STEP 3,4: REFERENCE, CURRENT, TREND CONDITIONS

ISSUE 1: DENSITY, CONDITION, LOCATION, & USE OF ROADS

KQ 1 - Where and to what extent has road density, condition, location and use influenced erosion, hydrologic, and channel processes?

The predominant erosion processes in the UMFWA are mass-wasting and surface erosion. These processes have been evaluated through landslide occurrence and effective drainage density.

Mass Wasting - Landslides — Reference

Pre-management (reference) conditions were established by reviewing older air photo sets (1955 and 1959). The vast majority of the analysis area was unroaded and unharvested with the exception of the valley bottoms and lower slopes of Staley, Simpson and Swift Creeks.

Debris slides were used as the primary evaluation mechanism for determining the reference or baseline condition of the analysis area. Debris slides typically occur on steep ground with shallow, rocky soil. Approximately 50 percent of the analysis area fits this criteria.

A comparison was made between events which occurred in unroaded, unharvested areas that appeared in sequentially younger air photo sets. For purposes of this report, these are referred to as "natural" or "naturally occurring". Of the 31 natural events noted between 1959 and 1972, 22 occurred between 1959 and 1967, presumably in conjunction with the 1964 flood. With two exceptions (west flank of McLean Mountain and Minnehaha Creek), these debris slides tended to impact a relatively limited area.

Evidence of numerous "pre-historic" debris slides was noted, although there was no clear means of determining when they occurred relative to the earliest photo sets. It is clear, however, that these chutes were active for a considerable length of time. Five of the 31 naturally occurring debris slides between 1959 and 1972 occurred within deeply incised pre-historic channels. The highest concentrations of these pre-historic channels chutes are located on the east flank of Staley Ridge and Tumblebug Gorge.

Three occurrences of large scale, deep seated slope movement were noted in the lower reach of Staley Creek. These three areas appear to have been active for several hundred years based on field observations. Active toe erosion is apparent in the most upstream of these three.

Mass Wasting - Landslides — Current/Trend

Approximately 471 miles of road exist within the watershed as determined through GIS. These roads were predominantly built for and funded by timber harvest activities, and provide access for a variety of commercial, administrative and recreational uses.

The greatest period of road construction was between 1964 and 1980. Eighty percent of the transportation system was complete by this time. Before 1972, roads were located primarily in the valley bottom and lower sideslopes of Simpson, Staley, Swift, Pioneer Gulch, lower Echo Creek and along the MFW River to the upper end of Paddy's Valley. During the late 60's and early 70's the road network established access to Tumblebug Creek and the southern perimeter of the analysis area. By 1980, all major midslope roads on steep ground were in place, and the road system had expanded into the upper reaches of Echo Creek. Linkage of the primary road system was largely complete. Road construction between 1980 and 1990 consisted of dispersed local roads with concentrations in the Bear Mountain area and privately held Simpson Creek drainage.

Many of the roads constructed prior to 1980 used sidecast construction methods and are now at risk for failure as a result of latent construction defects. In addition to construction techniques, a high percentage of roads were built on steep, erosive soils, conducive to mass failures.

Table 3 shows an estimate of the miles of road constructed over time based on interpretation of available air photos.

Table 3. Road construction progression based on aerial photos.

Photo Year	Existing Road Miles	% Current Road Miles	Rate Miles / Yr.
1959	71	15	
1964 (est.)	118	25	9.4
1967	165	35	15.7
1972	236	50	14.2
1980	377	80	17.6
1990	471	100	9.4

Road construction in conjunction with timber harvest has had an effect on the spatial and temporal distribution of landslide occurrences within the UMFW Watershed Analysis Area when compared to natural processes. Table 4 shows a comparison of naturally occurring and road related debris slides.

Table 4. Natural versus road related debris occurrences by year.

Photo Year	Natural Debris Slide Occurrences	Road Related Debris Slide Occurrences
1959	7	0
1967	22	3
1972	2	4
1980	0	10
1990	0	3
1996 Storm	0	2

Approximately 50% of the Watershed Analysis area is characterized by steep ground with shallow, erosive soil. Approximately 85% of the road related debris slides have occurred in this setting with 30% occurring in the Staley Creek drainage. The rest are distributed fairly evenly throughout the analysis area.

Two road related debris slides have been identified to date as being associated with the 1996 flood event. This represents approximately 10 percent of the road related slope movements for the Rigdon Ranger District. The relatively low frequency of occurrence is likely the result of being on the fringe of the storm front, greater natural stability than the rest of the District and the elevation (greater retention of snow pack during the storm).

Surface Erosion - Drainage Density — Reference

There are 478 miles of stream channels, cataloged in GIS, in the watershed. The average density of stream channels is 3.1 miles per square mile, with a high of 3.2 in the older weathered volcanics of the Staley Subwatershed to a low of 1.8 in the young porous volcanics of the Timpanogas Subwatershed. In general, the stream densities are low in the UMFW Watershed when compared to the rest of the Forest average of 4 to 4.5 miles/sqmile.

The highest stream densities occur in Staley, Swift and Simpson/Echo Subwatersheds in the Low storm response areas. These densities are 5.7, 5.4 and 6.3, respectively.

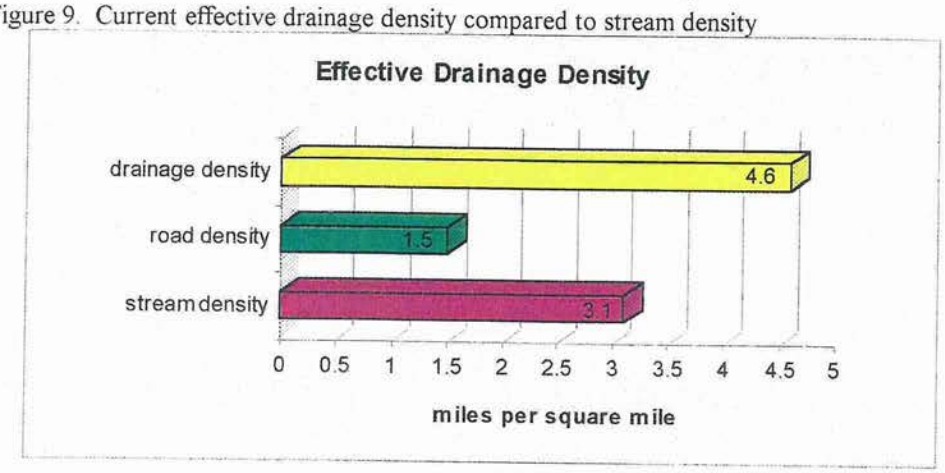
Surface Erosion - Drainage Density — Current/Trend

Road ditches act like class IV streams, interrupting subsurface flow, expanding the drainage network and delivering runoff to the stream system within a shorter time period. There are 471 miles of road

within the UMFW watershed giving an average road density of 2.7 miles per square mile. The road intersects stream reaches 672 times, providing a conduit to funnel water and sediment directly from the road prism into the stream system.

According to a study by Wemple (1994), the hydrologically effective road miles contributing ditch runoff to the stream system is 57.3 percent of the total road network miles. This corresponds to 273 miles of road within the Watershed, and a road density of 1.5 miles per square mile. Thus, stream density at 3.1 plus the hydrologically effective road density of 1.5, increases the total effective drainage density to 4.6 miles per square. As a result, the effective drainage density under the current condition has increased by 50 percent of the reference condition (Figure 9). The effective drainage density in combination with a low hydrologic recovery percentage is likely to create a flashy stream environment.

Figure 9. Current effective drainage density compared to stream density



If we look at the spatial distribution of the increased road density, the highest effective drainage density is seen in the Pioneer Subwatershed, with a range from 4.8 to 8.3 miles per square mile. The highest percent increase occurs in Tumblebug, with a 50 percent increase in the Moderate Storm Response areas. Overall, the effective stream density increases over 40 percent throughout the watershed in Moderate and High Storm Response areas. The highest number of stream crossings occur in Staley and Simpson/Echo Subwatersheds with 72 and 55 crossings respectively (Table 5).

Table 5. Storm response category and drainage network.

Storm Response		Subwatershed					
		23 1	23 2	23 3	23 4	23 5	23 6
Low	# Str. Crossings	56	22	40	20	15	27
	Stream Density	5.7	3.6	3.6	3.9	5.4	6.3
	Road Density	1.7	2.1	1.9	2.4	1.3	2
	Effective DD	7.4	5.7	5.5	6.3	6.7	8.3
	% Change	23	37	35	38	19	24
Moderate	# Str. Crossings	52	29	42	33	38	68
	Stream Density	2.9	2	1.6	2.7	2.6	2.7
	Road Density	1.8	2	1.2	2	1.1	2.1
	Effective DD	4.7	4	2.8	4.7	3.7	4.8
	% Change	38	50	43	42	30	44
High	# Str. Crossings	72	9	38	23	34	55
	Stream Density	2.4	2.8	1.4	2.3	2.7	4
	Road Density	1.8	1.4	1	0.7	1.2	1.7
	Effective DD	4.2	4.2	2.4	3	3.9	5.7
	% Change	43	33	42	23	31	30

The increase in drainage density in Moderate and High Storm Response areas decreases the effective time it takes for stream runoff to enter the channel, increasing channel velocities and scour. The interruption and collection of subsurface flow into ditches, reduces the transport time of water from the hillslope to channel network.

Similarly, the potential for delivery of fine sediment from road surfaces into the stream network has doubled over reference conditions. The quantity of fine sediments entering the stream system as a result of the road prism is dependent on the quality of road aggregate, frequency of road use, road location, and storm response of the area. The increased drainage density of 50 percent is expected to remain essentially the same over time. Some improvement is expected through road decommissioning and re-establishment of runoff patterns.

Channel Segments - Response, Transport, and Source

The sensitivity and response of channel segments relies on the theory of fluvial geomorphology for Western Cascade streams developed by Montgomery and Buffington (1993). Understanding the sensitivity of the various response, transport, and source channels segments to changes in coarse sediment input, fine sediment input, large woody debris, peak flow and riparian vegetation, helps the manager understand the vulnerability of an area to changes in upslope process (Table 5 and 6).

Due to budget limitations and management priorities, this iteration of the channel analysis is limited to important fish bearing portions of the mainstem MFW and major tributaries. These include the majority of *response* reaches, i.e. those most likely to exhibit the effects of natural and management related impacts, plus a sample of *transport* reaches. *Source* reaches, i.e. steep headwall/sidewall tributaries most directly influenced by hillslope processes, receive a cursory evaluation.

