and sedimentation were identified as the main environmental consequence of placer mining. The DEQ conclusions for some streams or stream segments were determined using data, while for some streams it was based on observation. The 1988 DEQ Report identified vegetation removal, roading, water withdrawals and dredging as causative processes.

Team Findings - Since there is very little water quality information available for the Little Applegate or its tributaries, some data was gathered in 1994 to help quantify current conditions and to verify DEQ concerns. This data was gathered at or near the same locations as streamflow measurements (see Figure #10). Water temperature was considered the most critical parameter; it was measured using continuous recorders from the middle of June through September. Dissolved oxygen data was collected monthly from June through September; this is the critical period when the combination of high temperatures and/or low DO may prove deleterious to fish. Nutrient sampling consisted of the analysis of a single sample collected at each of five locations on the main Little Applegate River and near the mouth of Glade and Yale Creeks; these samples were analysed for orthophosate phosphorus

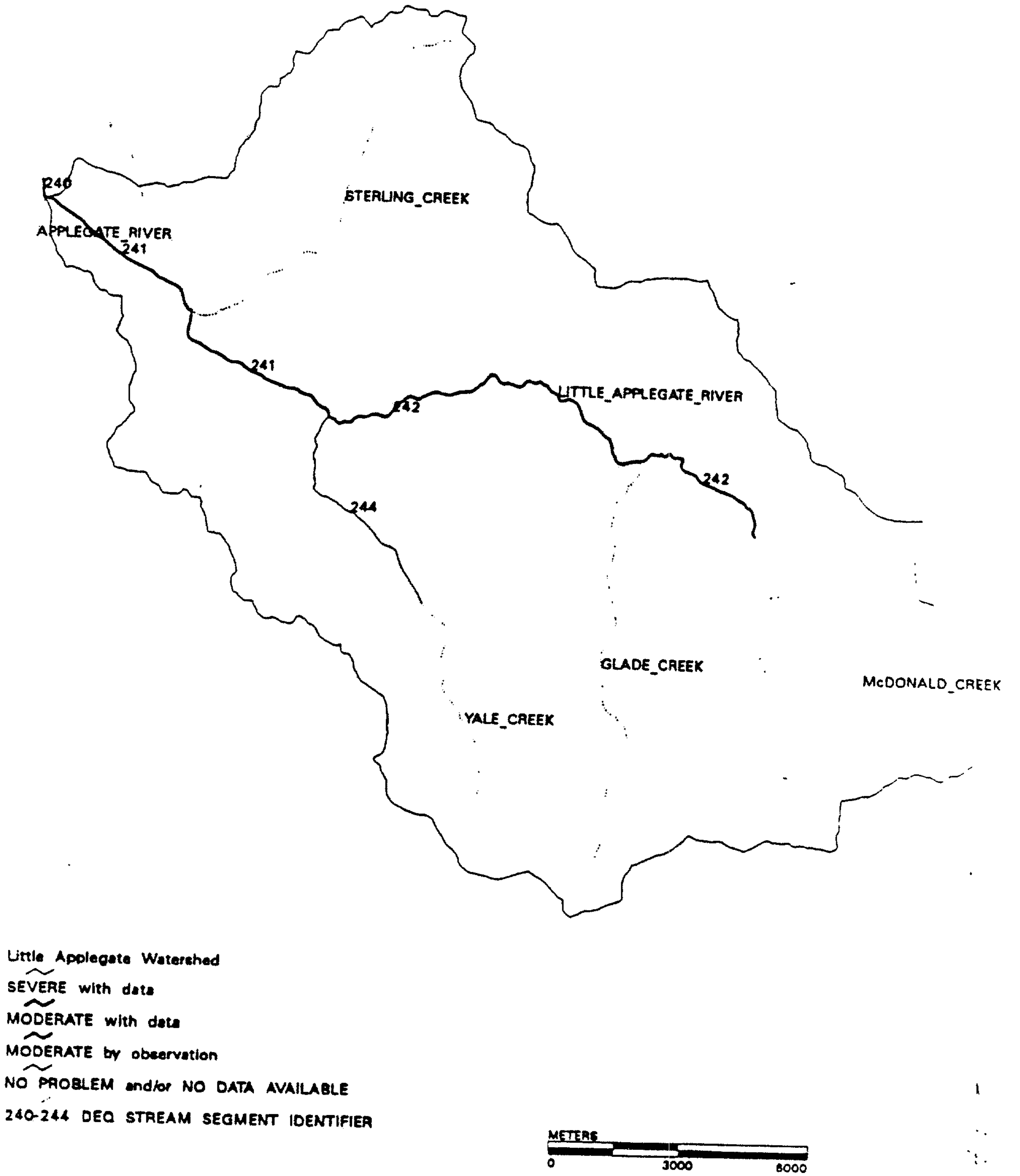
Figure 7

WATER QUALITY CONDITIONS
Little Applegate Watershed
DEQ August 1988

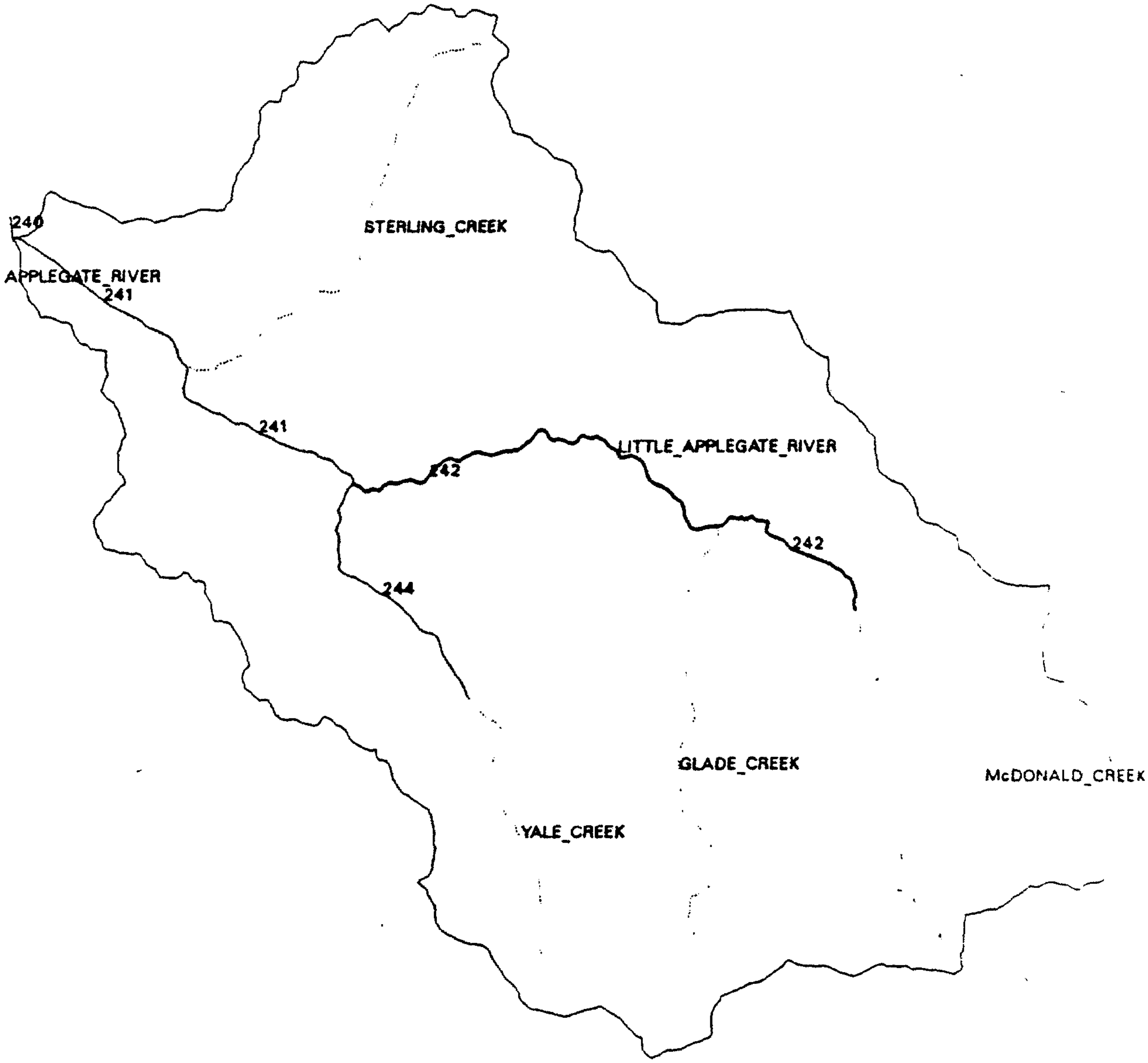


Figure

WATER QUALITY CONDITIONS AFFECTING FISH
Little Applegate Watershed
DEQ August 1988



STREAM QUALITY CONDITIONS AFFECTING AQUATIC HABITAT
Little Applegate Watershed
DEQ August 1988



Little Applegate Watershed

MODERATE with data

MODERATE by observation

NO PROBLEM and/or NO DATA AVAILABLE

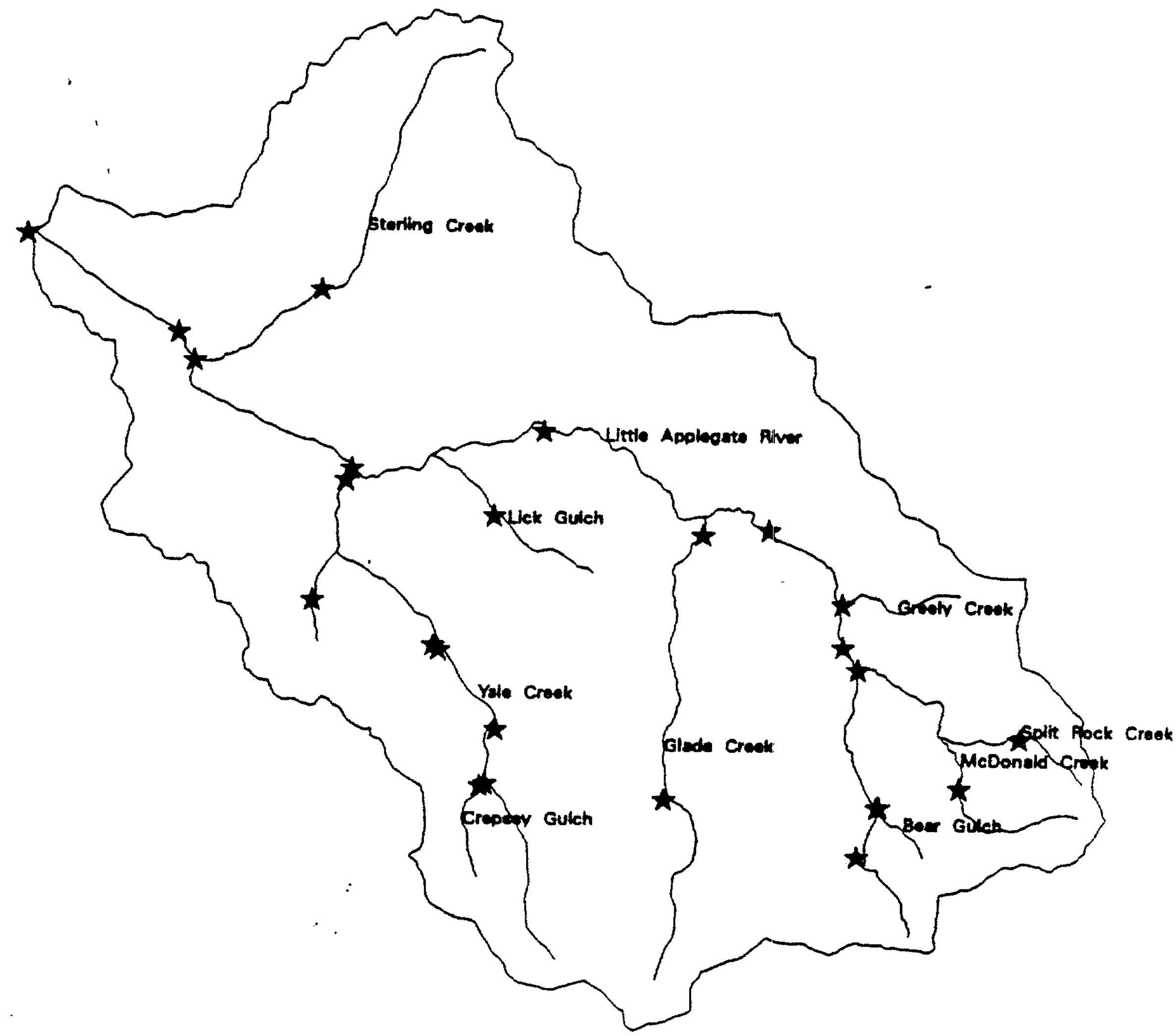
240-244 DEQ STREAM SEGMENT IDENTIFIER

METERS

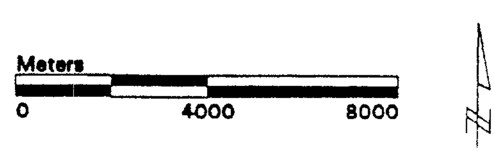
0 3000 6000

Figure 10

LOCATIONS OF WATER QUANTITY/QUALITY MONITORING STATIONS



Star represents station locations.



Sediment is also a critical water quality parameter. Data was not available so that inferences had to be made of its impact by using professional judgment and results of the stream habitat and benthic macroinvertebrate surveys (ODFW 1994, ODFW 1995, Wisseman 1995).

Temperature Findings - Figure #11 displays the percentage of time that stream temperatures fall within specified ranges for the 1994 seven-consecutive-day period of highest stream temperatures: this analysis is from data recorded at seven stations on the Little Applegate River. Figure #12 displays the same information for different reaches of the main tributaries to the Little Applegate. The temperature ranges were chosen based on their affects on salmonids (see Stream Ecosystem Report). For example, temperatures over 68 degrees are rated poor in that they cause stress to fish and result in poor survival: temperatures below 61 degrees are rated good since they are ideal for salmonids.

Two major observations are made from Figures #11 & #12. First, temperatures in tributary streams appear to be generally good for salmonids. During the hottest 7-day period of a drought year, only Yale Creek near its mouth (M.P. 0.0) experienced temperatures over 65 degrees, which is about in the middle of the "fair" range; that occurred for a third of the time in that peak 7-day period. The higher temperatures (65-68 degrees) of Yale Creek near its mouth may be at least partly explained by water diversions. The same findings and conclusions might be made for Lower McDonald Creek (M.P. 0.0) when TID is diverting water; however, this was not the case during 1994 since the TID diversion was shut down on July 6 due to superior downstream rights. Whether subwatershed stream temperatures could have been cooler than recorded during 1994 is not certain but can be inferred from the current condition of streamside vegetation that is discussed in the Riparian Transition Zone Section of this Report. The second major observation is that high temperatures are largely confined to the main stem Little Applegate and that they increase substantially from the headwaters toward the mouth.

Another way to display high temperature data is shown in Figures #13 (stations on the Little Applegate River) and #14 (tributary stations). These graphs display the average of the maximum daily stream temperatures recorded in July and August 1994.

According to Figure #14, except for lower Yale Creek (M.P. 0.0), lower Glade Creek (M.P. 0.3), and lower McDonald Creek (M.P. 0.0), current peak temperatures in all of the Little Applegate tributaries are within the "good" or most desirable range as defined in Figure #11. Lower Yale Creek falls well in the "good-fair" range during both July and August. Lower Glade and Lower McDonald barely exit the "good" range in July but return to that range in August.

Upper Little Applegate River from above Bear Gulch (M.P. 20.0) to the Little Applegate River ford below McDonald Creek (M.P. 17.0) shows a gradual downstream increase in average maximum daily temperatures in both July and August (Figure #13); temperatures in the upper part of this reach are rated "good" and approach the ""good-fair" range at the ford during July. From the River ford to Tunnel Ridge (M.P. 10.1), temperatures remain in the "good-fair" range. Temperatures enter the "fair-poor" range somewhere between Tunnel Ridge and Yale Creek (M.P. 6.4). They are rated "fair-poor" to "poor" below Yale Creek. There is about a nine degree increase in temperature during July and August in the 10 miles of river from Tunnel Ridge to the mouth.