Five different *response* channel types and four different *transport* channel types were analyzed to determine their sensitivity to selected input factors. The term "sensitivity" here refers to the magnitude of predicted change in channel form in response to each input factor. The biological significance of these factors and of channel adjustment to inputs is discussed in the synthesis section of this document

Field data from multiple sources plus additional photo interpretation was used to aid determinations of reference and current conditions. Judgement of the sensitivity of each channel type is based on reference and current conditions and is generally consistent with theory unless field data indicates otherwise. Data compilation sheets, developed to improve consistency, are included in the appendix. See glossary for definition of channel morphology terms.

Each channel type was rated as having a High, Moderate, or Low sensitivity to each input factor. A rating indicating a range of sensitivity (ex. High to Moderate) attempts to accommodate some of the variability within channel types as well as the uncertainty of predictions.

It is predicted that response reaches exhibit a moderate to high sensitivity to all these variables. Transport reaches reflect a low to moderate sensitivity to coarse and fine sediment, and a moderate response to other variables. Source reaches exhibit a low response to sediment and variable response to the other factors, depending on channel substrate.

Generally, an increase in sediments will result in an increase in channel width, reduced pool volume, and embeddedness of larger riffle particles. A loss of large woody debris will result in a loss of channel ability to create pools, sort sediment, and dissipate energy. An increase in the magnitude of bankfull discharge will increase bedload transport, depth of scour and/or bank erosion. Loss of riparian vegetation will result in lose of bank stability and source of large wood. The end result of the loss of habitat complexity will be a decrease in aquatic species viability and distribution.

The analysis of channel segments was completed by stream reaches in channel types. The spatial distribution of the stream reaches is given in Figure 10. A summary and description of the sensitivity ratings in this watershed are given in Table 6 and 7 for the UMFWA. Data compilation sheets used to determine sensitivity are given in Appendix C.

Figure 10
Surveyed Stream Reaches
Upper Middle Fork

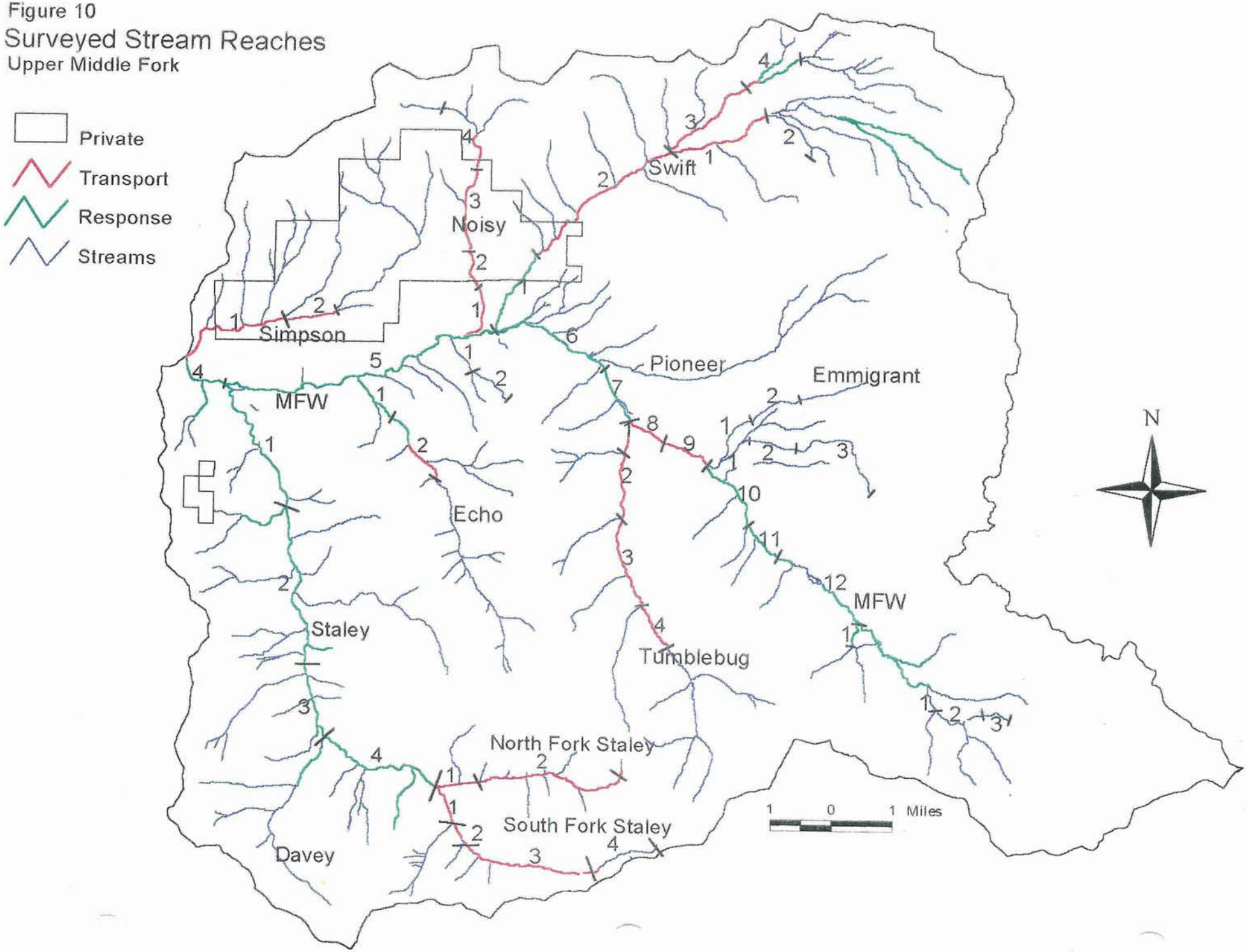


Table 6. Results of channel sensitivity ratings for dominant channel types.

Response Segments	Valley Segment/ *Rosgen Code	Surveyed Reaches in Each Segment	Coarse Sediment Input	Fine Sediment Input	Large Woody Debris Input / Loss	Peak Flow Input	Riparian Vegetation Removal
Wide Mainstem Valley	F3/C	MFW 4-7 Staley 1	Moderate to High	Moderate to High	High to Moderate	High	High
Alluvial/ Colluvial Fan	F4/B	Noisy 1 Swift 1 Echo 1	Moderate	Moderate	Moderate to High	Moderate to High	Moderate to High
Alluviated Mountain Valley	V4/B	Staley 2-4 S. Fork Staley 4	Moderate to High	Moderate to High	High to Moderate	Moderate to High	Moderate to High
U-Shaped Trough	U1/C U2/B	MFW 10-12 Swift 4	Moderate to High	High	High to Moderate	High	High
Transport Segments	**Valley Segment/ *Rosgen Code**	**Surveyed Reaches in Each Segment**	**Coarse Sediment Input**	**Fine Sediment Input**	**Large Woody Debris Input or Loss**	**Peak Flow Input**	**Riparian Vegetation Removal**
V - Shaped Moderate Gradient (less confined)	V1/B	MFW 9 Tbug 1 & 2 S. Fork Staley 1 - 3 Simpson 1	Moderate to Low	Low to Moderate	Moderate	Moderate	Moderate
V - Shaped Moderate Gradient	V1/A	MFW 8 Simpson 2 Swift 2 Echo 2 Noisy 3 - 4 Tbug 3 - 4	Low to Moderate	Moderate to High	Moderate	Moderate to High	Moderate to Low
V - Shaped High Gradient	V2/A	Bear 1 Noisy 2 Swift 3 N. Fork Staley 1 - 2	Low to Moderate	Moderate to High	Moderate	Moderate to Low	Moderate
Moderate Slope Bound Valley	M1/B	Mac 1 Pioneer Gulch 1 - 2 Emigrant 1 Beaver 1	Moderate	Moderate	Moderate	Moderate to High	Moderate to High
Source Segments	**Segment Code**	**Reaches**	**Coarse Sediment**	**Fine Sediment**	**CWM**	**Peak Flow**	**Riparian Vegetation**
Very High Gradient Headwater	H3/A	numerous	Low	Low	Variable depending on substrate	Variable depending on substrate	Variable depending on substrate

* A = Cascade Dominant B = Step/Pool Dominant C = Pool/Riffle Dominant

Table 7. Definitions of Response Ratings (adapted from the Channel Condition Module of the Middle and Upper Cispus Watershed Analysis).

Input Factors	High Response	Moderate Response	Low Response
Coarse Sediment Input	Significant increases in channel width and bar development. Reduced pool volume. Aggradation may cause morphology to shift from pool-riffle to plane-bed or braided channel. Supply exceeds transport capacity.	Minor adjustment in channel width, bed particle size, bar development and/or pool volume. A very large, persistent increase required to trigger significant changes in channel morphology.	Sediment temporarily stored, then transported downstream. Little or no change in channel morphology expected. Transport capacity exceeds supply.
Fine Sediment Input	Large accumulations of fines observed, significant pool filling, deposition along channel margins, and embeddedness of larger riffle particles. Supply exceeds transport capacity.	Minor accumulations of fines in backwater pools or along channel margins. Slight embeddedness of larger particles in riffles. A very large, persistent increase required reduce pool volume or increase embeddedness.	Increased fine sediment temporarily stored only in sheltered areas. Transport capacity exceeds supply.
Large Woody Debris Input or Loss	Critical for forming pools, sorting sediment, creating scour that cleanses gravel, and/or dissipating energy via steps and deflection. Input would improve these functions. Loss would impair them. Channel morphology readily adjustable to changes in CWM supply.	Contributes to forming pools, storing and sorting sediment, cleansing gravels, and dissipating energy via steps and deflections but other roughness elements such as boulders also provide these functions. Channel morphology less adjustable to changes in CWM supply.	Not the primary roughness element and does not significantly affect channel morphology by forming pools, steps or deflections, or storing and sorting sediment.
Peakflow Input	Significant increase in bedload transport, depth of scour, and/or bank erosion. Coarsening of streambed and channel widening or incision depending on channel confinement, bed and bank resistance, and base level control.	Minor increase in bedload transport, depth of scour, median bed particle size and/or bank erosion. Very large increase required to trigger a significant change in channel width or depth.	Little or no change in channel morphology expected due to resistant bed and bank materials. Simple expansion of flow rather than physical channel adjustment.
Riparian Vegetation	Critical to provide root strength for bank stability, dissipate flood energy and retain fine sediment. Main source of essential CWM, aids side-channel development.	Contributes to bank stability and energy dissipation.	Not essential for stability and energy dissipation.

Response Channel Segments **Ref/Cur/Trend**

F3/C Meandering Pool/Riffle Channels in Wide Mainstem Valley Segments

These segment types include approximately 8.5 miles of the mainstem MFW, from the watershed boundary near the mouth of Simpson Creek upstream to the mouth of Tumblebug Creek. It also includes the first 2.8 miles of Staley Creek, the largest tributary in the watershed. **Surveyed Reaches**: MFW and Staley Creek. Extrapolated Reaches: none.

Landslides - Coarse Sediment Rating - Moderate to High Sensitivity

These segments exhibited channel widening and increased bar development in response to sediment supplied during the 1964 flood. The channel pattern in most segments also changed from single to multiple threads, indicating aggradation. In addition, the frequency of deep pools significantly decreased in most segments, probably due in part to filling by sediment. Survey data shows long stretches of homogeneous riffles in the mainstem MFW. This condition indicates a shift from pool-riffle to plane-bed morphology may be occurring in these segments. Figures 11 and 12 display changes in width and pattern in the MFW as measured on airphotos.

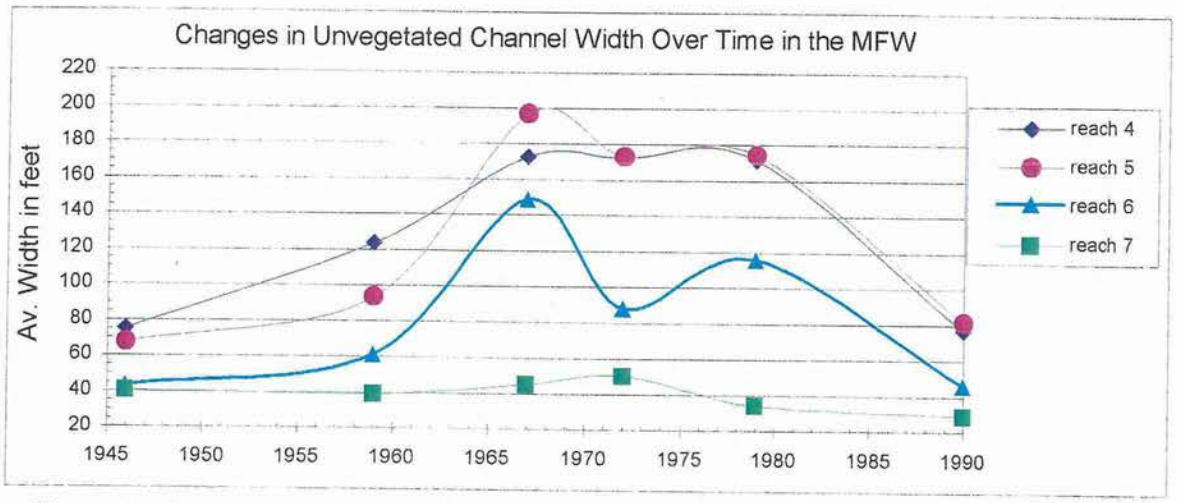


Figure 11. Changes in channel width of the MFW River in response to changes over time.

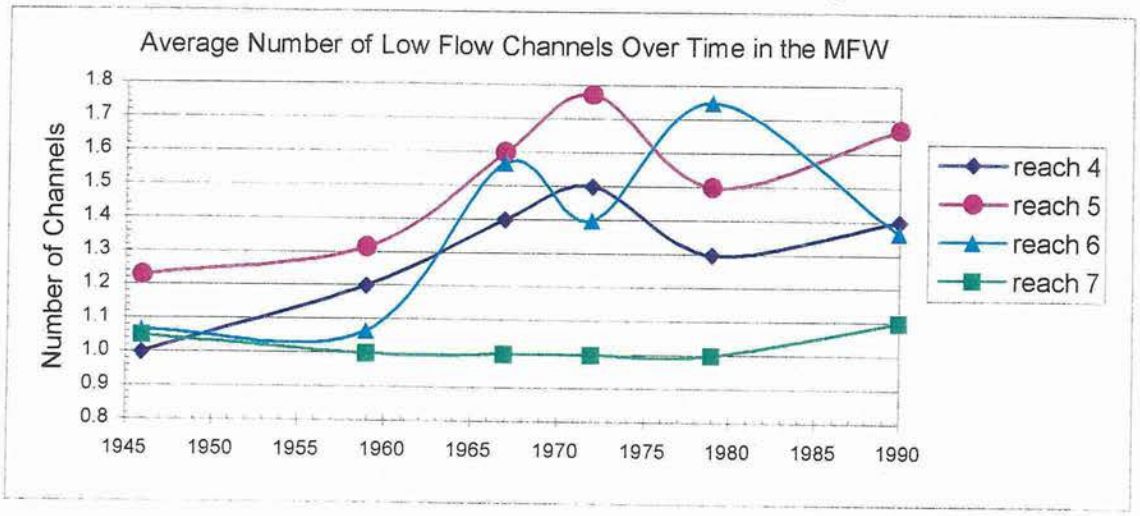


Figure 12. Average number of low flow channels in the MFW over time.

Drainage Density - Fine Sediment Rating

The stream gradients generally range from 1-3 percent, low enough to allow fine sediment accumulation. Field surveys of these reaches, have not detect large percentages of fine sediment. It is possible, however, that fine sediment has accumulated in the subsurface below the armor layer. The highest percentage of fines, 8 percent, was reported in Staley 1, the only depositional reach in that drainage. Two active earthflows are also present in the drainage and may contribute fine sediment to the stream.

V4/B Moderate Gradient Step/Pool Channels in Alluviated Mountain Valley Segments

These occur only in the older, more weathered geology of the Staley Creek Subwatershed. They include the upper 3 reaches of the mainstem of Staley Creek and the uppermost reach of the South Fork of Staley Creek. **Surveyed Reaches**: Staley 2, 3, &4 S. Fork Staley 4. Extrapolated Reaches: Davey Creek, RM 0 - 1.0, Maple Cr. RM 0 - 0.75.

Landslides - Coarse Sediment Rating - Moderate to High Sensitivity

The three segments of Staley Creek all showed increased bar development and channel widening after the 1964 flood. Survey data also indicates a decrease in the frequency of deep pools in Staley 3 and 4 (Staley WA, 1994). Two debris flows, one harvest related in 1967 and one road related in 1980, contributed coarse sediment to Staley Reach 4. An active earthflow with superimposed torrent tracks also occurs in this reach. Figure 13 displays changes in width for two reaches of Staley Creek.

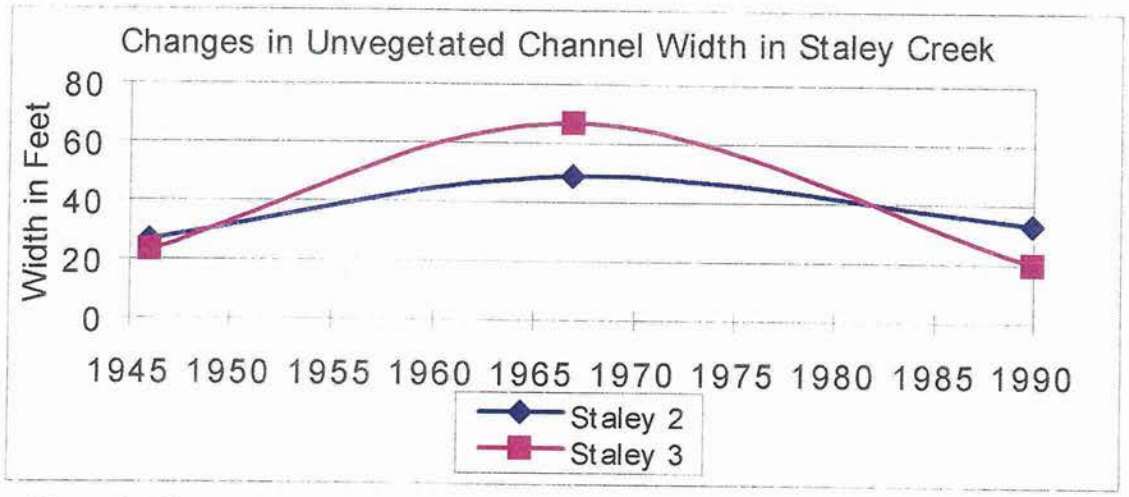


Figure 13. Changes in unvegetated channel width in Staley Creek over time.

Drainage Density - Fine Sediment Rating

Alluviated mountain valley reaches generally have high enough gradients (3-5%) to transport fine sediment frequently. In Staley Reach 2 & 3, only 3% of riffle substrate is fine sediment. However, in Staley Reach 4, the percentage increases to 10%, likely due to increased supply related to the earthflow mentioned above and the naturally high erosion potential of the soils combined with past removal of riparian vegetation. Exposed eroding banks are probably the main source of fine sediment with road drainage a likely additional source.

U1/C-U2/B Moderate to Low Gradient Pool/Riffle Channels in Glaciated U-Shaped Valleys

This type occurs at high elevations and includes 4.3 miles of the upper mainstem MFW between Emigrant Creek and Spring Meadow Creek. It also includes one mile of upper Swift Creek above the upper crossing of road 422. **Surveyed Reaches**: MFW 10, 11, & 12 and Swift 4. Extrapolated Reaches: Beaver 2, Tumblebug headwaters.

Landslides - Coarse Sediment Rating - Moderate to High Sensitivity

Survey data indicates increased gravel bar deposition in all segments except MFW 12. Channel braiding was noted in MFW 11, and frequent mass wasting was noted in Swift 4, indicating sediment supply may currently exceed transport capacity. A decrease in the frequency of deep pools has also likely occurred in MFW 10 & 11.

Drainage Density - Fine Sediment Rating

In these segments, gradients are low enough (2 -4%) to allow accumulation of fine sediment. Visible embeddedness of riffle substrate was noted in field surveys for all segments. Non-cohesive glacial till and pumice soils provide a source of fine sediment via bank erosion, mass wasting and road runoff.

F4/B Moderate Gradient Step/Pool or Pool/Riffle on Alluvial/Colluvial Fans

This type includes the lower one to two miles of three major tributaries of the MFW, plus shorter reaches of smaller tributaries. **Surveyed Reaches**: Noisy 1, Swift 1, Echo 1. Extrapolated Reaches: Skunk, Found, Indigo, Spring Meadow Creeks, RM 0-.75, and lower 0.5 mile of first order tributaries to the MFW.