Figure #11

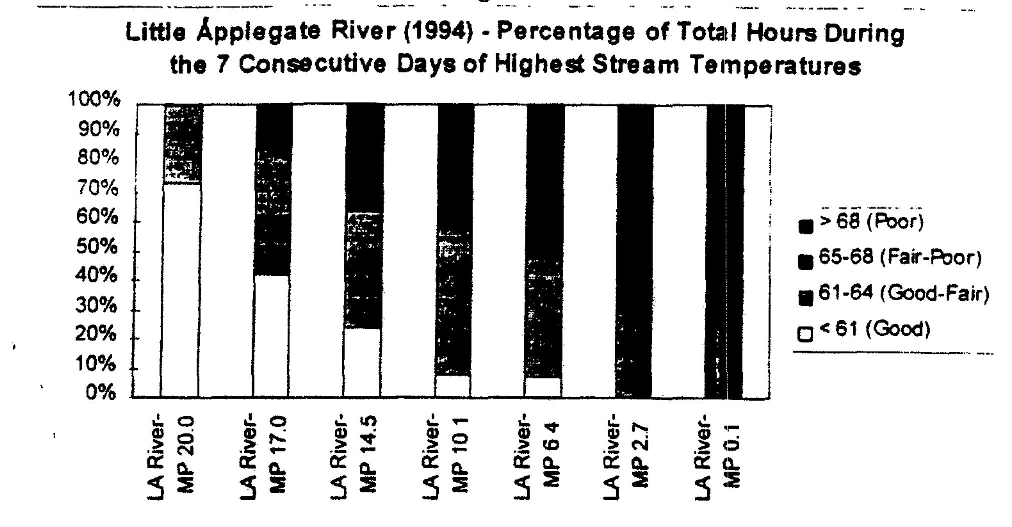


Figure #12

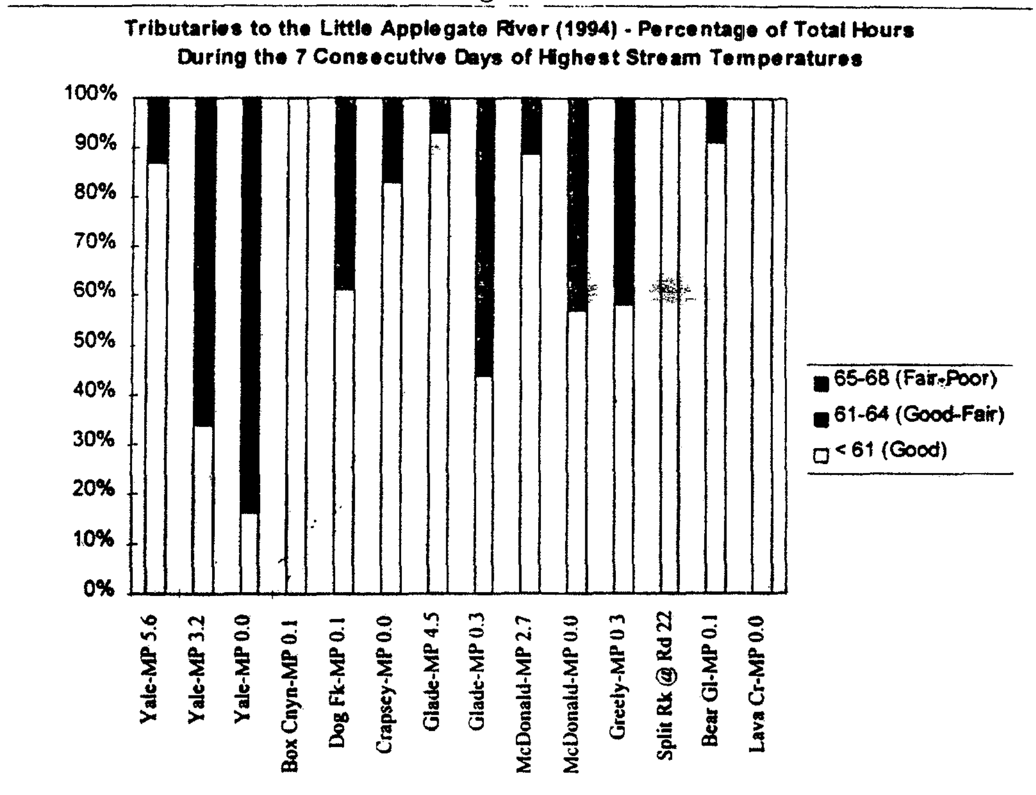


Figure #13 - Average Daily Maximum Temperature During July and August 1994

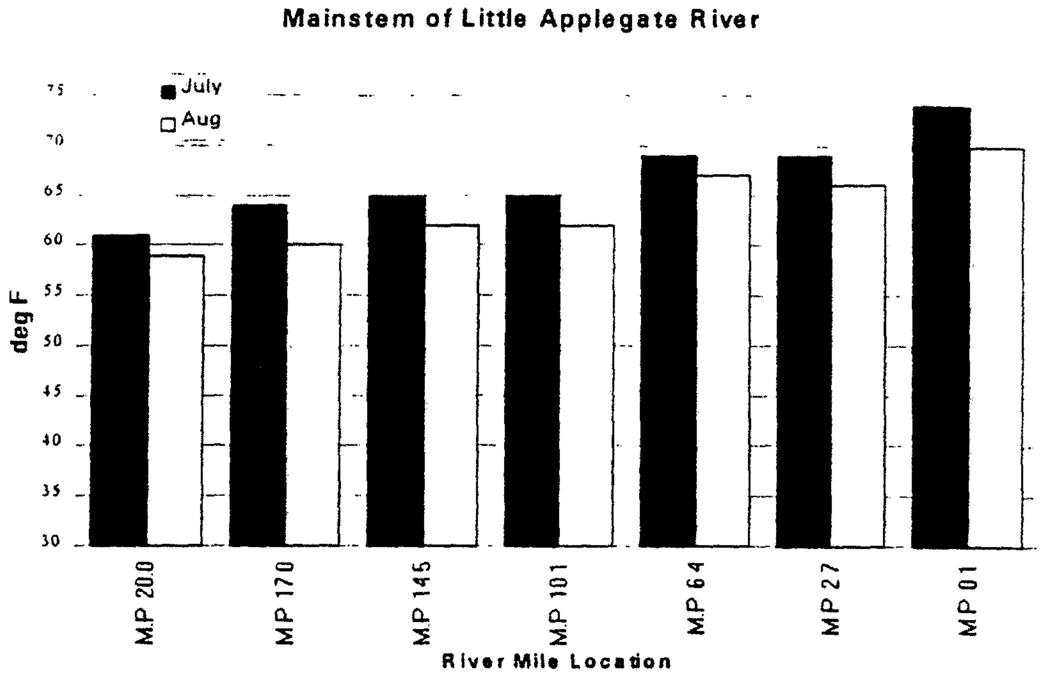
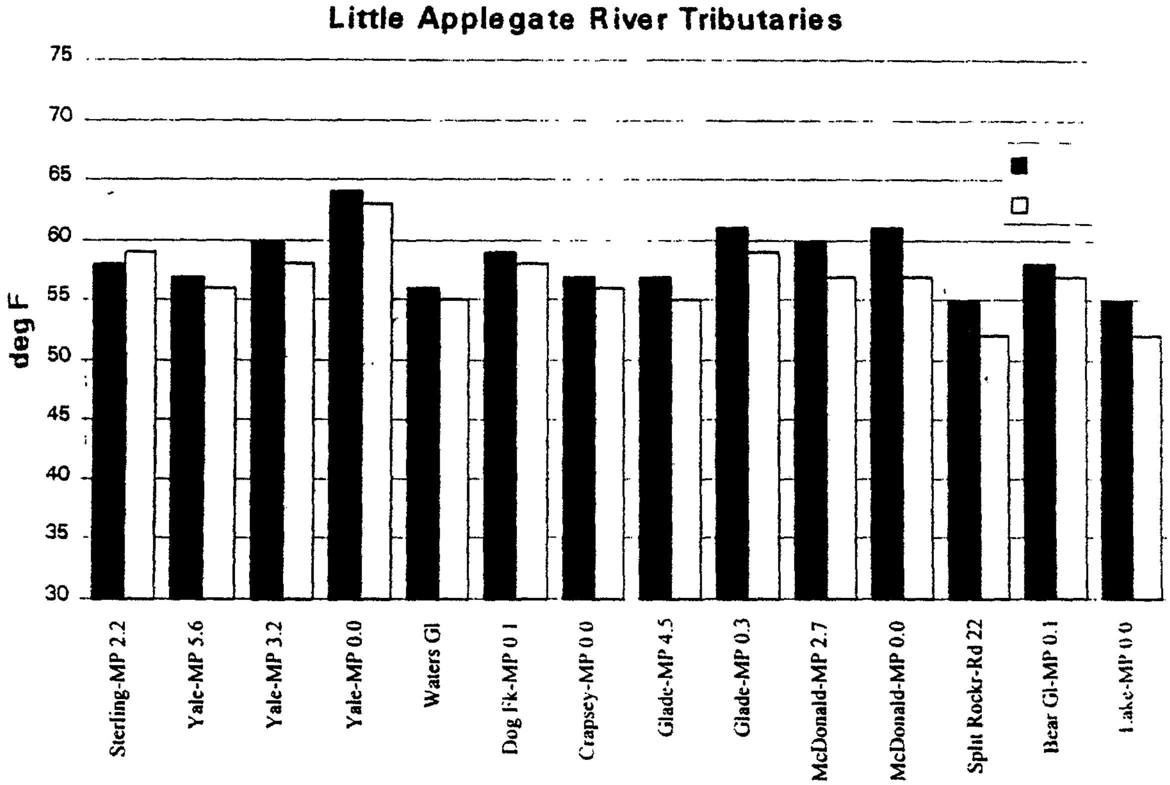


Figure #14 - Average Daily Maximum Temperature During July and August 1994



Some of the increase in temperature in the reach upstream of Tunnel Ridge is likely natural but the increase is probably also influenced by recent harvesting of the riparian zone (see Riparian Transition Zone Section of this Report). The more dramatic increase in the comparable length of river downstream of Tunnel Ridge is believed mainly attributable to water withdrawals (see Hydrology Section of this Report). However, conversion of the streamside vegetation from what was likely oak and pine and streamside alder/cottonwood to only the streamside alder/cottonwood may be contributing some to the temperature increase in the lower reach; this is discussed in more detail in the Riparian Transition Zone Section. A detailed discussion on the effects of stream temperatures on salmonids and other aquatic organisms is found in the Stream Ecosystem Report.

It is logical to assume that drought-year 1994 stream temperatures were significantly higher than might occur in a year of average runoff. Maximum daily temperatures from 1994 were therefore compared to data obtained for three stations on the Little Applegate River during 1993, a year of slightly above average runoff. The comparisons are displayed in Figures #15, #16, and #17. The results suggest that the differences in maximum stream temperature between drought and normal runoff years is as much as eight-ten degrees F until late July. The differences are very small, if not insignificant, for about a four-week period from early August to early September on the main river below Tunnel Ridge. During that period, maximum daily temperatures for the two years were usually within two degrees of each other; some of the 1993 daily maximum temperatures were even higher than recorded on comparable dates in 1994.

Figure #15

Maximum Daily Temperature in Little Applegate River at Tunnel Ridge (M.P. 10.1)

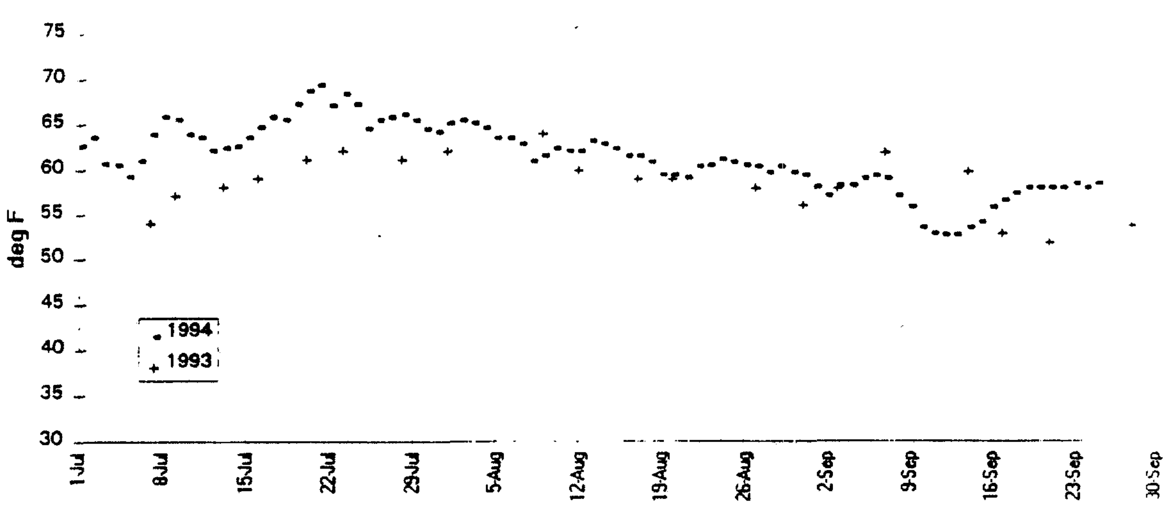


Figure #16

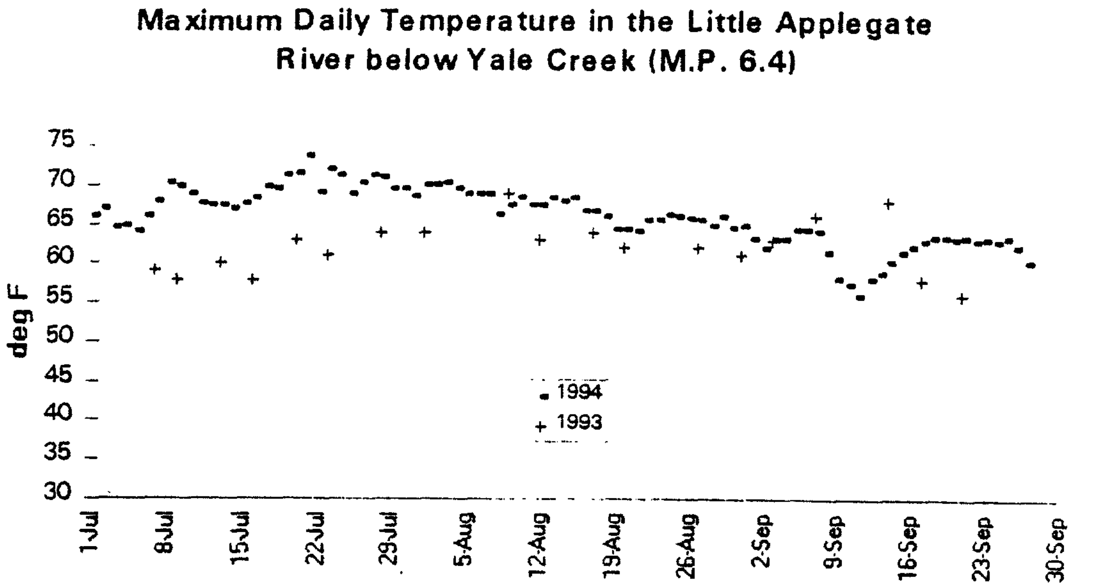
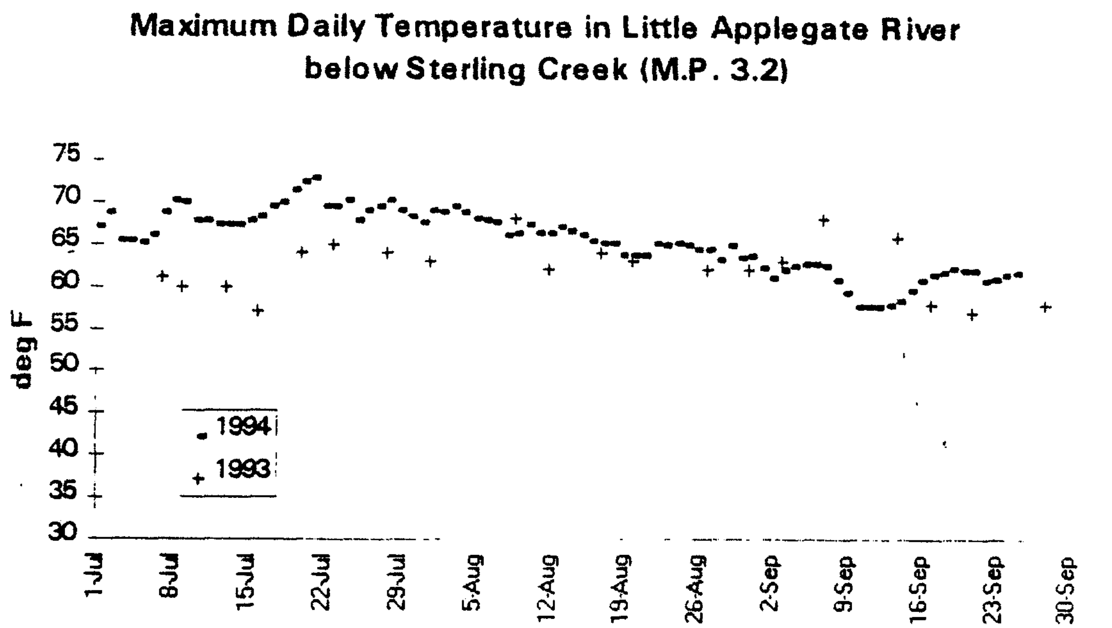


Figure #17



Dissolved Oxygen (DO) Findings - Dissolved oxygen measurements were taken monthly from June through September 1994. They were measured at the same sites as were streamflow and temperature, and were done concurrently with the late-July through September monthly streamflow readings. Tables #6 and #7 summarize DO data in mg/l and percent saturation.