Landslides - Coarse Sediment Rating

These segments exhibit a moderate increase in channel width and bar development after the 1964 flood, except in Swift 1. This reach showed greater response due to transport and deposition of sediment from debris flows originating in upstream tributaries. Survey data also indicated a substantial decrease in the frequency of deep pools in Swift 1, which is likely due in part to filling by sediment.

Drainage Density - Fine Sediment Rating

In these segments, gradients which range from 3-5%, should generally be sufficient to transport fine sediment but it is possible for sediment supply to exceed transport capacity. This may be the case in Noisy 1 where 12% of the substrate in riffles is fine sediment. The drainage above this reach has been extensively harvested and roaded which has likely increased sediment supply.

Transport Channel Segments — Ref/Cur/Trend

V1/B Mod.Confined Step-Pool Channels in V-Shaped Mod.Gradient (less confined) Valleys

This type includes a higher gradient reach of the mainstem MFW from Emigrant Creek downstream 0.9 mi. This is a transition reach between upstream reaches in a glacially carved valley and downstream reaches in a wide mainstem valley. This type also includes the lower 2 miles of Tumblebug and Simpson Creeks, two major tributaries to the MFW, plus the lower 3.6 miles of S. Fork Staley Creek. Extrapolated reaches include: Davey Creek RM 1.0 - 3.0.

Landslides - Coarse Sediment Rating

Inputs of coarse sediment from mass wasting have occurred in all these segments in the past 40 years, and have been especially frequent in Tumblebug Creek. Storage capacity for coarse sediment is somewhat limited due to valley confinement. Channel response in terms of widening and pool filling has been relatively slight with the exception of Simpson 1. During the 1964 flood, a large debris flow was transported through this reach to the MFW. Much of the material was also deposited in large bars along channel margins. Figure 14 displays the relative changes in channel width in these two segments.

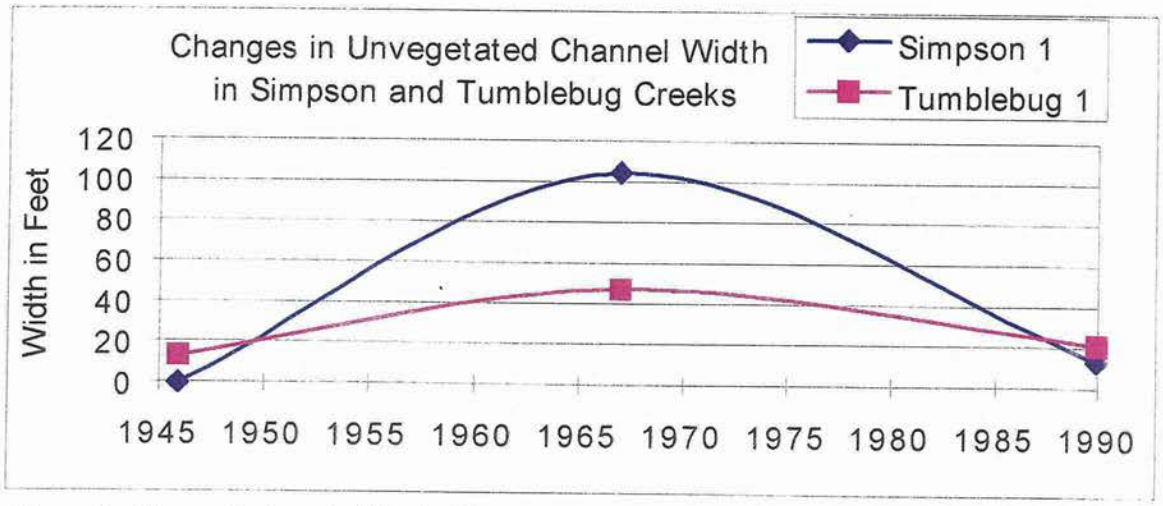


Figure 14. Changes in channel widths in Simpson and Tumblebug Creeks over time.

Drainage Density - Fine Sediment Rating

In these segments, gradients range from 3 to 7 percent and are generally high enough to transport fine sediment. Survey data indicates no visible embeddedness of riffle substrate in most segments. Embeddedness was visible however in S. Fork Staley Reach 3. Supply, likely from the immediate upstream reach, may exceed transport capacity in this case. In Simpson Reach 1, 7 percent of riffle substrate was fine sediment.

V1/A Steep Confined Step-Pool/Cascade Channels in V-Shaped Moderate Gradient Valleys

This type includes a relatively steep gradient bedrock confined reach of the MFW from Tumblebug Creek upstream 0.7 miles. It also includes similar bedrock gorge-type reaches in upper Tumblebug Creek. This type is also found in the upper half of Noisy Creek, and in middle sections of Simpson, Swift, and Echo Creeks. Channel types are found in v-shaped valleys with confined moderate gradient channels. **Surveyed Reaches** include: MFW 8, Simpson 2, Swift 2, Echo 2, Noisy 3 & 4, Tumblebug 3 & 4. Extrapolated Reaches include: Simpson above the end of reach 2.

Landslides - Coarse Sediment Rating

Gradient and confinement of these segments generally limits sediment storage and potential morphologic adjustment. Evidence of increased bar development and decreased pool frequency occurs only in Simpson 2 and Swift 2. These two reaches have gradients of roughly 4%, the lowest of this channel type. Both reaches have received significant mass wasting input in the past 35 years and increased width persists in Swift 2. Echo 2 has also experienced mass wasting input and channel widening, but it is unclear how related this response is to coarse sediment in this reach (Figure 15). Frequent mass wasting is part of the natural geomorphic setting of Tumblebug 3. The channel morphology is created by this regime and significant adjustment to this input factor is unlikely.

Drainage Density - Fine Sediment Rating

In these channel types, gradients range from 4 to 11 percent in these segments and are sufficient to transport fine sediment. No visible embeddedness was noted in MFW Reach 8. However in Swift Reach 2, Simpson Reach 2, and Noisy Reach 3 & 4, riffle substrate consisted of 6 to 20 percent fine sediment, a higher percentage in some cases than in lower gradient reaches downstream. Sediment supply may be close to transport capacity in these segments. A likely source in the case of Swift and Noisy Creeks is roads located in soils with very severe surface erosion potential which drain via small tributaries into these reaches. This situation also occurs in Tumblebug Reach 3 & 4. Field data for

embeddedness in these two segments is indeterminate but may be up to 25 percent. No data is available for Echo Reach 2.

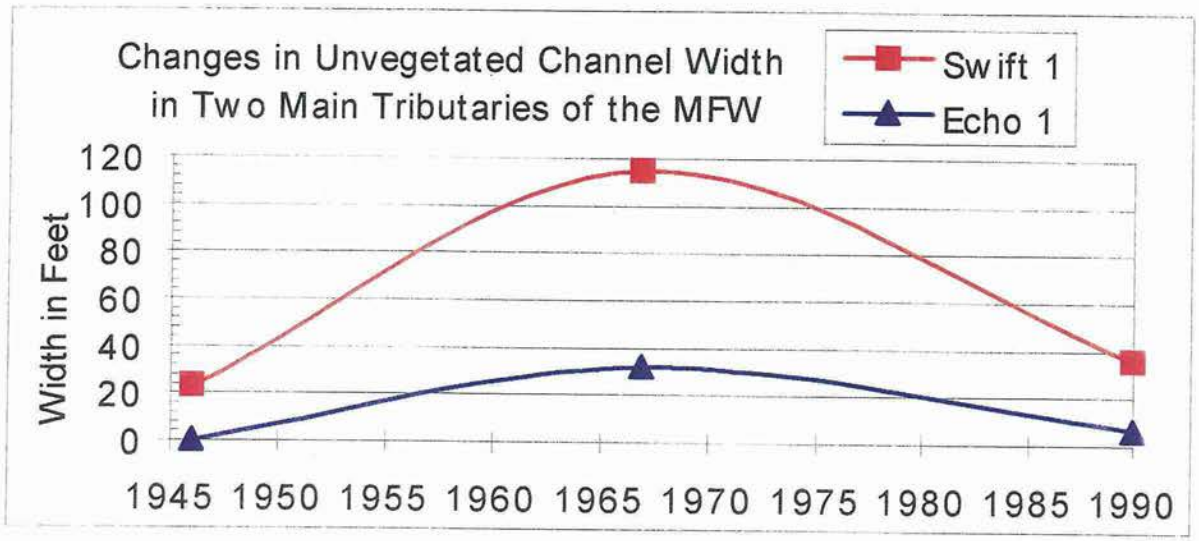


Figure 15. Changes in unvegetated channel width in two main tributaries in the MFW.

V2/A Step-Pool/Cascade in V-Shaped High Gradient Valleys

This type includes all of N. Fork Staley Creek, plus middle reaches of Noisy and Swift Creeks. The first mile of Bear Creek, the largest tributary of Swift Creek, is also included in this type. **Surveyed Reaches**: Bear 1, Noisy 2, Swift 3, N. Fork Staley 1 & 2 and Extrapolated Reaches: S. Simpson above reach 2, Dome RM 0 - 1, Spider RM 0 - 2, W. Fork Tumblebug RM 0 - 2.5, Royal, Hayseed, and Dee Creeks RM 0 - 1, Emigrant RM 3 - 4.5, and most major tributaries to Swift Creek.

Landslides - Coarse Sediment Rating

The potential for storage of coarse sediment is limited in these channels. Input from large-scale mass wasting has apparently been infrequent in all segments except N. Fork Staley. Frequent mass wasting from upper banks was noted in Swift 3. Little data is available to assess changes in morphology over time, but some channel widening and decreased pool frequency may have occurred in Swift Reach 3. Field data also indicates a moderate increase in bar development in this reach and a lesser increase in Bear Creek and N. Fork Staley.

Drainage Density - Fine Sediment Rating

In these channels gradients range from 6 to 12 percent, yet riffle embeddedness is higher than in lower gradient reaches downstream. Sediment supply may be close to transport capacity. In N. Fork Staley, cobble embeddedness is 35 to 40 percent, with some sediment deposition in pools. Embeddedness and deposition in pools was also noted in Bear Reach 1. In Noisy Reach 2, 10 percent of riffle substrate is fine sediment, and in Swift Reach 3 it is 16 percent. In the case of Noisy Creek, the most likely sediment source is upstream reaches (see discussion above), while Swift Reach 3 is connected via tributaries to two roads in soils in High Storm Response areas. Roads located in High Storm Response areas are also likely sediment contributors in N. Fork Staley along with bank materials.