Table #6
Summary of Dissolved Oxygen (DO) Data - 1994
Little Applegate River

Location	River Mile	DO (mg/l) Range	DO (mg/l) Average	Percent Saturation Range	Percent Saturation Average
Above Bear Gulch	20.0	8.7 - 10.0	9.5	90 - 110	98
Below McDonald Creek	17.0	8.1 - 10.1	9.0	88 - 99	93
Above Glade Creek	14.5	9.0 - 9.8	9.2	87 - 100	93
At Tunnel Ridge	10.1	8.2 - 9.8	8.9	86 - 98	92
Below Yale Creek	6.4	8.2 - 9.5	8.8	82 - 102	96
Below Sterling Creek	2.7	8.4 - 9.8	9.1	90 - 109	99
At Mouth	0.0	7.4 - 8.7	8.2	90 - 98	95

Table #7
Summary of Dissolved Oxygen (DO) Data - 1994
Tributaries to the Little Applegate River

Location	DO (mg/l) Range	DO (mg/l) Average	Percent Saturation Range	Percent Saturation Average
Bear Gulch near Mouth	8.9 - 10.0	9.3	94 - 100	96
Upper McDonald Creek	9.1 - 10.0	9.5	92 - 105	97
Split Rock Creek	9.2 - 9.6	9.4	86 - 102	96
McDonald Creek near Mouth	8.7 - 10.4	9.2	93 - 98	95
Greely Creek near Mouth	8.2 - 9.4	8.8	87 - 100	90
Upper Glade Creek	8.6 - 10.2	9.4	91 - 105	96
Lower Glade Creek	7.8 - 10.0	9.2	83 - 101	94
Crapsey Creek near Mouth	9.1 - 9.8	9.4	92 - 100	95
Upper Yale Creek	9.2 - 9.9	9.5	92 - 104	97
Dog Fork near Mouth	9.1 - 9.3	9.2	94 - 97	96
Yale Creek at Kenny Meadows	9.0 - 9.4	9.2	95 - 96	95
Yale Creek near Mouth	8.8 - 9.2	9.0	94 - 99	95

Since the data in Tables #6 & #7 represent only four readings at each site over a four month period, the numbers should be reviewed with some caution. This is evident when it is noted that there is usually a six-to-10 degree F diurnal fluctuation in stream temperatures; the diurnal range is commonly 12-16 degrees at the mouth of the Little Applegate (see Water Temperature Summaries in the Little Applegate Watershed Analysis Planning Files). Since DO is largely temperature-dependent, it may fluctuate accordingly. Other factors can interact to influence the DO content of streams but it is believed that temperature is the major determinant in the Little Applegate Watershed.

Having recognized the data limitations, we have nonetheless made some general conclusions. These conclusions support what has been observed concerning DO concentrations in similar mountain streams in Southwestern Oregon. First, DO does not appear to be a critical concern in any of the **tributaries** to the Little Applegate River. Only one reading below 8.0 mg/l was recorded, this being

7.8 mg/l on Lower Glade Creek; and only one stream had an average (for four summer readings) below 9.0 mg/l, this being 8.8 mg/l on Greely Creek. The literature (Meehan 1991) suggests that DO concentrations above 8 or 9 mg/l are ideal for salmonids and that concentrations below about 6 mg/l result in conditions that are highly stressful to survival. The DO range of approximately 6 to 8 or 9 mg/l is a transition zone where growth, food conversion efficiency, and swimming performance begin to become adversely affected. The DO data for the **main stem Little Applegate** suggests that DO also is not critical for salmonids there except that it may approach the transitional range of concern between Sterling Creek and the mouth. This is supported by the benthic macroinvertebrate survey (Wisseman 1995) where it is suggested that low DO in gravels of the Little Applegate below Yale Creek may be a problem. The Stream Ecosystem Report should be reviewed for a more indepth discussion of the effects of dissolved oxygen concentrations on salmonids and other aquatic organisms.

The DO percent saturation was found to be high. The range for all readings was 82 to 110 percent, and all stations had average readings of 90 percent or more. This may be explained by the generally high gradient nature of the streams (see discussion on channel morphology in the Watershed Condition Section); the large percent of cascading and riffle area associated with these streams assures a high degree of oxygenation.

The overall acceptable DO levels are likely due to the combination of adequate temperatures (for DO concentrations), good mixing, and the lack of instream wood and organic material in general (Stream Ecosystem Report, ODFW 1994, ODFW 1995) which indicates a relatively low oxygen demand for decomposition.

Again these conclusions are based on limited information. But based on our knowledge of DO in similar mountain watersheds, there is strong reason to believe that DO is generally not limiting in most if not all of the Watershed. If any future monitoring is done, it should be confined to the lowest six miles of the Little Applegate, particularly below Sterling Creek.

Nutrient Findings - A single measurement for nutrients (as orthophosphate phosphorus) was made on August 9, 1994. The seven stations where an analysis was made did not always coincide with those locations where streamflows, temperatures, and DO were measured. Table #8 summarizes the station locations and results.

From Table #8 it appears that phosphorus levels are low in Glade Creek and the upper Little Applegate River above the BLM Recreation Site upstream of Tunnel Ridge. Concentrations apparently progressively increase downstream of the BLM site to the mouth of the Little Applegate. Lower Yale Creek has concentrations which appear greater than the more pristine (uninhabited) Glade Creek but lower than that in the main stem Little Applegate near their confluence. The apparent increase in phosphorus concentrations coincides with human habitation along the lower Little Applegate and Yale Creek. It is possible that orthophosphates applied to agricultural or residential cultivated land as fertilizers may enter surface waters from irrigation water return flow (Taras et.al. 1971).

Table #8

Little Applegate Watershed Orthophosphate P Readings (August, 1994)		
	Est. River Miles	
	Above Confluence	Orthophosphate P
Station Location	With Named Stream	(mg/liter)
L. Applegate R. @ FS2250 Rd Crossing near Brickpile Ranch	14.5 Mi Ab Applegate R	0.02
Glade Cr @ 1969 Bridge (FS 2250 Rd Crossing)	1.3 Mi. Ab Little Applegate R.	0.02
L. Applegate R. @ BLM Rec Site	11.8 Mi. Ab Applegate R	0.04
Yale Cr @ Bridge 502	0.5 Mi. Ab Little Applegate R.	0.09
L. Applegate R. @ Bridge 501 above Yale Cr	6.6 Mi. Ab Applegate R	0.27
L. Applegate R. @ 2324 L. Applegate Rd below Sterling Cr	2.7 Mi. Ab Applegate R.	0.29
L. Applegate R @ Mouth	0.0 Mi.	0.32

Phosphorus concentrations in the lower main stem Little Applegate are high in regards to recommended water quality standards. However, there has not been the nuisance proliferation of algal blooms that are commonly associated with excess introduction of nutrients. Perhaps this is due to the relatively turbulent flows as occur in the river; or, there may be other factors limiting such growths. Regardless, any firm conclusions should not be drawn from a single measurement. Results of the initial reading mainly suggest that additional monitoring is advised to determine the extent and consequences, if any, of nutrient enrichment in the Little Applegate. Additional monitoring should include the addition of sites on main tributaries, readings at various seasons and flows, and the analysis of nitrogen levels.

Sediment Findings - Information on turbidity and sediment loading is not available for the Little Applegate River Watershed. Since there was no opportunity to collect such data, some conclusions have been made based on anecdotal information, visual observations, and information included in habitat and benthic invertebrate surveys (ODFW 1994, ODFW 1995, Wisseman 1995).

High turbidity is routinely observed in the Little Applegate River and its tributaries in response to storm-generated runoff. This has been observed on the entire length of the main river to its headwaters near Bear Gulch and in McDonald Creek. Other streams with high turbidity and/or sediment loads include Yale Creek and Rush Creek. Even the lower part of Glade Creek sometimes experiences visible turbidity in direct response to storms. It is reportedly standard procedure for local residents to pump water from the Little Applegate, Yale Creek, and their tributaries for storage just prior to storms; this assures a supply of non-turbid water for domestic use during storm periods.

Because of the moderate to steep gradients of the streams in the Watershed (see Watershed Condition Section of this Report), much of the fine sediment is transported out of the Little Applegate Watershed into the Applegate River. This is most evident in subwatersheds whose sediment supply is dominated by silt and clay sized materials including Glade Creek, Yale Creek, and other tributaries to the Little

Applegate generally in the lower two-thirds of the watershed. But while there appears to be littl visible evidence of deposition in these streams, the stream habitat survey (ODFW 1994, ODFW 1995) and the benthic macroinvertebrate survey (Wisseman 1995) reveal that deposition and embeddedness are concerns in all seven subwaterheds.

During storms, streams in the upper third of the watershed, including Greely Creek, McDonald Creek, Bear Gulch, and some of the facing slopes to the Little Applegate River above Greely Creek, are heavily laden with sediment of coarse-grained decomposed granite origin. Even though the channels here are mostly steep-gradient high energy "A2" and A3" and moderate-gradient "B3" types (see Watershed Condition Section), stream energy is insufficient to transport all of the additional coarser sediments through the system except during unusual events. The reason is that the approximately two-year flood event is recognized as the flow which most influences channel forming processes. Its ability to transport sediment influences channel shape and structure. Since the addition of large quantities of sediment over historic levels, the channels have adjusted. In the case of "A2" and "B3" channels (see Watershed Condition Section) the result is deposition of coarse sand-sized decomposed granite which has reduced pool capacity and produced varying degrees of embededness in riffles (Stream Ecosystem Report); these channels are stable and are resistant to bank cutting. In the case of "A3" channels there is also sediment deposition in pools and riffle areas. But the adjustment in "A3" channels includes some bank cutting; some of the stream energy that was expended in plunge pools which now have smaller capacities, now is directed laterally into banks which have low resistance to these forces. Stream aggradation and adjustment has resulted in a new state of equilibrium where stream energy and an increased sediment supply assure a slow downstream routing of coarse grained decomposed granite while maintaining the aggraded conditions of the feeder streams. During large flood events much of the sediment stored in the tributary channels is transported into the lower Little Applegate and Applegate Rivers. In the exceptional (100-year) flood events, sediment is deposited on the agricultural lands adjacent to the Little Applegate River (History Report). However, unless the sediment sources from human processes are treated, the tributaries and main Little Applegate which are "flushed" of sediments in large events, quickly aggrade to the current condition.

Human Processes Affecting Sediment Delivery - While a certain amount of sedimentation is natural, much of the current rate is induced by human processes. Much of the natural contribution originates with the occasional debris slide such as the 1983 Sheep Creek Slide in McDonald Creek subwatershed. Refer to the Geormopholy Report for a detailed description of the natural mass wasting processes (earthflows and debris slides/flows) and their effects on the sediment regime of the Watershed. That report also discusses how human processes may trigger and thus accelerate mass wasting forces.

Most of the sediment load above natural levels is contributed from roading, timber harvest (primarily yarding activities), grazing, and land failures such as associated with the TID ditch which conveys water from McDonald Creek to Wagner Gap where it leaves the Little Applegate Basin.

The greatest single cause of accelerated erosion and sedimentation is roads. The variables that most determine severity of sedimentation are the proximity of roads to streamcourses and unstable areas, the inherent erodibility of the landscape, and road design factors involving surfacing, control of surface drainage, stabilization of cut/fill slopes, and stream crossing facilities.

Figure #18 displays the extent of road development within Riparian Reserves as defined in the President's Forest Plan. Riparian Reserve widths for the Little Applegate Watershed zone are described in the Riparian Transition Zone Section of this Report. Even though they don't apply to private lands, Riparian Reserve widths are applied in this figure for uniformity in identifying the most critical sediment sources. The roads displayed in Figure #18 are those included in the GIS data base as system roads. There are other roads that are closed or otherwise not recognized as system roads so that there are actually more roading impacts than described in those figures. All other variables being equal, roads located in this zone produce the bulk of road-induced sediment.

Figure #19 displays erodibility potential within the Little Applegate Watershed based on broad groupings of soils at the landscape level; see the Site Productivity Report for a discussion of how erosion hazard ratings were developed. Roading and other human processes on those soil types with erodibility ratings of "very high" and "high" are the greatest potential and actual producers of sediment. The "very high" are the source areas of coarse grained sediments from soils derived from shallow granitics and glaciated granitics; these are found in the McDonald Creek and Upper Little Applegate Subwatersheds. The "high" are the source areas of finer sediments from soils derived from subdued metavolcanics and bench and earthflows; these are mainly found in the lower half of Glade and Yale Creek Subwatersheds.

When considering the information displayed in Figures #18 & #19, the greatest sediment producing roads are those that are both within Riparian Reserves and on soils with "very high" erodibility.

Logging impacts are another major source of sediments. The most damaging process is indiscriminate ground-based yarding which often results in excessive compaction, soil disturbance, and concentration of surface runoff similar to roads. This is a water quality concern throughout the watershed but especially within Riparian Reserves, on steep slopes, and on "highly" and "very highly" erodible soils.

Past grazing impacts to the headwaters of the Little Applegate River, McDonald Creek, and Glade Creek are addressed in the Watershed Condition Section. The discussion there is similar to that discussed in the Sediment Findings subsection above. The grazed headwaters of McDonald Creek especially remain a significant source of sediment.

The TID Ditch is a major contributor of decomposed granite to McDonald Creek, Greely Creek, and the Little Applegate River. Some of this is associated with debris slides immediately below the ditch. These slides were triggered during major storm events when these slopes became saturated from high rainfall and excess water topping the ditch. Some of the sediment is attributed to improperly located release gates and the release of ditch water through these gates onto the granitic slopes below. The result is that some of the slopes below the gates are deeply gullied and actively cutting.

Water Quality Trends:
With the main assumption that there is no augmentation of summer instream flows in the lower Little Applegate River, there will be no improvement (decreases) in the high stream temperatures in this section of river. This also assumes there is no overall change in stream shade provided by the riparian zone along the Little Applegate River and its (perennial flow) tributaries.

FIGURE 13

ROADS IN RIPARIAN RESERVES

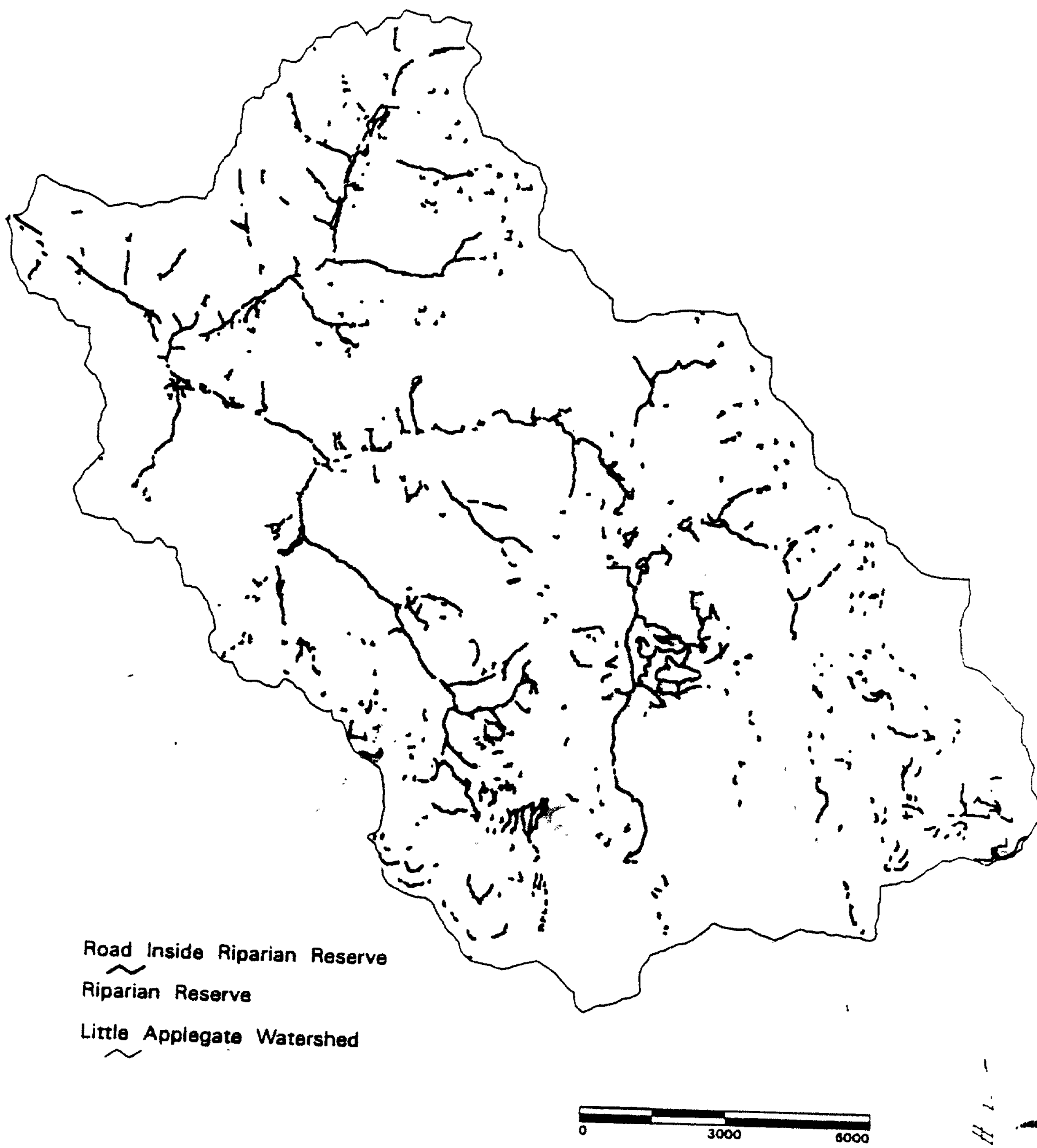
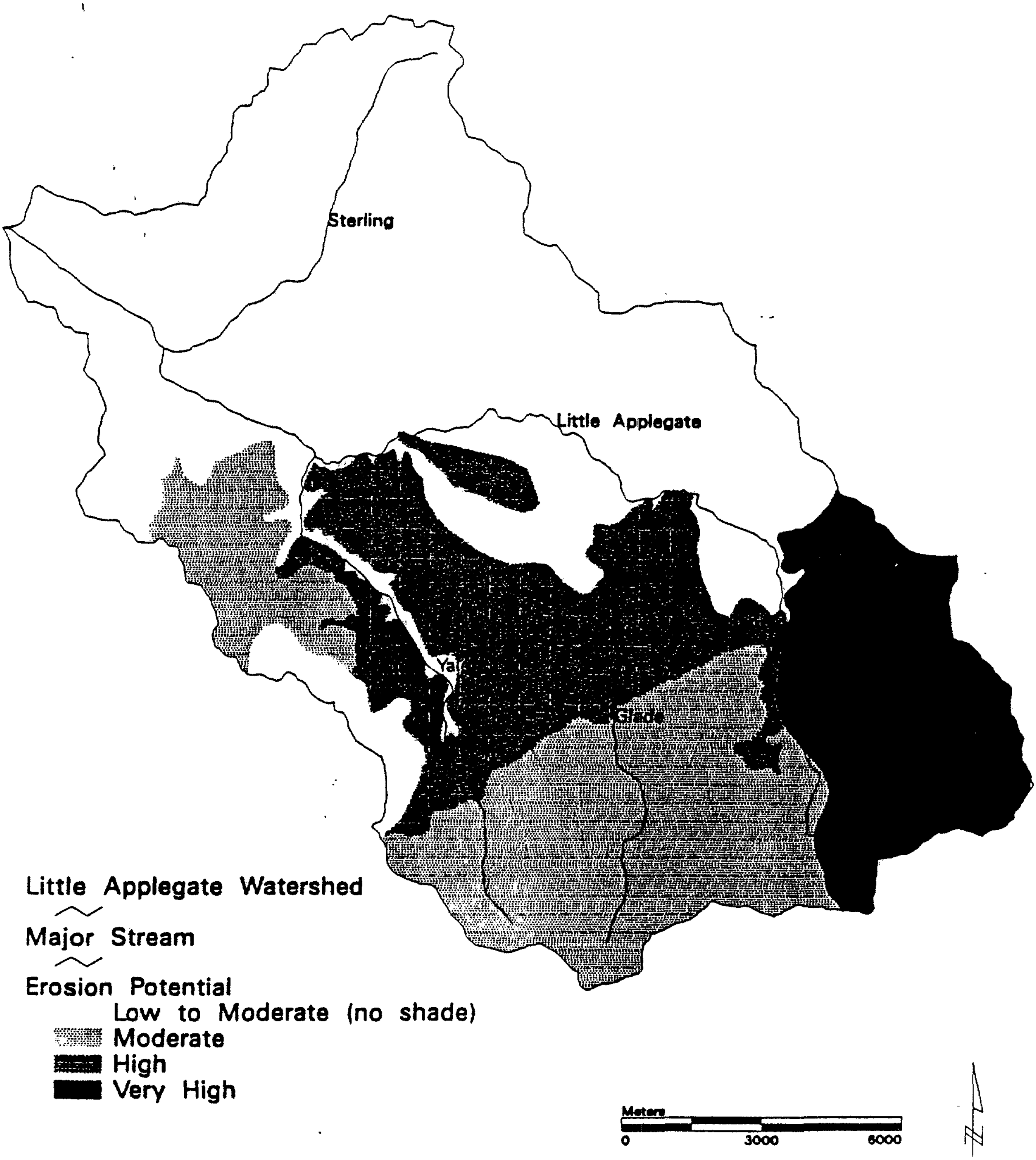


Figure 19

LITTLE APPLEGATE WATERSHED EROSION POTENTIAL



Stream temperatures in the upper Little Applegate River above Tunnel Ridge should partially improv (decrease) as cutover Riparian Reserves on public lands are allowed to recover, and as the riparian zone in private ownership, which was heavily cut over in 1994, is allowed to recover per new State regulations pertaining to stream protection. However, the narrow buffers that eventually recover on private land will not provide the full shading potential needed for recovery of temperatures to historic levels.

Stream temperatures in Glade Creek and upper Yale Creek should slightly improve due to the establishment of Riparian Reserves on the largely public lands in these watersheds.

There should be no change in temperatures in the Middle Little Applegate from Glade Creek to Yale Creek. This assumes maintainance of the current riparian zones and continuing water diversions. which are concentrated in the 1 1/2 miles above Yale Creek.

Dissolved oxygen trends will (inversely) llow that of water temperatures but, regardless, will not significantly change from current conditions. Similarly, nutrient levels will not change assuming continuation of current agricultural practices in the valley bottoms.

Sediment production originating from public lands should somewhat decrease with implementation of the President's Forest Plan pertaining to protection of Riparian Reserves. Sediments originating from private lands will likely not change; this assumes continuation of current practices, particularly relating to roading and yarding activities. However, to decrease sediment to acceptable levels to benefit cold water fisheries, there must be a vigorous restoration effort, particularly on the granitics, subdued metavolcanics, and bench and earthflows. This should apply to both public and private lands. The implementation of best management practices (BMPs) which protect adequate riparian areas as well as restrict adverse impacts to upslope areas are needed in conjunction with restoration efforts so as to preclude the need for future restoration efforts. To be most effective, the restoration efforts and BMP implementation would utilize Riparian Reserve widths universally regardless of ownership.

Options and Guidance to Improve Water Quality:
If the desired future condition is to improve habitat conditions for anadromous and resident fish and other aquatic species, several concurrent actions must be taken on both public and private land. Restoration of the riparian zone and instream flows are two of those actions that are discussed elsewhere in this report under the sections on Riparian Transition Zones and Hydrology; those actions will contribute to improved habitat conditions vis-a-vis pool depth, cover, etc., and to improved (i.e. lower) stream temperatures. Direct stream habitat improvement actions may be involved as identified in the Stream Ecosystem Report.

Another action, addressed here, is the consideration of options to improve water quality by reducing sediment. This involves a comprehensive watershed restoration effort. That effort should include all ownerships.

Prioritization of Restoration Efforts - Based on the observations made under the prior discussions on sediment findings, and on human processes affecting sediment delivery, a proposed prioritization of watershed restoration efforts follows:

Very High Priority -

Grazed headwaters of McDonald Basin;
Roads within Riparian Reserves on "Very Highly" erosive soils;
Yarding impacts (skid trails, landings, etc.) in Riparian Reserves on "Very Highly" erosive soils;
TID Ditch and slopes.

High Priority -

Roads within Riparian Reserves on "Highly" erosive soils;
Yarding impacts (skid trails, landings, etc.) in Riparian Reserves on "Highly" erosive soils;
Roads and yarding impacts on "Very Highly" erosive soils outside of Riparian Reserves;
Grazing impacts in the headwaters of Glade Creek and upper Little Applegate River.

Moderate-High Priority -

Roads within Riparian Reserves on "Moderately" erosive soils;
Yarding impacts (skid trails, landings, etc.) in Riparian Reserves on "Moderately" erosive soils;
Roads and yarding impacts on "Highly" erosive soils outside of Riparian Reserves;
Harvest units or other disturbed sites with very high or very severe erosion hazard whose area-wide effective ground cover (aside from roads and yarding) is less than 85 percent (LRMP 1990).

Moderate Priority -

Roads and yarding impacts within Riparian Reserves on "Low-Moderately" erosive soils;
Harvest units or other disturbed sites with high or severe erosion hazard whose area-wide effective ground cover (aside from roads and yarding) is less than 70 percent (LRMP 1990).

Low Priority -

Roads and yarding impacts on "Low-Moderately" erosive soils outside of Riparian Reserves;
Harvest units or other disturbed sites with very slight, slight, low or moderate erosion hazard whose area-wide effective ground cover (aside from roads and yarding) is less than 60 percent (LRMP 1990).

While Riparian Reserves apply only to public lands, it is desirable that restoration efforts on private lands be prioritized using equivalent distances in the above prioritization scheme.

Watershed Restoration Assessment - In the spring of 1994 the Forest Service and BLM completed a preliminary inventory of restoration opportunities on public lands in the Little Butte Creek and Little Applegate River Watersheds. Based on that survey, about $240,000 of road stabilization work, and $114,000 of upland and riparian projects, were funded on National Forest lands in the Little Applegate Watershed. Another $71,000 of road decommissioning was funded on BLM land in the Watershed. Much of this work has been completed.

In anticipation of additional restoration dollars, an ongoing inventory of additional restoration opportunities has been initiated by the BLM and Forest Service. This inventory involves public lands and certain shared roads which cross both private and public lands. This information is being entered into the Forest Service watershed improvement needs (WIN) inventory and the comparable inventory system used by the BLM. Refer to the Watershed Restoration Report for specific restoration opportunities identified to date. That Report contains three sections: a summary of projects grouped by project type in a chart format; a 1:24000 scale map locating individual projects; and, inventory forms (USFS WIN Oracle database and BLM's database). As restoration dollars become available, this inventory should be used in conjunction with the subsection on project priority that preceded this to determine projects which are most effective in reducing sediment sources. Since it is not complete, plans are to add to the inventory in FY95. In addition, efforts should be made to inventory and rehabilitate sediment sources on private lands, with emphasis on "very high" and "high" priority areas previously described.

SECTION 4

RIPARIAN TRANSITION ZONE

The Riparian Transition Zone (RTZ) as defined here is the predominantly terrestrial zone bordering the aquatic ecosystem (perennial and intermittent streams. lakes. and ponds) and wetlands. This zone has been variously described in Land and Resources Management Plans for public lands as "streamside management zones" and "streamside protection zones," and more recently in the President's Forest Plan as "Riparian Reserves." Although the vegetation structure of the Riparian Transition Zone is predominantly the same as in the upland terrestrial ecosystem. its close proximity to the aquatic zones sets it apart in importance. The integrity of this zone is as important to channel structure, fish habitat. nutrient cycling, water quality, and the affected instream fauna as it is to the upland terrestrial zone and dependent species. It is also uniquely important to certain species (e.g. certain amphibians) which are dependent on both aquatic and terrestrial zones. The importance of the Riparian Transition Zones for streambank stability, coarse woody debris (CWD), shade, cover, dispersal, control of sediment. etc. are addressed in detail in many research publications and in the 1993 FEMAT report.

This section focuses on the importance of the RTZ to the aquatic ecosystem and its dependent species. The Wildlife Report focuses on terrestrial species and habitat.

Historic and Current Condition:
Utilizing the President's Forest Plan for guidance, an attempt was made to compare the current condition of the RTZ to that which historically occurred. In doing so two assumptions were first made. One assumption is that in forested landscapes, forest stands in a late successional development stage are those that provide the desired conditions which maintain and protect the aquatic ecosystem and its riparian-dependent species (FEMAT Report 1993). For purposes of this Report late successional development stage refers to stands that are either in late seral stage or exhibit certain late seral characteristics such as large trees. The other assumption is that, historically, late successional stage forest characteristics were largely maintained adjacent to streams, lakes, and wetlands in the Little Applegate Watershed.

Historic conditions in lower elevation RTZs likely meant open parklike stands of large pine and or oak with a grass/forb understory; this forest condition was maintained by frequent periodic fire whether ignited by pre-European inhabitants or (less frequently) from lightning. A dense more complex stand structure likely developed at high elevations in the true fir zone which experienced a low fire frequency. An intermediate level of stand complexity likely existed at middle elevations which experienced a greater fire frequency than in the true fir but lower frequency than the valley bottoms and lowlands; this zone was dominated by large pine on south slopes and Douglas-fir on north slopes and in draws. For this analysis no attempt was made to determine specifically where each type of stand dominated. All of these stand types exhibit late successsional characteristics pertaining to their influence on channel structure, habitat, nutrient cycling, and water quality. They provide a constant source of CWD as well as input of finer organic material to channels. While the more open stand may have provided less shade, it is likely that the more frequent low intensity fires that maintained these conditions burned even less intensely in the cooler more humid microclimate adjacent to streams

Thus more of the low fire tolerant conifers and hardwoods, which would normally be burned, likely survived in the streamside zone. As a result, stream shading may not have been much lower than under the denser complex stands.

Changes in Development Stage (Successional) Composition of RTZs - In order to compare current conditions within the RTZ to **historic (pre-European settlement) conditions**, reference is made to the Vegetation Report and analysis files supporting that Report. The analysis that produced that report was partly based on some of the earliest most reliable vegetation information available, 1947 forest type mapping (see Analysis Files). It was supplemented with anecdotal accounts of vegetation structure at the time of European settlement of the Watershed in the 1850s (History Report).

The Vegetation Report supports the assumption that late successional dev lopment forests were largely maintained in the sparsely-inhabited and higher elevation tributaries to the Little Applegate River prior to the onset of intensive timber management following World War II. This generally applies to McDonald Creek, Upper Little Applegate, Glade Creek, Upper Yale Creek, and portions of the Middle Little Applegate subwatersheds. The 1947 vegetation map displays the extent of those late successional development forests.

Since the vegetation in the valley bottoms of the Little Applegate below Tunnel Ridge, of lower Yale Creek, and of virtually all of Sterling Creek were long ago altered, the 1947 map does not give a true picture of what likely occurred in these subwatersheds prior to European settlement. Historical accounts are that a pine-oak type was the dominant vegetation in valley bottoms adjacent to perennial flowing (Class 1-3) streams prior to hydraulic mining and conversion to agricultural uses (History Report). The reestablishment of a dominant pine overstory on some of the mined area along the lower Little Applegate River lends some credence to those accounts. Most of the southfacing (mostly Class 4) streams in these subwatersheds had RTZs dominated by grass, shrubs, and oak, just as they are today; they are likely at their maximum potential vegetative development and aren't likely to support significant amounts of conifers.

The overall consensus then is that prior to European settlement, almost all (over 90 percent) of the Riparian Transition Zone adjacent to perennial flowing (Class 1-3) streams reflected the late successional characteristics of the dominant surrounding forest landscape. This was also the case adjacent to many intermittent (Class 4) streams in the higher elevation watersheds.