M1/B Moderate Gradient Step-Pool Channels in Moderate Slope Bound Valleys

This type includes lower reaches of smaller tributaries to the MFW in the upper half of the watershed. **Surveyed Reaches** include: Mac 1, Pioneer Gulch 1 & 2, Emigrant 1, Beaver 1. Extrapolated Reaches include: Goodchill rm 0 - 1.5, lower .25 miles of several first order tributaries draining slopes northeast of MFW 10 - 12..

Landslides - Coarse Sediment Rating

These channels are capable of some storage of sediment, though field data indicates little or no additional bar development is occurring in these segments. Large-scale mass wasting has generally been infrequent. Sediment trapping features such as CWM are currently low.

Drainage Density - Fine Sediment

Field surveys indicate significant embeddedness in all segments. Long sections of dry channel also occur in all segments, except Mac Reach 1. Some pool filling was also noted in Emigrant Reach 1 and Beaver Reach 1. Non-cohesive pumice soils are a likely source.

Source Channel Segments — Ref/Cur/Trend

H3/A Cascade Channels in Very High Gradient Headwaters

These channels are headwall/sidewall tributaries with tightly confined, steep gradient channels. The only **surveyed reach** in this watershed is: Royal. Extrapolated reaches are numerous. This channel type occurs throughout the watershed, most often in first and second order channels.

Landslides - Coarse Sediment Rating

These small, high energy channels have little sediment storage capacity, and lots of transport capacity. Only very large inputs from mass wasting are likely to temporarily affect channel morphology.

Drainage Density - Fine Sediment Rating

Very high transport, very low storage capacity.

KQ 3 - Where and to what extent has road density, condition, location and use influenced aquatic species distribution and habitat?

Salmonid reproductive success and migration use are the predominate biological factors in the UMFWA that may be effected by road density, condition, location, and use. Reproductive success is evaluated by the condition of the habitat, principally by the percent fines in response and transport reaches. Migration is evaluated by reviewing culverts that present a passage barrier to historic and/or present habitat.

Anadromous Fish Species — Reference

Spring Chinook that ran up the Willamette River had adapted over the centuries to water conditions that were needed to climb Willamette Falls near Oregon City. High spring flows provided access to clear the falls. High, less suitable water temperatures were common at this time of year. Eggs thus had to develop under warm, low flow summer conditions.

Fluvial bull trout spent most of their life in the main stem, predominantly in cool side channels in Lower Middle Fork (between Hills and Staley) and in Upper Middle Fork in cold, spring-fed main channel up to possibly Big Swamp Falls (in upper Paddy's Valley), more likely Emigrant Falls (near confluence with Beaver Creek).

Local historic accounts state that fluvial bull trout were harvested from Staley and Swift creeks in early to mid-1900's, probably spawning or feeding on emerging Chinook. Spawning fluvial, resident and rearing bull trout were likely in Swift, Echo, Staley and Tumblebug creeks and side channel/margin areas of the Middle Fork. Other systems that were possibly utilized were Noisy and Simpson creeks (Figure 16). The last proven bull trout sighting was in 1990 at Big Pine Openings near confluence with Simpson Creek. Several unproven sightings of bull trout have been recorded in the same area of the Middle Fork as well as Sacandaga Pool and up Swift Creek over the last five years (1990-1995). Potential habitat for current distribution and re-introduction is given in Figure 14.

Resident Fish Species — Ref/Cur

Historically, resident coastal cutthroat and bull trout were separated by predatory and habitat choices. Cutthroat trout preferred smaller, high gradient drainages, feeding primarily on insects and occasionally on small fish. Presently, however, with the loss of bull trout, cutthroat trout have begun to disperse further into the system where bull trout may have previously dominated (Figures 17 and 18).

Other resident species include mountain whitefish, two known sculpin species (torrent and pauite), large-scale sucker, speckled dace, Northern squawfish and Pacific lamprey. It is assumed that adequate distribution of the salmonid species will meet the distribution needs of the other native fish except possibly sculpin and dace.