Figures #20 thru #27 are maps displaying the changes that occurred from 1947 to 1993 in successional stage distribution within Riparian Reserve width boundaries defined in the President's Forest Plan. Changes are highlighted by subwatershed. Riparian Reserve widths for this region are 300 feet slope distance on each side of fish-bearing streams and adjacent to natural lakes and ponds; 150 feet slope distance on each le of perennial flowing nonfish-bearing and intermittent streams, and adjacent to constructed ponc id res rvoirs and wetlands greater than one acre; and includes all streamcourses, water bodies, we ands/ri rian vegetation, and unstable and potentially unstable areas (including earthflows). The Riparia. Reserve widths from the President's Forest Plan are adopted and used synonymously wi the RTZ further in this discussion since these widths are current direction for public lands (only) and supercede others that were included in various Forest and BLM land resource management plans. It is emphasized that Riparian Reserve widths do not apply to private lands: the

Figure 20a
Little Applegate Watershed
1947 Plant Community Successional Stages
Within Riparian Reserve Widths

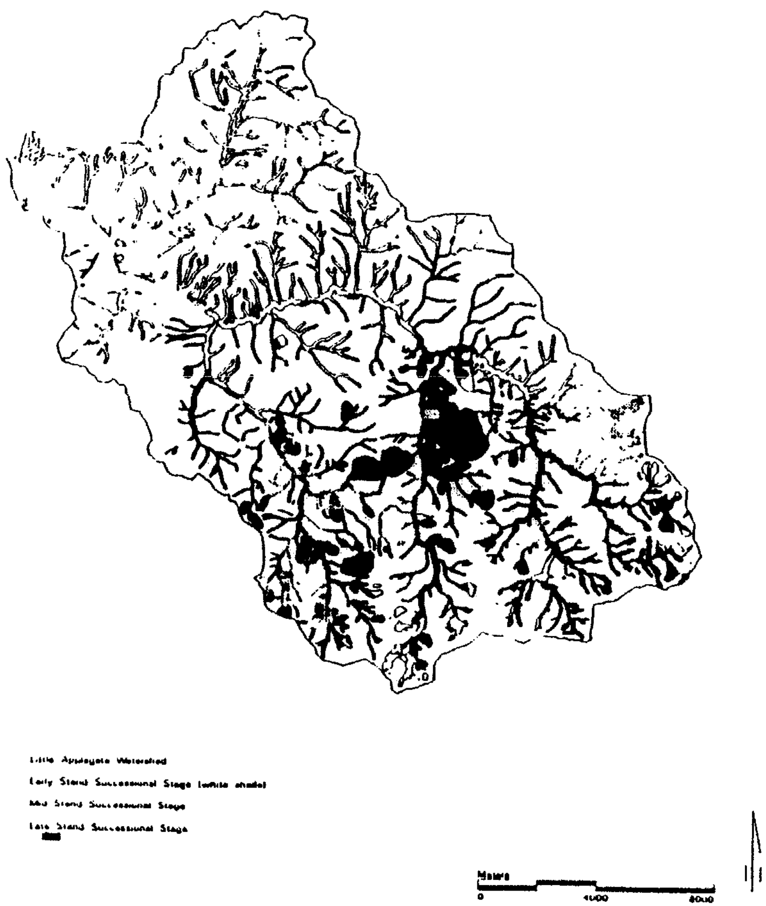


Figure 20b
Little Applegate Watershed
1993 Plant Community Successional Stages
Within Riparian Reserve Widths

Figure 21a
Upper Little Applegate Subwatershed
1947 Plant Community Successional Stages
Within Riparian Reserve Widths

Figure 21b
Upper Little Applegate Subwatershed
1993 Plant Community Successional Stages
Within Riparian Reserve Widths

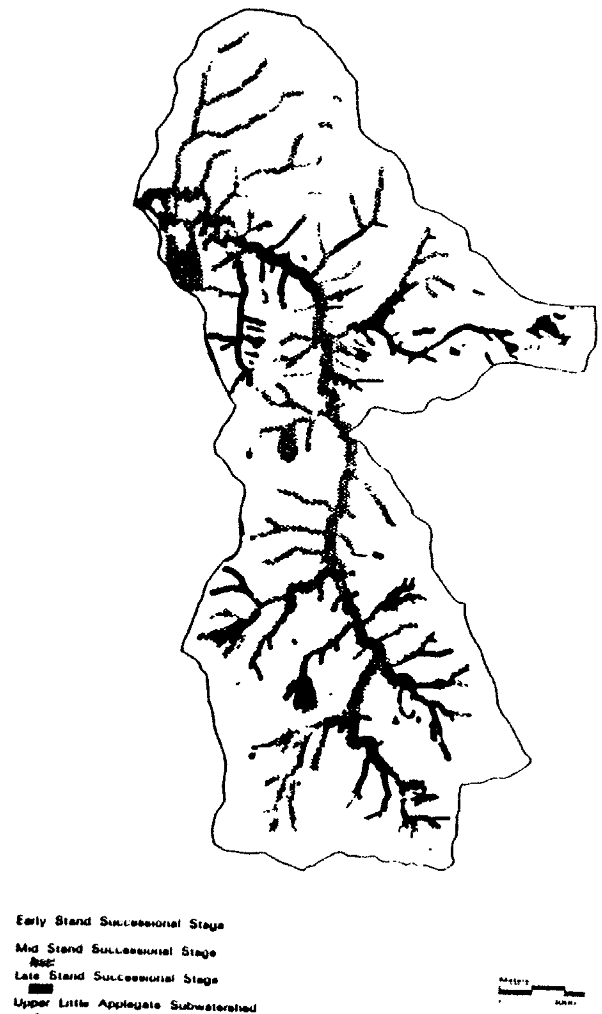


Figure 22a
McDonald Creek Subwatershed
1947 Plant Community Successional Stages
Within Riparian Reserve Widths

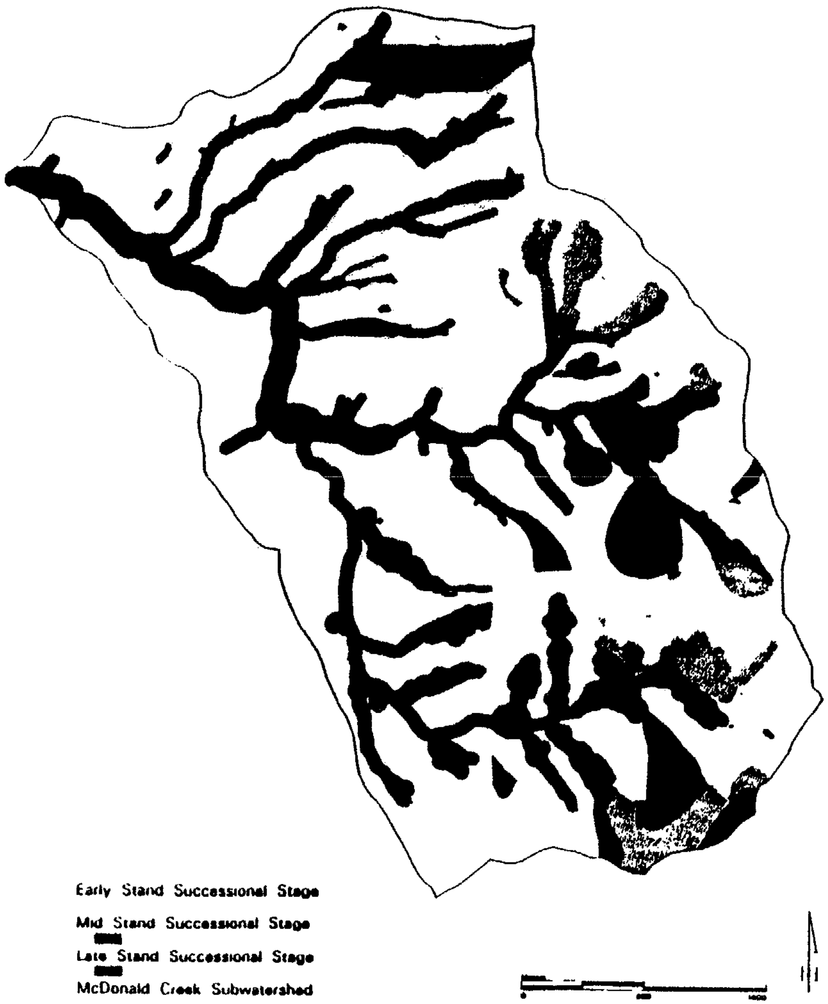


Figure 22b
McDonald Creek Subwatershed
1993 Plant Community Successional Stages
Within Riparian Reserve Widths

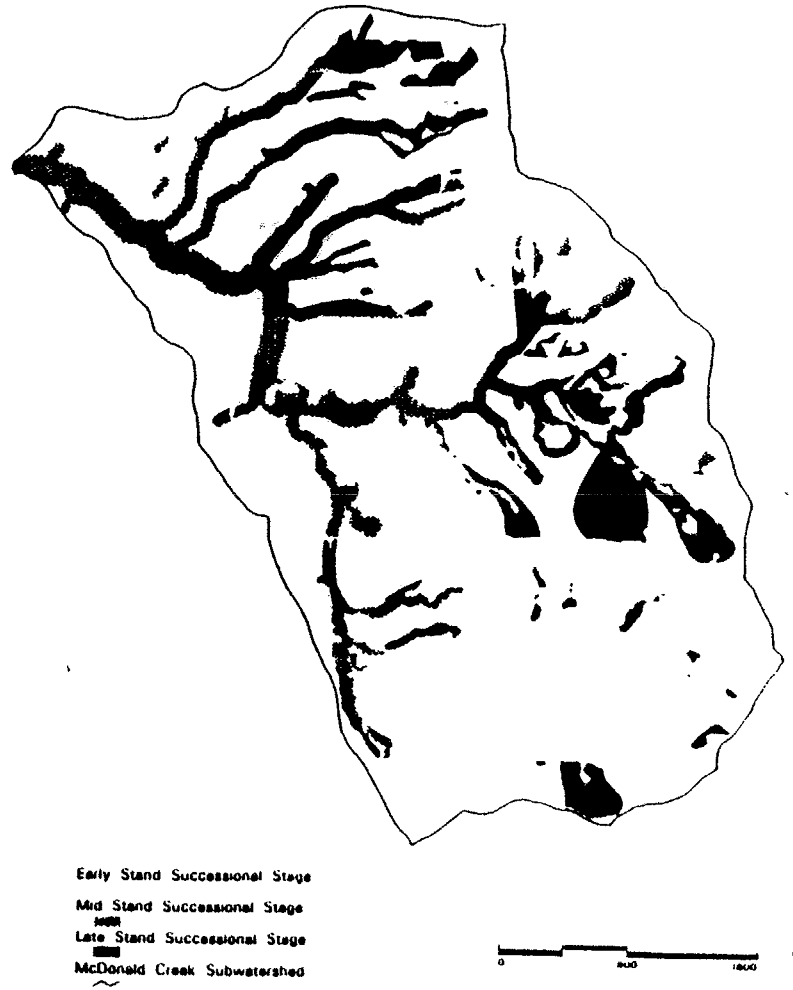


Figure 23a
Glade Creek Subwatershed
1947 Plant Community Successional Stages
Within Riparian Reserve Widths

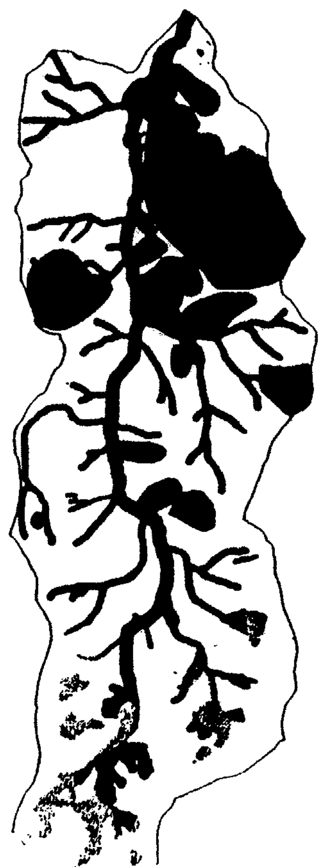


Figure 23b
Glade Creek Subwatershed
1993 Plant Community Successional Stages
Within Riparian Reserve Widths

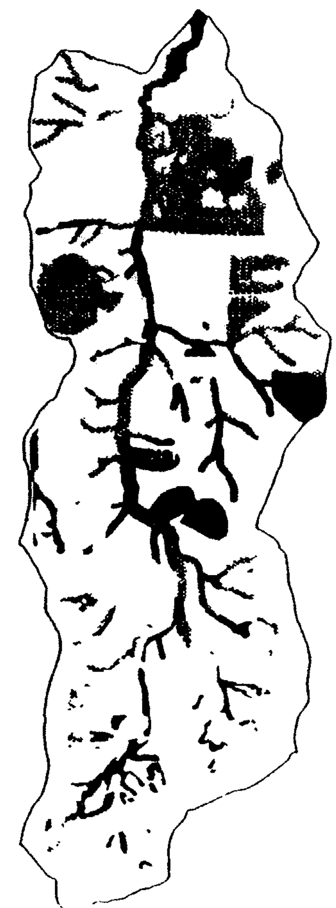


Figure 24a
Middle Little Applegate Subwatershed
1947 Plant Community Successional Stages
Within Riparian Reserve Widths

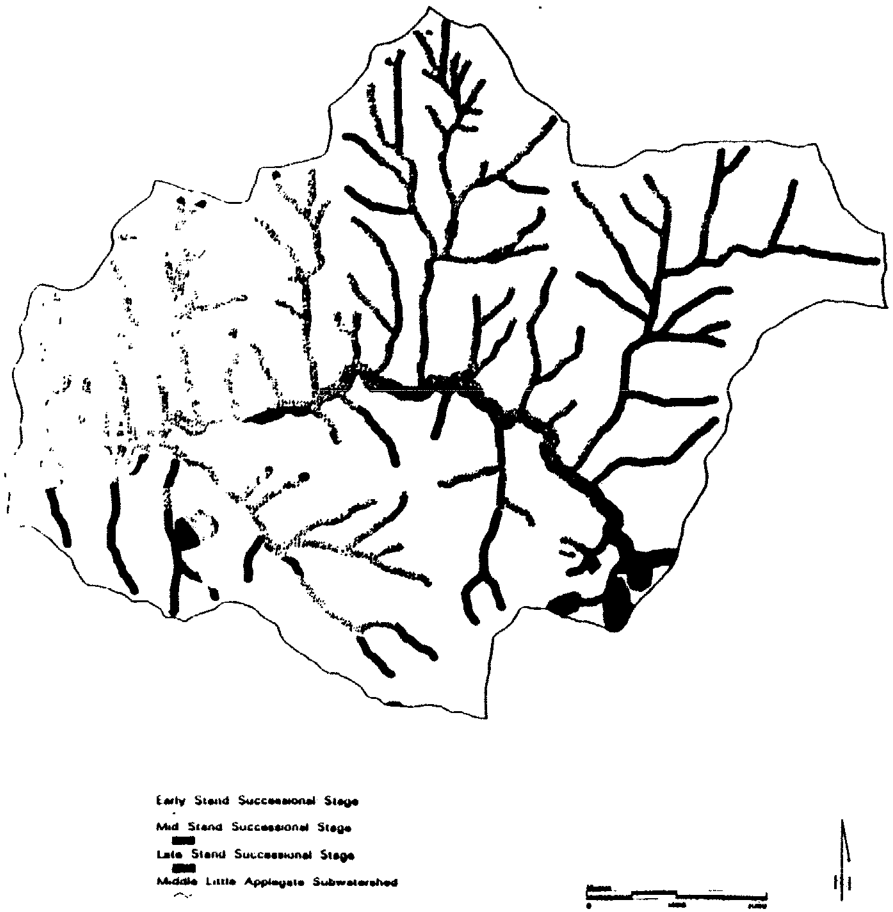


Figure 24b
Middle Little Applegate Subwatershed
1993 Plant Community Successional Stages
Within Riparian Reserve Widths

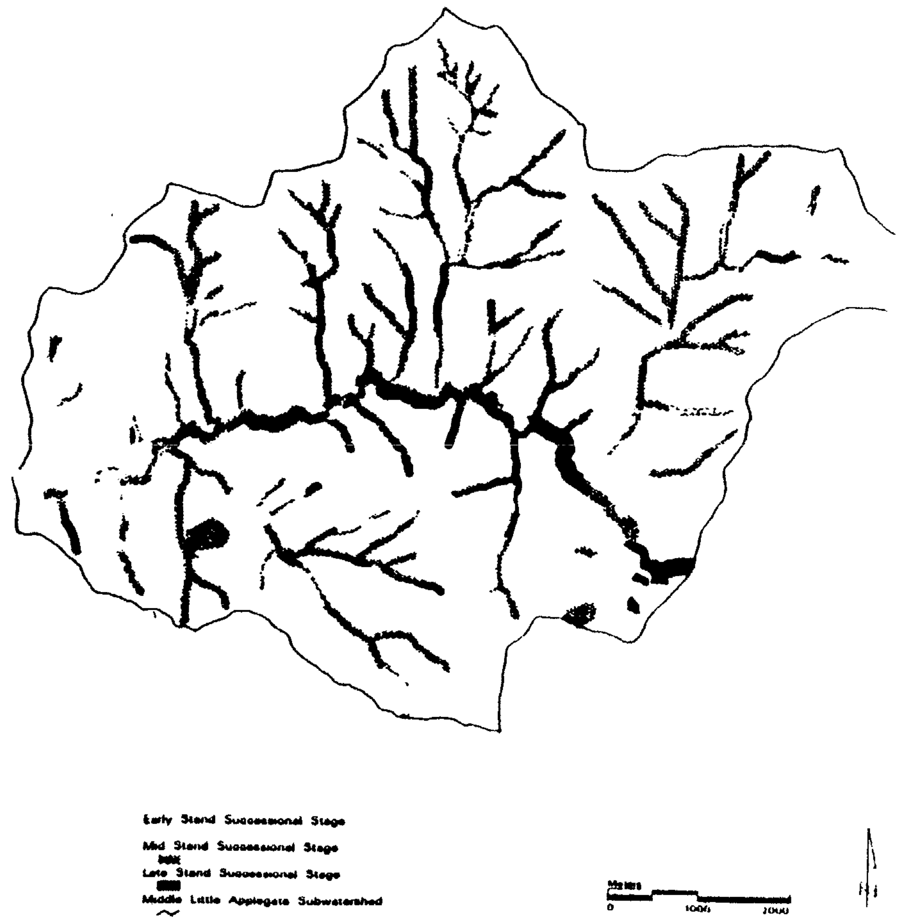


Figure 25a
Yale Creek Subwatershed
1947 Plant Community Successional Stages
Within Riparian Reserve Widths

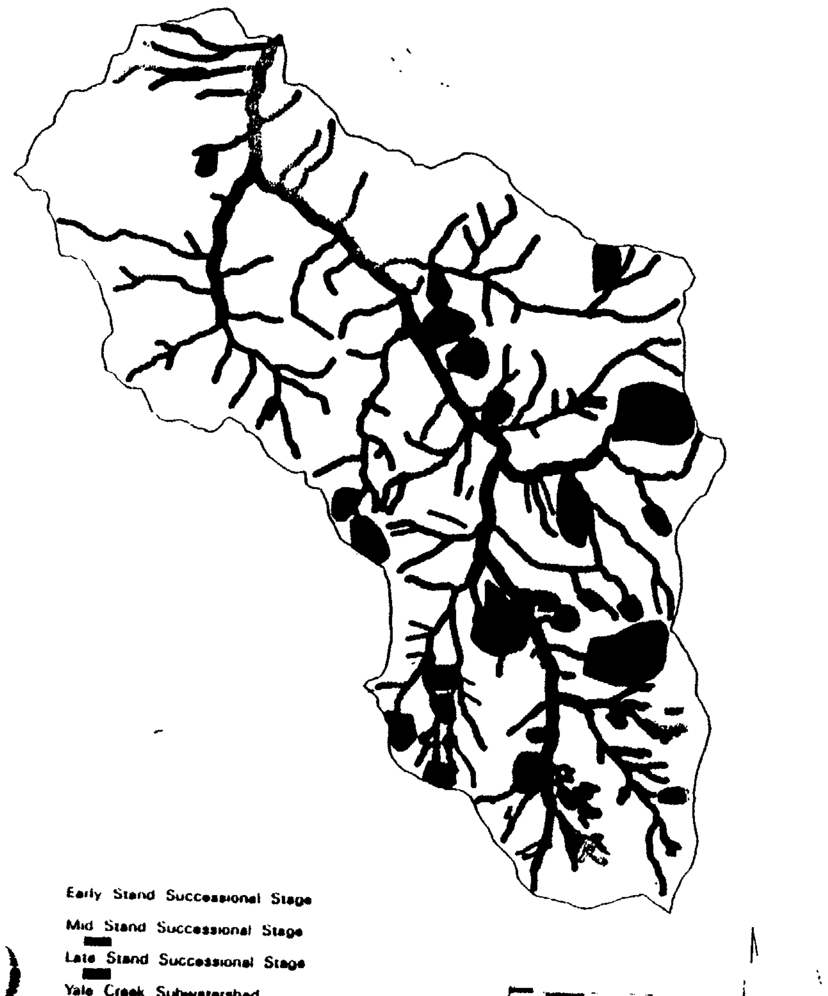


Figure 25b
Yale Creek Subwatershed
1993 Plant Community Successional Stages
Within Riparian Reserve Widths

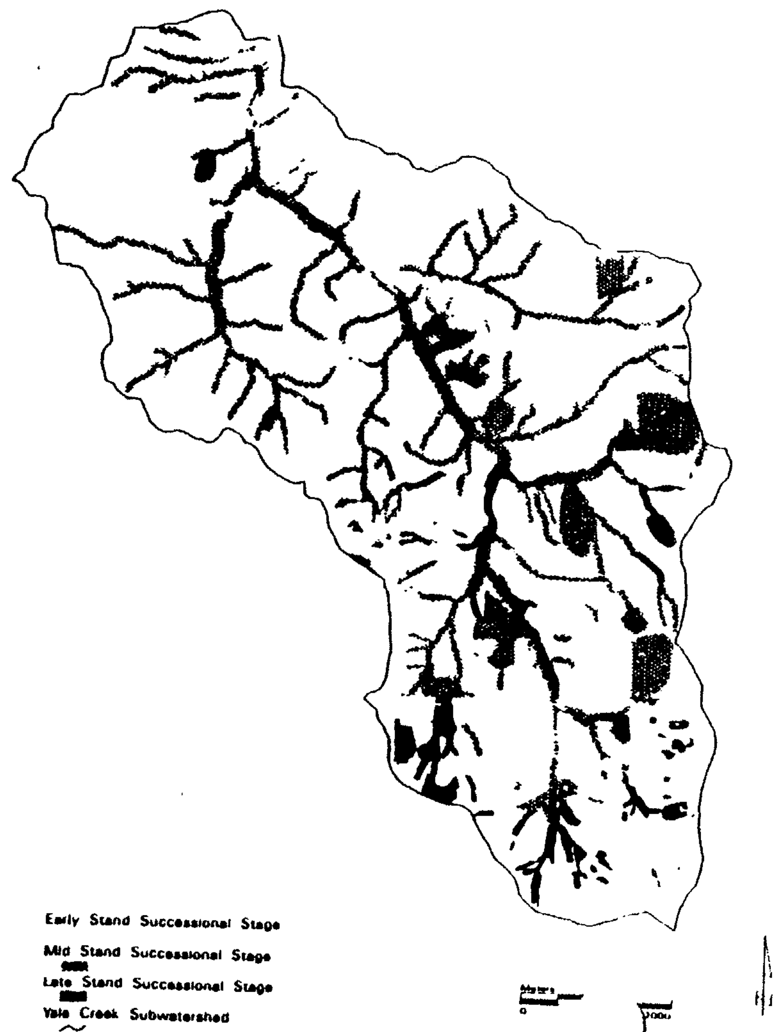


Figure 26a
Sterling Creek Subwatershed
1947 Plant Community Successional Stages
Within Riparian Reserve Widths

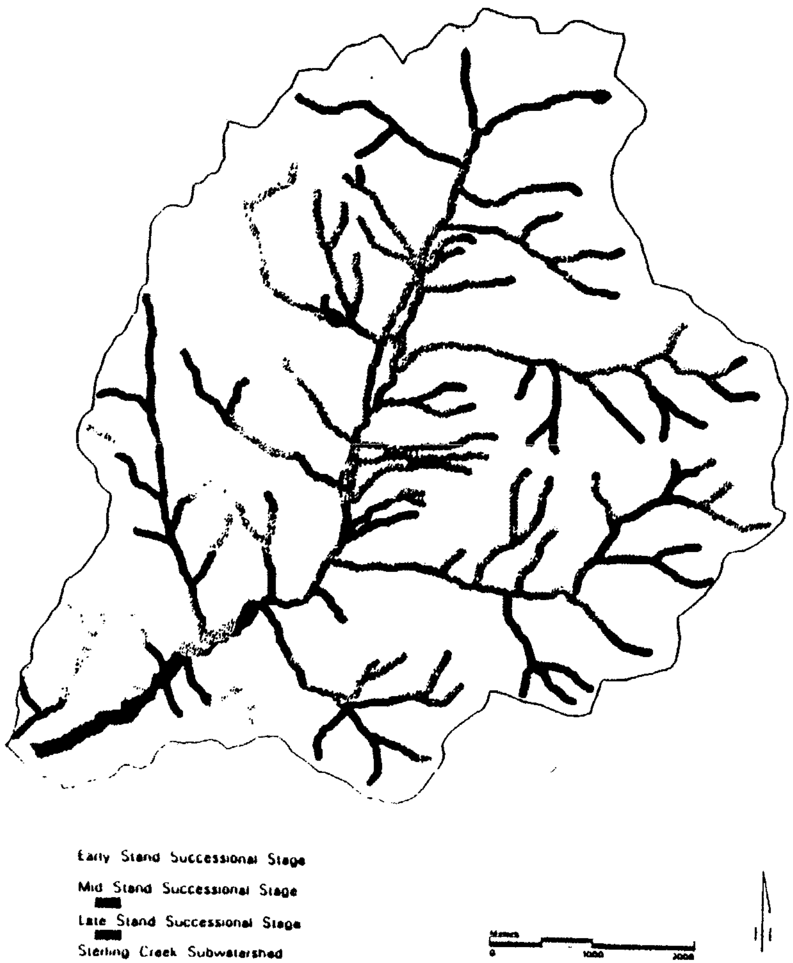


Figure 26b
Sterling Creek Subwatershed
1993 Plant Community Successional Stages
Within Riparian Reserve Widths

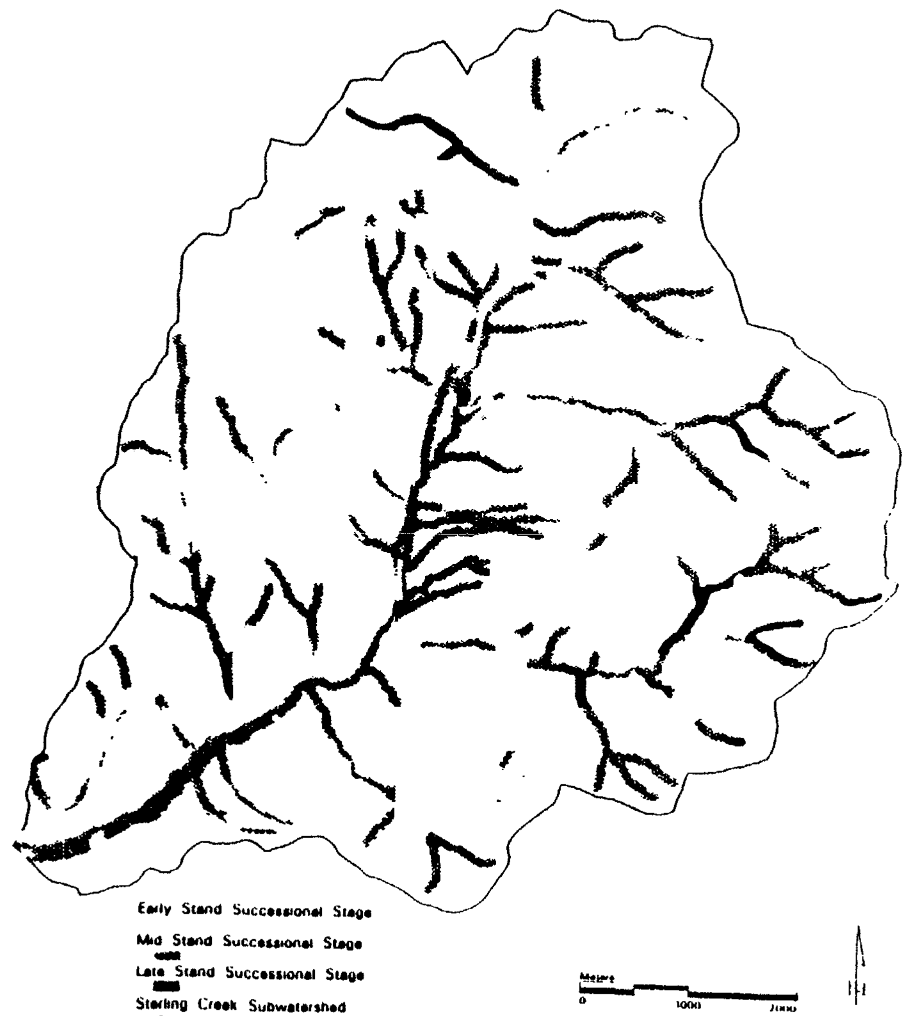


Figure 27a
Lower Little Applegate Subwatershed
1947 Plant Community Successional Stages
Within Riparian Reserve Widths

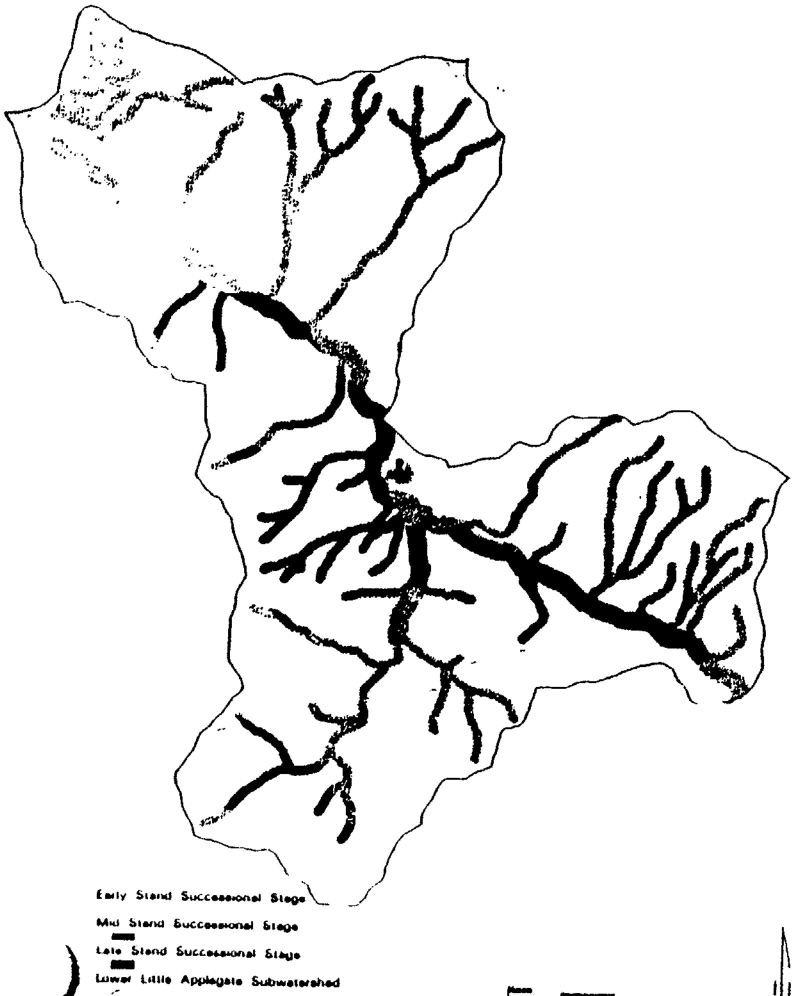
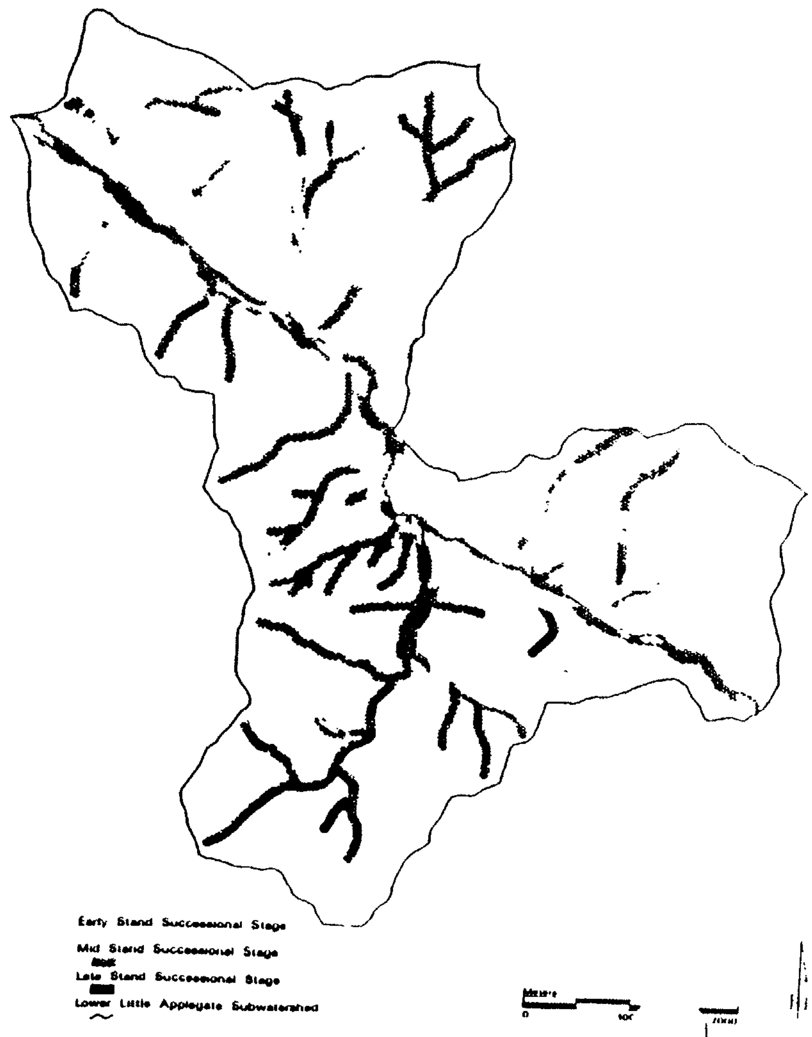


Figure 27b
Lower Little Applegate Subwatershed
1993 Plant Community Successional Stages
Within Riparian Reserve Widths



widths are applied here on all ownerships only for consistency in making comparisons of changes in streamside vegetation successional development over time.