Figure 16. Historic Bull Trout Distribution

Upper Middle Fork

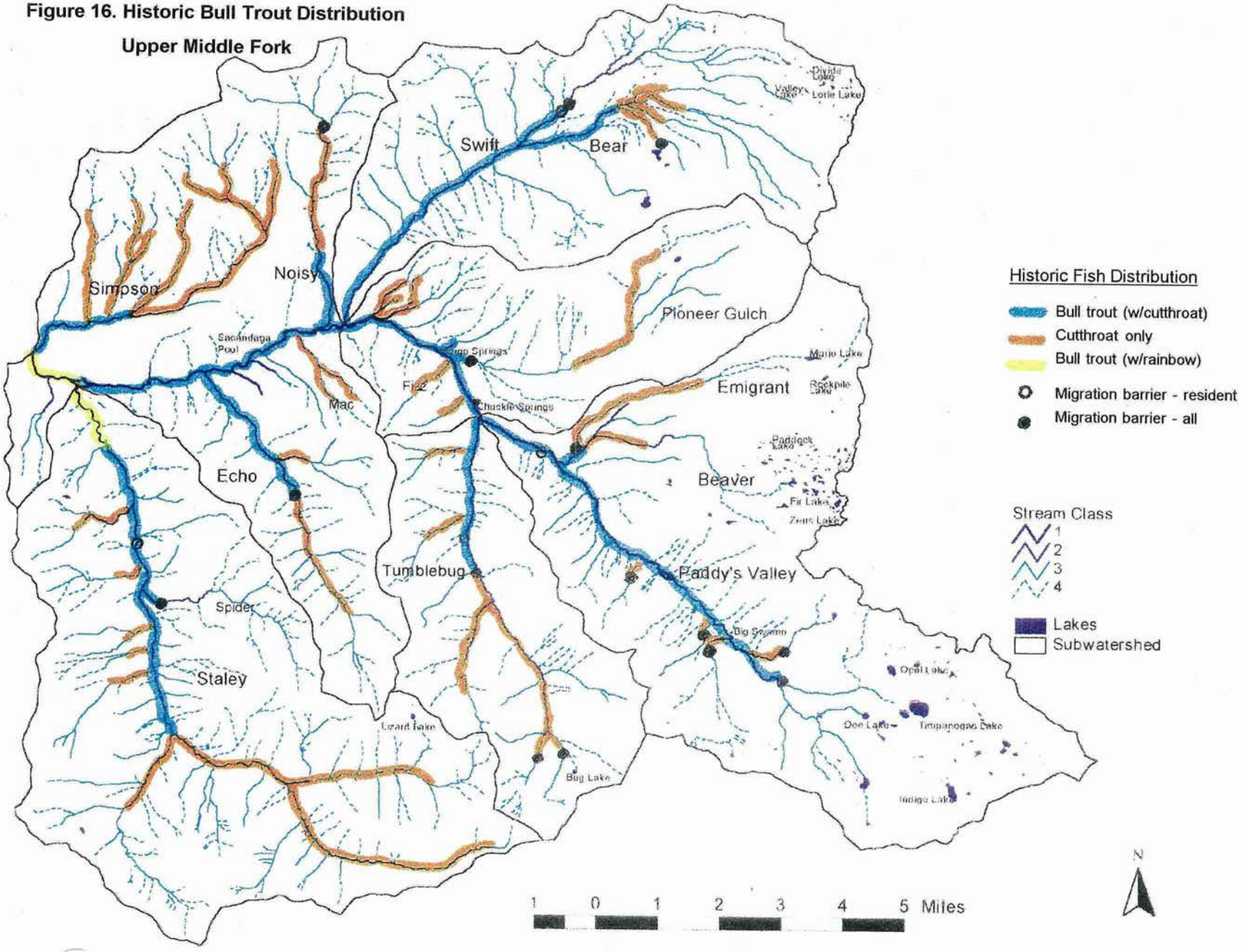


Figure 17. Potential Bull Trout Distribution

Upper Middle Fork

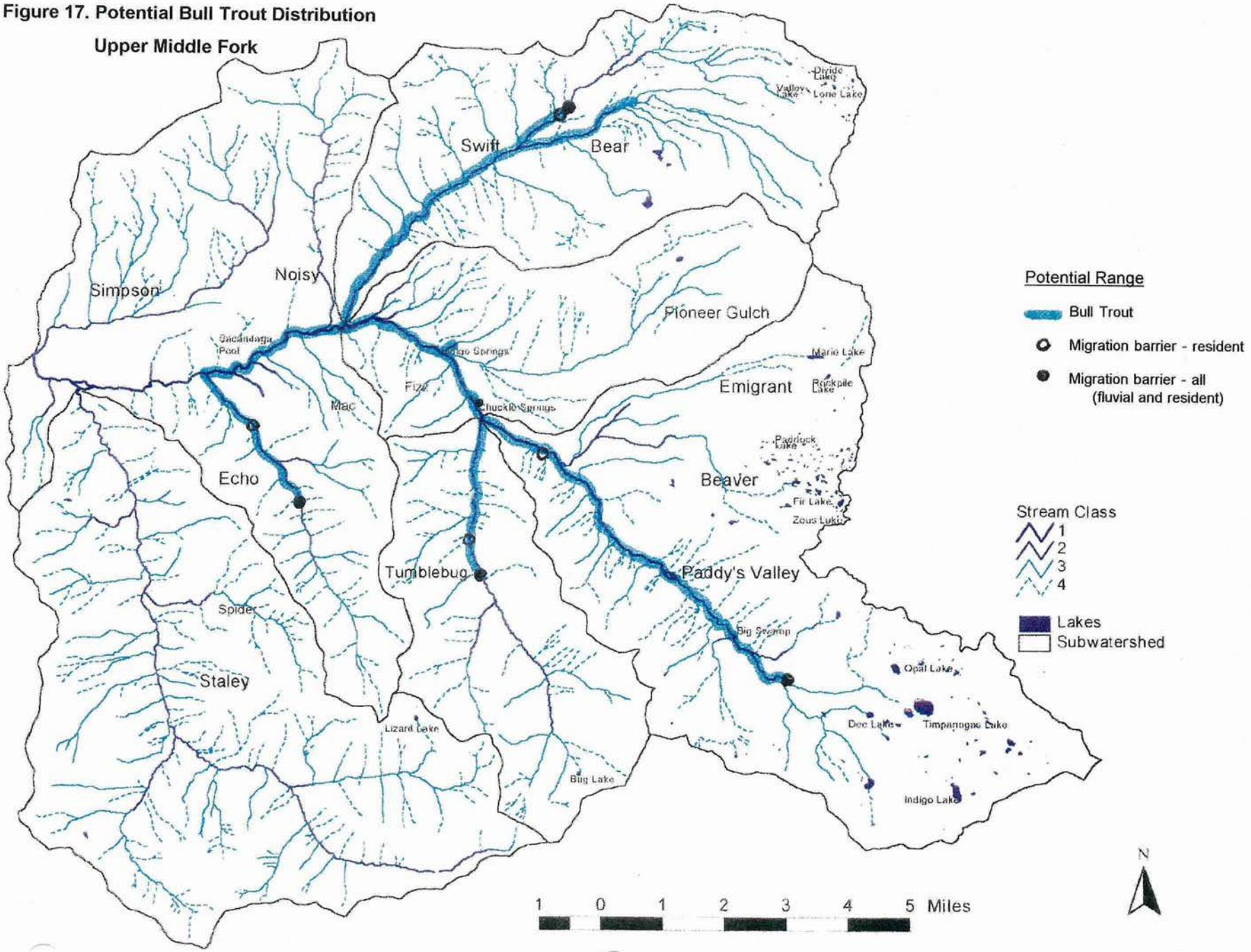


Figure 18. Current Fish Distribution

Upper Middle Fork

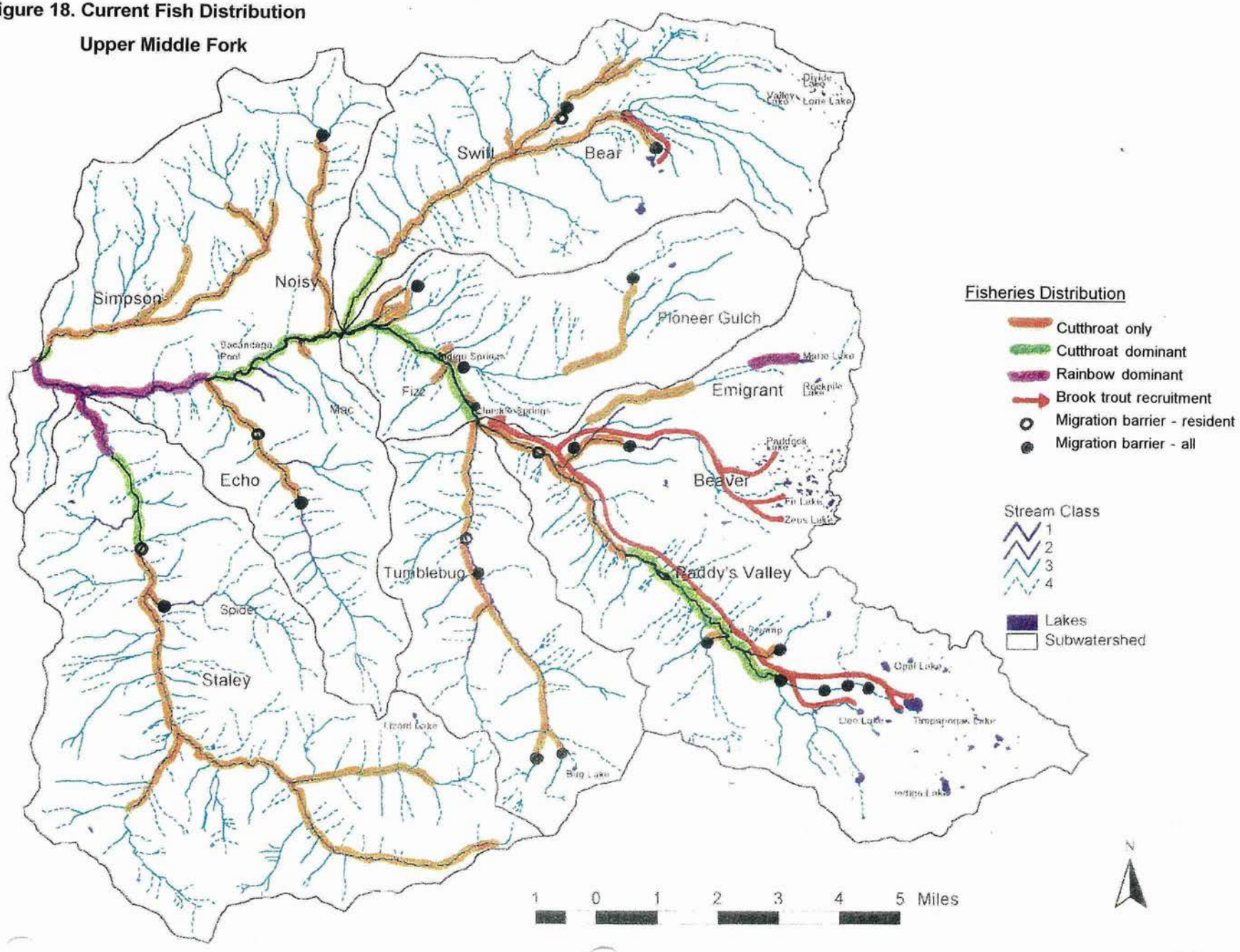


Figure 18. Current Fish Distribution Upper Middle Fork

Anadromous and Resident Fish Species Current/Trend

Today, adequate conditions exist for Spring Chinook in Echo, Swift and Tumblebug creeks as well as in the Middle Fork above the confluence of Staley Creek. In the past few years, the Oakridge Fish Hatchery has been releasing spawning adult Chinook salmon that were collected below Dexter into the MFW above Hills Creek Reservoir. These fish have been observed spawning primarily in cold, spring-fed, glacial upwelling areas in the Upper MFW (between Sacandaga and Indigo) as well as the lower reaches of Staley and Swift Creeks.

From the previous sections on erosion and channel response it can be summarized that Staley, Tumblebug, and Swift Creek Subwatersheds may have reaches that compromise the reproductive success of bull trout and resident cutthroat trout (Table 7). It is assumed that the inputs of coarse and fine sediments have been a combination of landslides, road drainage, and bank erosion exacerbated by high storm flow response regimes and erosive soils. The high risk roads, which are roads located on highly erosive soils in high storm response areas, are also listed

Table 8. Channel type, location, and percent embeddedness in UMFWA.

Channel Type	Subwatershed	Location	% Embedded	Effective Drainage Density	High Risk Roads
Response	23-1	Staley Reach 4	10	4.2-7.4	2134-243 2144-335, 370
Transport	23-1	N Fork Staley Reach 2	35-40	4.2-7.4	2136-300 2137
	23-2	Tumblebug Reach 3,4	< or = 25	4-5.7	2144-370
	23-5	Swift Reach 2,3	16-20	3.7-6.7	2120
	23-6	Simpson Reach 1,2	7 6-20	4.8-8.3	None Identified
	23-4	Noisy Reach 2,3,4	Unknown		2144-299
	23-3		Unknown		2154-270 2153-353

Culverts that pose possible migration barriers for fluvial bull trout and a definite migration barrier to resident fish are the following: Echo Creek (RD 2143/325), Bear Creek (RD 2149), Noisy Creek (RD 2100), Spider Creek (RD 2136), and South Fork Staley (RD 2136/300).

In addition to culverts listed as barriers for bull trout, the following are other barriers to cutthroat trout migration: Pioneer Gulch (RD 2149), Emigrant Creek (RD 2154/382), Beaver Creek (RD 2153), Swift Creek (RD 2300, 2300/422), Tumblebug Creek (RD 2144), Mac Creek (RD 2144) and Dome Creek (RD 2134).

KQ 5 - Where do opportunities exist to minimize user conflicts? Where do opportunities exist to minimize user impacts to Riparian Reserves?

Human uses have changed somewhat through time. Past use was centered more on economic gain and survival. Present uses are centered on economic gain with more emphasis on recreational pursuits. Resource use such as timber harvest and livestock grazing were once the mainstay economic pursuits. While timber harvest levels have fallen to lower levels than experienced in the seventies and eighties, and livestock grazing of meadows is nonexistent, recreational use and the sale of special forest products are found to be increasing according to sales data.

Road construction activities fragmented or obliterated many of the historic trails which were located in valley bottoms and ridge tops. The remnants of these impacted trails were no longer practical to maintain. In response to recreation demands, new trails have been proposed or constructed in recreation corridors which usually consist of valley bottoms. An example is the Middle Fork Trail which was constructed as a recreational trail associated with water rather than a transportation facility like the majority of the historic trails.

Dispersed Recreation Use in Riparian Reserves — Reference

Over the centuries, Native Americans developed a well-defined trail system. Aikens (1976) points out that the use of linear ridges as transportation routes is a known prehistoric practice. References citing the existence of a widespread aboriginal trail system are numerous. Wailing, in his History of Lane County (1884), states that:

"The story of the presence of these aborigines is well-marked throughout the district. The early settlers found man-made prairies along the Willamette River for whence foot trails lead into the mountain recesses and to the trout streams and the areas noted for their herds of deer and elk."

Between 1864 and 1867, Byron J. Pengra and his associates surveyed and built the Oregon Central Military Wagon Road (OCMWR) through Willamette Pass. This road location was located adjacent to the MFW River until turning eastward at Paddy's Valley and climbing over Emigrant Pass to Summit Lake. As result, access to the Upper Willamette became much easier.

Stephen Rigdon and his wife Zilphia operated a way station along the OCMWR located at Rigdon Meadows from 1871 until 1896. The improved road access and way station provided a focal point that increased use of the river and streams as a result of increasing the human population of the area by providing an attraction.

An elaborate trail system was constructed during the early to mid 1900's to service lookouts and provide access for fire suppression. The historic trail system (prior to the 1950's) was approximately 140 miles in length according to district maps of the late 1950's. Many of the trails had their origins at the MFW River.

Dispersed Recreation Use in Riparian Reserves — Current/Trend

As settlement and population growth continued, so did the desire to camp and hike. As timber harvest increased and associated road access, recreation in dispersed sites developed. Presently, there are four developed campgrounds located adjacent to the MFW River and high lakes (Table 9).

Table 9. List of developed campsites and capacity in UMFWA.