Successional stage acreages from Figures #20 thru #27 were summarized for the entire Little Applegate Watershed and for subwatersheds. These are displayed in Figure #28. These figures display the changes in successional stage acreages in Riparian Reserves between 1947 and 1993, as well as give a comparison between subwatersheds.

From Figure #28 it is evident that there has not been a substantial change in the small acreage of Riparian Reserve in late successional stage in the Lower Little Applegate and Sterling Creek Subwatersheds. This is because many of those (valley bottom) streamside areas have been continuously maintained in the altered (early succession) agricultural condition since the 1800s, except for the narrow strip of mid-succession sized alder and cottonwood adjacent to the channels. Also, as mentioned earlier, much of the RTZ adjacent to the generally southfacing intermittent streams in these subwatersheds is in a "permanent" early or mid successional status of grass/forbs, shrubs, or oak.

The Upper Little Applegate, McDonald Creek, Glade Creek, Middle Little Applegate, and Yale Creek Subwatersheds display a significant decline in the late succession composition of Riparian Reserves since 1947, coinciding with the advent of intensive timber harvest. In the case of the Upper Little Applegate and McDonald Creek, the area in the early stand development stage is likely more pronounced than the above figures indicate; this is due to logging of this zone on private land during 1994 so that the 1993 vegetation map does not reflect this change.

Overall, the Little Applegate Watershed witnessed a decline of over 6600 acres of Riparian Reserve-width RTZ in late successional development stage between 1947 and 1993. This represents a 67 percent decrease. The decrease from historic (pre-1850) levels has been much greater.

Current Succession Composition of RTZs by Ownership - The current (1993) acreages of RTZ or Riparian Reserve in early, mid, and late successional stage were summarized by ownership by subwatershed and are displayed in Figure #29. Public land acreages are broken down for the BLM and Forest Service for the entire Little Applegate Watershed. The public land acreages are not broken down between the BLM and Forest Service for subwatersheds.

From Figure #29 it is shown that about 3283 acres of Riparian Reserve width RTZs are currently in a late successional developmental stage. Eighty percent of this (2641 acres) is National Forest. 11 percent (354 acres) is BLM and nine percent (288 acres) is private. Again it is repeated that Riparian Reserves don't actually apply to private lands and these widths are used universally here for comparison purposes.

Figurer #28 - Successional Stage Distribution Changes in the Little Applegate Watershed (1947-1993)

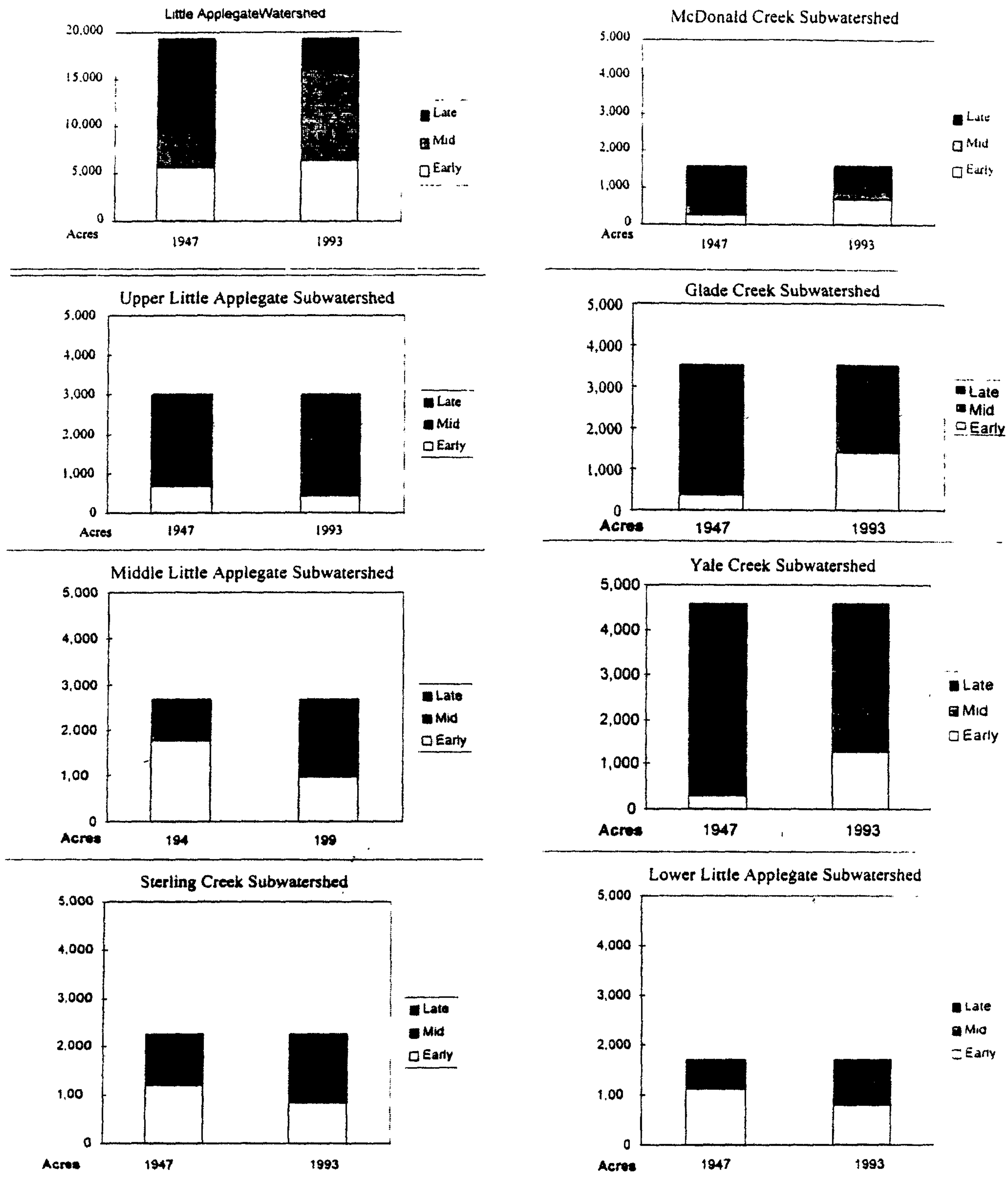
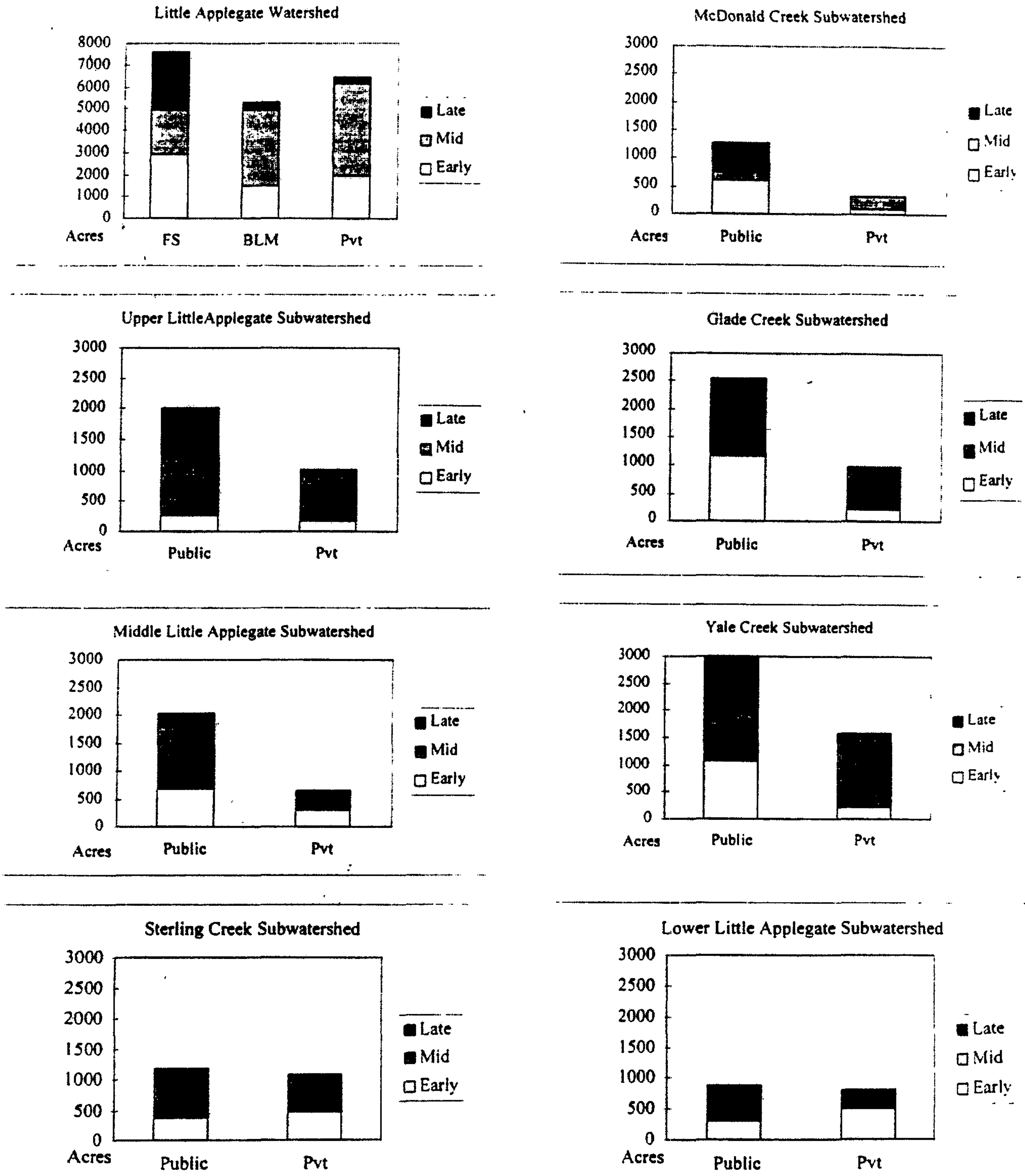


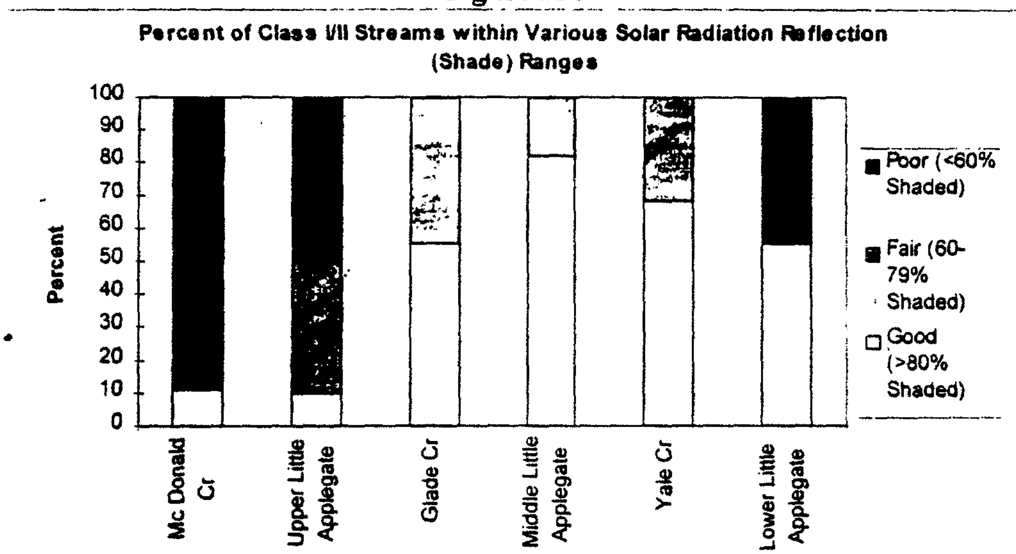
Figure #29 - Successional Stage Distribution in the Little Applegate Watershed By Ownership (1993)



Effects on Coarse Woody Debris (CWD) - The decline of the late successional component in Riparian Reserves is reflected in the low amounts of **CWD** found in many tributaries as well as along most of the Little Applegate River. According to the stream habitat survey data (ODFW 1994, ODFW 1995) and the Stream Ecosystem Report, Split Rock Creek, Lake Creek, Bear Gulch, Garvin Creek, lower McDonald Creek, and the uppermost 1/2-mile of the Little Applegate River are rated "high" in that they contain ≥20 key pieces (≥10M X 0.6M) of CWD per mile of stream. Crapsey Creek, Glade Creek, upper Yale Creek, and a short 3/4-mile reach of the Little Applegate River are rated "moderate" (10-19 key pieces per mile). Lower Yale Creek, Dog Fork, and over 90 percent of the length of the Little Applegate River are rated "low" (<10 key pieces per mile). The lowest 10 miles of the Little Applegate River averages only 2.0 key pieces per mile. There is no data for Sterling Creek but it is almost certainly rated as "low."

Effects on Stream Shade - An attempt was made to determine how much effect the decline of the late successional component of Riparian Reserves has had on **stream shade** and consequently summer stream temperatures. Increased water temperatures can often be traced to removal of shade-producing vegetation adjacent to channels (FEMAT Report 1993). The approach taken to do this was to use the solar pathfinder, an instrument which estimates the amount of daily total solar radiation that reaches (or is reflected from) a particular site at a particularly time of year. The percent of reflected solar radiation is comparable to the shading efficiency of the adjacent vegetation and landscape. The measurements were made along Class I and II streams within each subwatershed except Sterling Creek, which largely flows subsurface during the summer. The results are displayed in Figure #30:

Figure #30



From Figure #30 it is apparent that McDonald Creek and the Upper Little Applegate River (above Glade Creek) are most exposed to solar radiation. They have the smallest proportion of channel length (about 10 percent) in the "good" range (>80 percent shading of solar radiation). They also have the highest proportion of channel length (near 50 percent) in the "poor" range (<60 percent shaded).

The Middle Little Applegate River (between Glade Creek and Yale Creek) has the highest proportion of stream length (over 80 percent) in the "good" range and has the best overall shading. About half of that shading is provided by hardwoods, mainly alders, which provide a filtered shading.

Yale and Glade Creeks are entirely in the "fair" to "good" range, with Yale Creek showing more shading. However, more of the shade in Glade Creek is provided by dense-canopied conifers than is the case in Yale Creek.

The Lower Little Applegate has about equal proportions in the "good" and "poor" range. Very little shading there is provided by conifers.

Extent of Roading in RTZs (Riparian Reserves) - Most of the plant successional changes in Riparian Reserves described to this point are due to manipulation of vegetation from timber harvest and conversion to agricultural uses. These can be thought of as reversible impacts. By comparison, the successional change from roading is usually irreversible (unless purposely restored). Besides permanently removing late successional vegetation which might be important for aquatic needs, **roads in Riparian Reserve width RTZs** have the highest potential to contribute sediment to streams (see Water Quality Section). They may affect wildlife movement and distribution (Wildlife Report).

Finally, while most roading in the RTZ is on ground once occupied by forest plant communities, some of the high elevation wetland communities are affected. The result is local disruption of surface and subsurface flows in some of these wetlands. This in turn can result in erosion and changes in the vegetation associated with those communities. The exact acres of wetlands affected is not known but they occur mostly in the headwaters of Glade Creek, McDonald Creek and the Upper Little Applegate Subwatersheds.

Refer to Figure #18 (Water Quality Section) for a visual display of roading within Riparian Reserves in the Little Applegate Watershed. It is estimated that about 75 percent of the lengths of the Little Applegate River, Glade Creek, Yale Creek, and Sterling Creek have roads within the Riparian Reserve adjacent to those main streams.

An estimate of road acres in riparian areas by subwatershed is presented in Table #9. As with the comparison of changes of vegetation successional stages (above), the Riparian Reserve widths are applied universally to all land ownerships here only for consistency in identifying road impacts to the streamside zone.

While the acreage and percentage of Riparian Transition Zone (Riparian Reserves on public lands) converted to roads may not appear to be significant, it is apparent from Figure #18 (Water Quality Section) that they are concentrated adjacent to the Class 1 and 2 fish bearing streams. Therefore the areas with the most important riparian values are most disrupted by roading.

Table #9
Road Area Within Riparian Reserves

Subwatershed	Road Miles in RR's	Road Acres in RR's	Total RR Acres	Percent RR in Roads
McDonald Cr	9.4	37.6	1,607	2.3%
Upper Little Applegate	13.8	55.2	3,022	1.8%
Glade Cr	21.5	86.0	3,536	2.4%
Middle Little Applegate	18.6	74.4	2,674	2.8%
Yale Cr	36.5	146.0	4,580	3 2%
Sterling Cr	26.8	107.2	2,257	4.7%
Lower Little Applegate	12.0	48.0	1,704	2.8%
Little Applegate Watershed	138.6	554.4	19,380	2.9%

Condition Trends in RTZs (Riparian Reserves):
Assuming implementation of the President's Plan, Riparian Reserves on public lands will gradually recover and attain late successional characteristics. It will take from 50 years (for currently mid successional forest RTZs) to 80 years (for currently early successional forest RTZs) for these streamside areas to attain late successional characteristics. This recognizes that intermediate silvicultural treatments (e.g. thinnings) will need to be implemented in some of these areas.

With regards to industrial forestry lands, assuming the implementation of current State forestry regulations, streamside areas should recover to late successional characteristics but in a very narrow streamside corridor. It is estimated that the average width of RTZ on private land is about 10 percent of Riparian Reserve widths on public lands. Since nearly all of these acres are currently in early and mid successional stages, they will take from 50 to 80 years to attain late successional characteristics.

Streamside areas on private lands in other than industrial forest ownership, but in non-agricultural use, are expected to respond similarly to those on industrial lands since these are under the same State forest regulations. Those lands in agricultural use will likely remain in an early successional stage, except for the narrow mid successional band of alder and cottonwood next to some streams, which will remain that way; this assumes no change in current State regulations pertaining to streamside areas in agricultural zones.

In short, under current management practices it is doubtful that the RTZs on private lan[illegible] will significantly change from current conditions as affects riparian values. Owing to their narrowness, these RTZs will not provide the same protection to riparian values including wildlife movement, streams shading, CWD input to channels, etc. as occurs with Riparian Reserves on public lands.

Options to Improve RTZs (Riparian Reserves on public lands):
If the desired future condition is to improve the anadromous and resident fishery in the Little Applegate River and its tributaries, several concurrent actions should be taken on both public and private lands. Refer to the Hydrology and Water Quality Sections for a discussion of actions needed to improve streamflow and water quality conditions. Some of those actions may be repeated here since they benefit restoration of the Riparian Transition Zone.

Proposed actions which will maintain or improve RTZ, or Riparian Reserves, are detailed in Section C of the Standards and Guidelines (S&Gs) in Attachment A to the Record of Decision pertaining to the

President's Plan. These S&Gs address specific constraints to timber management, roads, grazing, etc. on public lands. Some of the more important S&Gs pertaining to the Little Applegate Watershed are highlighted as follows:

- Where possible, obliterate existing roads within Riparian Reserves and reroute them to less sensitive areas. Use the same priority scheme (with supporting roading and soil erodibility information) to determine where to do this as discussed under options to improve water quality (Water Quality Section of this Report). As a minimum these roads need to be stabilized to eliminate sediment if they cannot be obliterated and rerouted.

- Obliterate and plant to conifers those skid trails and landings located within Riparian Reserves. Use the same priority scheme discussed in the Water Quality Section.

- Identify specific grazing impacts to riparian areas, especially wetlands and streambanks, in the pending update of the Glade-Wagner Allotment Management Plan (AMP). Then implement corrective measures.

- Plant conifers within Riparian Reserves currently in hardwood stands but whose climax type includes conifers. Candidate hardwood stands are identified in the vegetation data base in the Little Applegate Watershed Analysis planning files; whether individual stands can proceed to a conifer climax will need to be determined by a site specific analysis.

- Encourage density management in Riparian Reserves that are currently early and mid successional stage conifer sites if this will hasten late successional development of the Riparian Reserve. Candidate sites are identified in the vegetation data base in the Little Applegate Watershed Analysis planning files.

While Riparian Reserve widths apply only to public lands, it is desirable that comparable RTZ restoration efforts be made on private lands. This is important since 68 percent of the 21.5 miles of the main stem Little Applegate River that is fish habitat is in private ownership; virtually all of the lowest 10 miles is private. Also, much of the sediment sources from shallow and glaciated granitics are on private land in McDonald Creek and the Upper Little Applegate Watersheds (Water Quality Section).

Verification and Guidance for Alteration of Riparian Reserves:

Interim Riparian Reserves - During 1994 an effort was made to field verify stream class; that is, to identify fish-bearing, perennial nonfish-bearing, and intermittent streams. There was not suffcient time to walk entire streams so that other criteria (subsection following this) could not be used to determine final boundaries; that will be done at the project level. About 95 percent of the streams identified on USGS quads and included in the BLM and USFS GIS data bases were field verified for stream class.

In addition to that, wetlands from the USFWS National Wetlands Inventory were added to the data base; sample field verification of wetlands revealed that the USFWS inventory is very accurate.

Finally, unstable and potentially unstable areas have been identified. Four separate types of instability were separately entered into the data base: unstable U3 lands, earthflows, debris slides, and land hazard zonation classes. Many of these areas have not been field reviewed; they were mapped from aerial photos and still require field verification.

Riparian Reserve maps have been individually created for streams, wetlands, and the four geologic features. Figure #31 (Interim Riparian Reserve map) is a composite of those maps.

The Interim Riparian Reserve Map above is similar to maps used in previous figures of this Report to display the roads/road segments which need priority treatment and the decline of late successional stages in the streamside environment or RTZs. However, Figure #31 only displays Interim Riparian Reserves for public lands since they do not apply to private lands. These reserves total 12,900 acres which is nearly 25 percent of the public lands in the Little Applegate Basin.

Until finalized at the project level, the Watershed Analysis team recommends use of the Interim Riparian Reserve buffers for application of S&Gs in the President's Plan.

Guidance for Changing Riparian Reserves - Only upon project-level review of Interim Riparian Reserves should any Riparian Reserve boundary be finalized and recorded as final in GIS. It is expected that there may be slight variation of the buffers adjacent to fish-bearing and perennial flowing nonfish-bearing streams, lakes, and wetlands greater than one acre. The buffers adjacent to intermittent streams are more likely to be altered at the project level than are those near perennial streams. Since they have not been fully field verified it is expected that many of the Interim Riparian Reserves associated with instability will change upon project level review.

Any changes in Riparian Reserve widths from the Interim widths must consider all riparian and terrestrial values associated with these areas (President's Forest Plan). As such, any changes should be determined by an interdisciplinary team including at a minimum a fishery biologist, wildlife biologist, hydrologist, geologist, and silviculturist. This team may be increased to include other disciplines such as when visual and recreational values warrant.

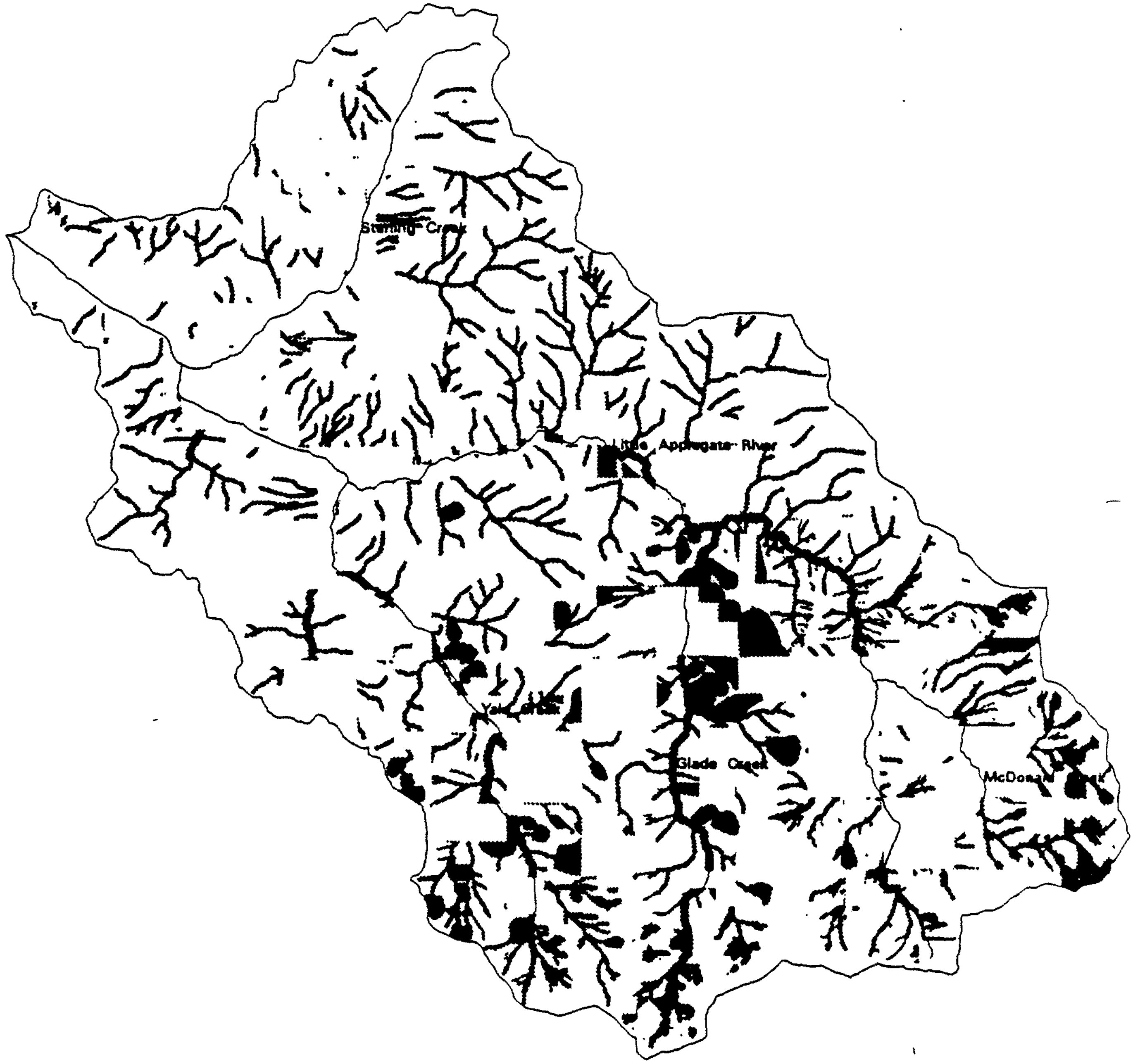
The following criteria should be used when considering site-specific changes to Interim Riparian Reserves:

- Needs of the specific species listed in the President's Plan (ROD 1994, FEMAT Report 1993). Within two years, protocols and guidelines are expected for those species thought to be dependent on Riparian Reserves.
- Spotted owl dispersal needs.
- Connectivity through matrix/AMA lands (corridors of suitable width).
- Area-wide or watershed-wide abundance (or deficiencies) of snags, large green trees, and late successional habitat.
- Verification of fish-bearing verses nonfish-bearing streams.

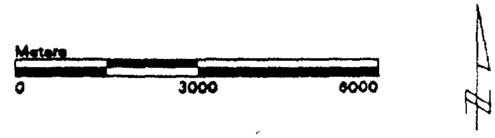
- Inherent potential erodibility of the landscape.
- Amount of effective ground cover within the Interim Riparian Reserve.
- Verification of landscape stability or mass wasting potential at given sites.
- Verification of wetland boundaries and size.
- Locations of natural slope breaks (inner gorges) and such manmade features as roads relative to the Interim Riparian Reserve boundaries.
- Potential plant community.

Figure 31

INTERIM RIPARIAN RESERVES ON FEDERAL LANDS



Shaded area represents interim riparian reserves on federal lands.



Hydrology Report References

Gallino.G. 1994. Personal Communication on Low Flows. Portland. Oregon: U.S. Department of the Interior. U.S. Geological Survey.

Harr. R.D. 1975. Forest Practices and Streamflow in Western Oregon. Corvallis. Oregon: U.S. Department of Agriculture. Forest Service, Pacific Northwest Forest and Range Experiment Station. Paper Presented at the Symposium on Watershed Management, Logan, Utah, August 11-13. 1975.

Harr. R.D. 1976. Hydrology of Small Forest Streams in Western Oregon. General Technical Report PNW-55. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station.

Harr. R.D.; Fredriksen, R.L.; Rothacher. J. 1979. Changes in Streamflow Following Timber Harvest in Southwestern Oregon. Research Paper PNW-249. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station.

Oregon Department of Environmental Quality. 1988. Oregon Statewide Assessment of Nonpoint Sources of Water Pollution. Portland, Oregon: Department of Environmental Quality (DEQ).

Oregon Department of Fish and Wildlife. 1994. Aquatic Inventory Project. Physical Habitat Survey for Yale Creek, Little Applegate River Watershed, Rogue River Basin.

Oregon Department of Fish and Wildlife. 1995. Aquatic Inventory Project. Physical Habitat Survey for the Little Applegate River Watershed, Rogue River Basin.

Oregon Water Resources Department. 1994. Water Resources Information System (WRIS) Files. Grants Pass, Oregon: Oregon Water Resources Department (OWRD).

Record of Decision (and Attachment A - Standards and Guidelines) for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl 1994. Washington, D.C.: U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management.

Riggs, H.C. 1972. Low-Flow Investigations. U.S. Geological Survey Techniques of Water-Resources Investigations, Book 4, Chapter B1.

Rosgen, D.L. 1993. Applied Fluvial Morphology. Lecture Reference Document. Wildland Hydrology Consultants, Pagosa Springs, Colorado.

Rosgen, D.L.; Fittante, B.L. 1986. Fish Habitat Structures - A Selection Guide Using Stream Classification. In: Miller, J.G.; Arway, J.A.; Carline, R.F. (Editors). 5th Trout Stream Habitat Improvement Workshop, Lock Haven University, Lock Haven, PA. Hamsburg, PA.: Penn Fish Comm. Publics.

Rothacher, J. 1973. Does Harvest in West Slope Douglas-fir Increase Peak Flow in Small Forest Watersheds? Research Paper PNW-163. Portland, Oregon: U.S. Department of Agriculture. Forest Service, Pacific Northwest Forest and Range Experiment Station.

Taras, M.J.; Greenberg, A.E.; Hoak.R.D.; Rand, M.C. (Editors). 1971. Standard Methods for the Examination of Water and Wastewater, 13th Edition. Washington, D.C.: American Public Health Association; American Water Works Association; Water Pollution Control Federation.

U.S. Department of Agriculture. 1990. Land and Resource Management Plan. U.S. Department of Agriculture, Forest Service, Rogue River National Forest.

U.S. Department of Agriculture. 1993. Determining the Risk of Cumulative Watershed Effects Resulting from Mulriple Activities, Endangered Species Act, Section 7. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region.

U.S. Department of Agriculture; U.S. Department of Commerce; U.S. Department of the Interior; EPA. 1993. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment - Report of the Forest Ecosystem Management Assessment Team (FEMAT).

U.S. Department of Commerce. Precipitation Data. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service Office, Medford, Oregon.

U.S. Department of the Interior. Compilations of Records of Surface Waters of the United States through September 1950. Part 14 Pacific Slope Basins in Oregon and Lower Columbia River Basins. U.S. Geological Survey WSP-1318.

U.S. Department of the Interior. Statistical Summaries of Streamflow Data in Oregon: Volume 2 -- Annual Low and High Flow, and Instantaneous Peak Flow. U.S. Geological Survey Open-File Report 93-63.

Wisseman, R. 1995. Little Applegate River Watershed Benthic Macroinvertebrate Biomonitoring for 1994.