Campground	Number of Sites	Capacity (PAOTS)*
Sacandaga	17	105
Indigo Springs	3	15
Timpanogas Lake	10	70
Indigo Lake	5	25

**Persons At One Time*

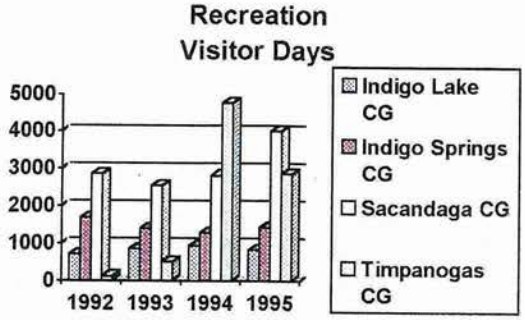
Indigo Lake Campground is the most primitive and consists of five campsites located on the northern end of Indigo Lake. The campground is a 1.9 mile hike from Timpanogas Lake via the Indigo Lake Trail. Campsites are primitive, consisting of split log tables and metal fire rings in keeping with the semi-primitive recreation opportunity spectrum setting.

The four developed campgrounds in this watershed are all experiencing increased visitor use over the past four years (Table 10). These campgrounds are all located within Riparian Reserve areas.

Actual use of the four campgrounds varies from seventeen to thirty-seven percent of peak season theoretical capacity. This relates to experiencing full campgrounds (all sites are occupied) on certain weekends, but not to the point of needing additional campsites.

Table 10. List of developed campsites and percent use of seasonal capacity.

Campground	Percent Use of Seasonal Capacity
Indigo Lake	17
Indigo Springs	35
Sacandaga	34
Timpanogas Lake	37



One Recreation Visitor Day equals one person visit for twelve hours. Recreational uses represented includes viewing scenery, fishing, camping, hiking swimming, gathering forest products, and picnicking.

In addition to developed campsites, there are several dispersed campsites in the watershed. Summer use at dispersed sites is generally focused near a body of water such as a lake, stream, or river. Late season use such as hunting camps will use the same water adjacent sites and will also include more remote dispersed sites located back in drainages and ridges nearer preferred hunting areas. There are eighty inventoried dispersed campsites in this watershed with the majority along the MFW River and lakes, both wilderness and nonwilderness.

These dispersed campsites have been inventoried by several different methods. Earlier methods used the Code-A-Site Inventory method. The Diamond Peak Wilderness and OCR Area sites were inventoried using Limits of Acceptable Change (LAC) methods. There are 42 nonwilderness dispersed sites and 38 wilderness dispersed campsites inventoried to date.

The majority of dispersed campsites located adjacent to the MFW are in the reach between Swift and Coal Creek. In this area, the Middle Fork Trail and dispersed sites occasionally intermix, that is they become adjacent to each other, causing conflicts between campers and trails users. The UMFWA has been identified as eligible for study as a potential Wild and Scenic River (Scenic Classification). It is in interim management as a Scenic River (Management Area 6b). The objective for this area to maintain the river environment in a natural state while providing for recreation opportunities. Scenic River Management Areas will consist of rivers or river segments that are free of impoundments, with shorelines and watersheds in mostly primitive condition. Shorelines will be primarily undeveloped, but accessible by roads.

The summer trail system is grouped by location and management objectives. These grouping include the Middle Fork, Timpanogas Basin, and Diamond Peak Wilderness trail groups (Table 11). There is a current total of 87.4 miles of maintained trail system within the watershed. Of the total of 31 trails or 87.4 miles, four trails or 18.7 miles (21 percent of the total) are located within Riparian Reserve areas.

Table 11. UMFWA Trails in Riparian Reserves.

Trail	Length in Miles	Riparian Reserve
Middle Fork Group		
Chuckle Springs	0.4	X
Indigo Springs	0.2	X
Middle Fork	17.0	X
Timpanogas Group		
Timpanogas Lake	1.1	X
Total Miles	18.7	

The current trail system is recreation oriented and most visitor use occurs on those trails located in the Riparian Reserve or on those trails leading forest users to high lakes. Most recreation infrastructure is accessible by primary and secondary roads. The primary road (Forest Road 21) provides the bulk of access to dispersed campsites along the MFW River.

The extent of the impact on riparian functions has not been documented. In high use areas the riparian vegetation may be denuded and surface erosion to streams and lakes potentially increased. Limits of Acceptable Change inventories of dispersed campsites areas need to be completed.

ISSUE 2: VEGETATION CONDITION AND PATTERNS

KQ 1 - Where and to what extent have management practices influenced landscape patterns such as seral stage distribution and coarse woody material?

This watershed covers a wide range of elevations and site conditions. Due to variations in site conditions and varying growth rates between stands, stand age does not correlate evenly to tree size across the watershed. Therefore, tree size rather than stand age has been used in this analysis. Stands were classified as stand initiation (SI), early stem exclusion (ESE), late stem exclusion (LSE), and mature and old growth (MOG) based on average stem size within the stand.. The understory reinitiation seral stage equates to mature stands. For the issues identified in this analysis, mature stands and old growth stands function similarly (Harris, 1984) and are therefore lumped into a single category (MOG). The stem exclusion stage was split into two categories to separate stands which are hydrologically recovered (LSE) and stands which are not fully hydrologically recovered (ESE). The four categories used in this analysis are fully described in Appendix D.

Seral Stage Distribution

Reference

Reference conditions were established using Forest Type mappings of 1947 (Douglas County) and 1949 (Lane County). County efforts were not coordinated, creating two artificial patterns in reference condition data: 1) a distinct line at the county border, and 2) stands which were less finely differentiated in Douglas county, so patterns in that portion of the watershed are generalized representation of on-the-ground conditions.

According to Forest Type mappings, mature and old growth forests were the dominate habitat, covering approximately 80% of the lands (Figure 19 and 20; Table 12). Although windthrow and mass wasting produced early seral stands, fire was the most prevalent natural disturbance initiating succession; three to five percent of the watershed experienced a stand-replacing burn in a series of mid-19th century fires, and another five to ten percent of the watershed was burned in a series of fires occurring in the early 20th century. These percentages reflect only areas of stand-replacing burn as recorded on the historic vegetation map, and do not include the large areas which experienced lower intensity underburns.

An important consideration in evaluating this information is to understand the source and reliability of historic data. The historic data was derived by aerial photo interpretation during the 1940's. Therefore, many fine-scale features are underrepresented. In addition, the Lane county portion of the watershed was stratified more finely than Douglas, so more accurately represents actual conditions. Aggregated figures for the watershed are therefore somewhat skewed by the Douglas county information.

- Old growth covered proportionally more of the low elevation habitats, accounting for approximately 90% of low elevation habitat versus approximately 70% of high elevation habitat.
- In the higher elevations, there were proportionally more late stem exclusion acres, largely attributable to: 1) higher number of lightening-caused fires along ridges; 2) greater likelihood for a stand-replacement fires along steep ridges, and 3) harsh growing conditions at higher elevations resulting in stands remaining in the stem exclusion stage for more extended periods than lower elevation stands.

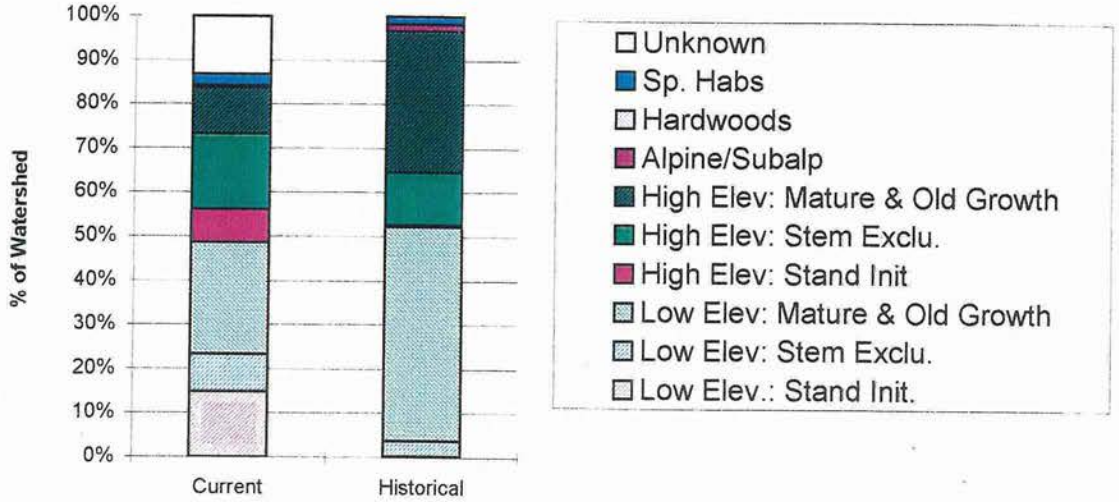


Figure 19. Reference and current seral stage percentages in the watershed.

Table 12: Current vs. Historical Distribution of Seral Stages

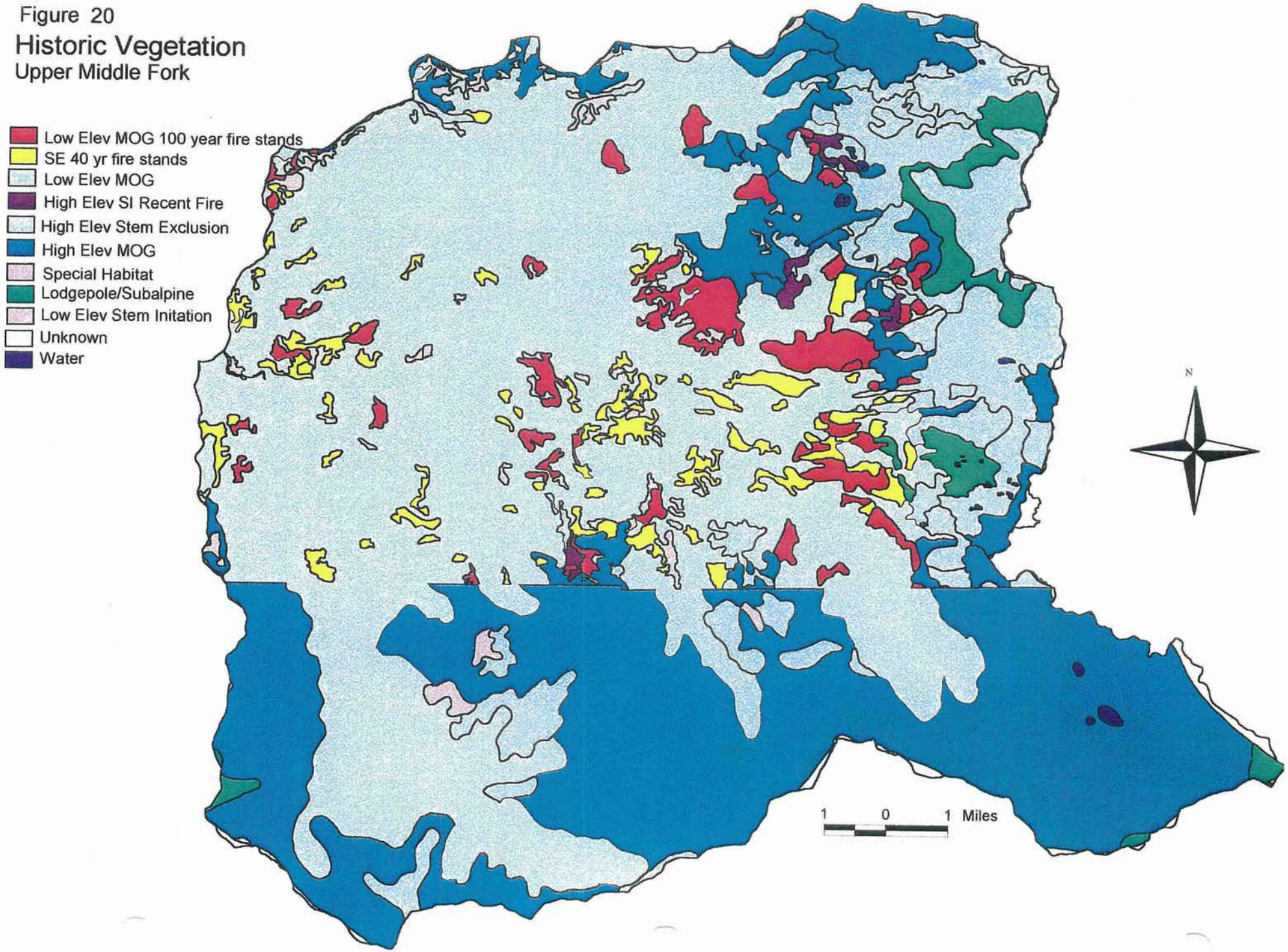
Species Group	Seral St.	Current % of WS	Historical % of WS
Low el.	SI	14.9	0.2
Pines, PSME	SE	8.5	3.5
	MOG	25.3	48.6
High el.	SI	7.5	0.4
Abies,TSME	SE	17.1	12.0
	MOG	10.5	32.0
Alpine/Sub		0.4	1.6
Hardwoods		0.1	
Special Habs		2.5	1.7
Unknown		13.2	

Note: The unknown category includes both stands for which dominant species is not known, and stands for which size category is unknown. The majority of these stands are located on private land.

Figure 20

Historic Vegetation

Upper Middle Fork



Seral Stage Distribution Current/Trend

Mature and old growth forests currently occupy 36% of the landscape, a loss of approximately 55% from historic conditions. Approximately 22 % is in the stem initiation stage, an increase of approximately 3600%. Stem exclusion accounts for 26% of the landscape, an increase of approximately 65% (Table 13 and Figure 21).

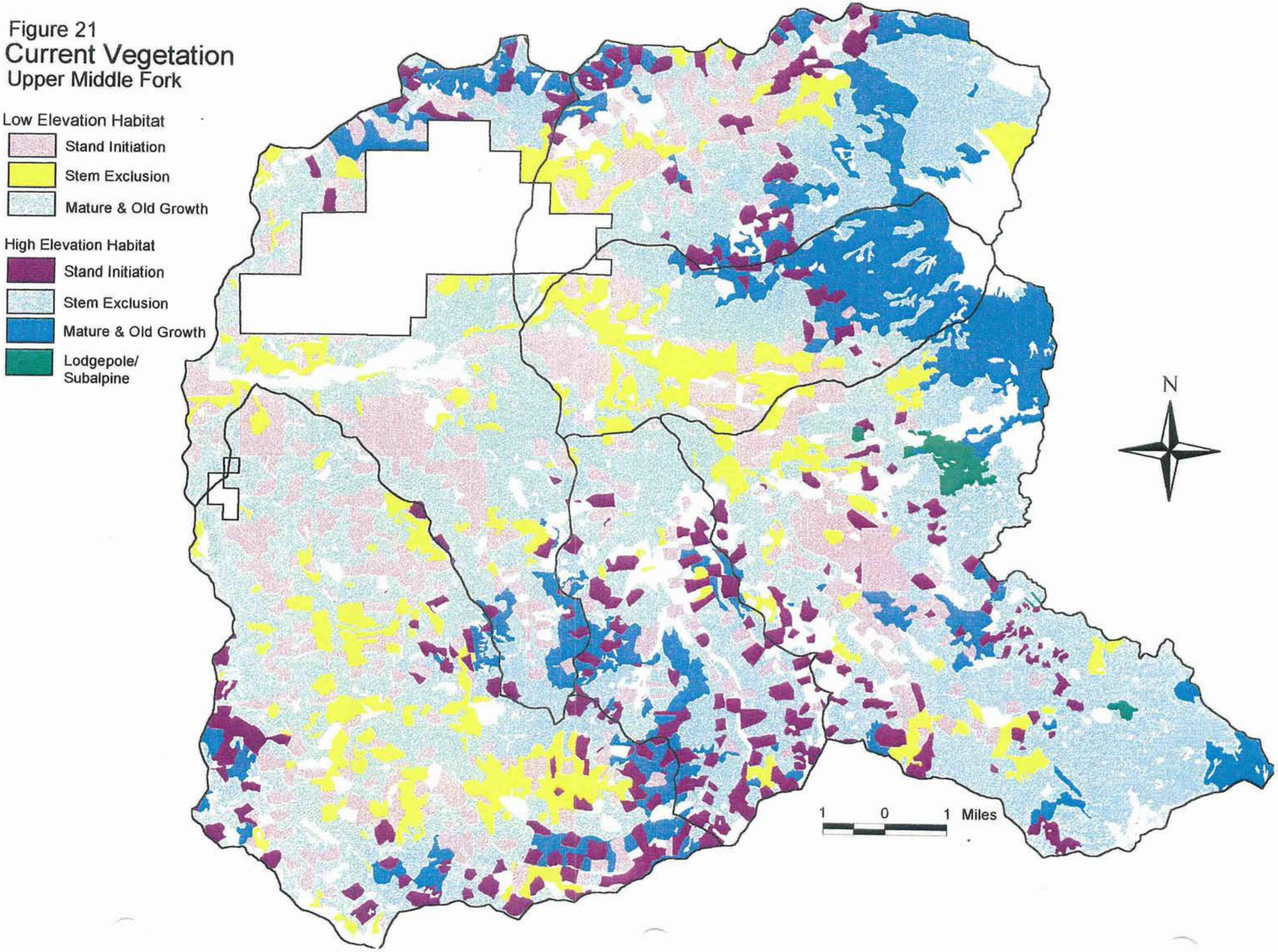
- Forty percent of current mature and old growth stands are located in large block reserves (Diamond Peak Wilderness, Oregon Cascades Recreation Area (OCRA) and LSR)
- The majority of low elevation late stem exclusion (LSE) stands are attributable to natural conditions.
- Although GIS records show much of the high elevation stands in the wilderness as LSE, satellite and aerial photo evaluation confirmed by ground-sampling shows that many of these stands are actually Mature or Old Growth.

Table 13: Current seral stage distribution by Subwatershed.

	SI		ESE		LSE		MOG		Unknown		Total
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Ac
Staley	8,117	31	1,245	5	3,692	14	11,820	46	1,057	4	25,931
Tumblebug	3,075	29	112	1	2,353	22	4,662	44	348	3	10,550
Timpanogas	4,743	18	632	2	13,431	52	5,772	22	1,150	4	25,728
Pioneer	2,525	22	878	8	1,606	14	5,802	51	605	5	11,417
Swift	3,585	21	303	2	4,913	29	5,876	35	2,158	13	16,836
Simpson	1,589	12	313	2	1,092	8	3,657	28	6,546	50	13,197
Echo	3,040	31	288	3	880	9	5,268	54	204	2	9,680
Total WA23	26,675	24	3,772	3	27,967	25	42,858	38	12,068	11	113,339

Notes: 1. Percent is based on Subwatershed acres.
2. Unknown category includes stands for which size class is unknown

Figure 21
Current Vegetation
Upper Middle Fork



Harvest Allocation Lands

Current/Trend

- Harvest allocations lands are 37% mature and old growth timber, or 16,154 acres. 4,003 acres of these MOG stands are on lands classified unsuitable for timber harvest (Table 14, Figure 22).
- Late stem exclusion stands cover 20% (9,131 acres) of harvest allocation lands with 2,687 of these acres on unsuitable lands.
- Early stem exclusion stands account for 3% (1,484 acres) of the harvest allocation lands, including 213 acres of unsuitable. The older stands with average stem size greater than seven inches are economically feasible for logging by ground-based systems if terrain allows.
- There is 30% (13,861 acres) of the harvest allocation land base in the stand initiation stage land, of which 2421 are unsuitable. Most stand initiation of which are the result of previous harvest activity. Based on current market and technologies, these stands will require up to 30 years to attain a size capable of producing commercial timber products, with some stands requiring longer periods due to harsh growing conditions.
- With approximately 1/2 of the FW-211 special habitats mapped, almost 2% of harvest allocation lands are FW-211 lands.
- There is no size data for 2% of harvest allocation lands, but photo analysis establishes that the majority of these stands are unmanaged stands.
- Providing there are no large-scale natural disturbances, MOG on congressionally and administratively withdrawn lands would provide the 15% late successional forest habitat in fifth field watersheds as required by the WNF Forest Plan as amended by the ROD.
- MOG on harvest allocation lands will likely decrease over time.

Table 14: Distribution of Seral Classes in Harvest Allocations

	SI		ESE		LSE		MOG		UNK SIZE	
	Suit	Unsuit	Suit	Unsuit	Suit	Unsuit	Suit	Unsuit	Suit	Unsuit
11A: Scenic Mod Middlegrd	2583	240	198	21	1934	633	3781	951	151	157
11C: Scenic PR Middlegrd	714	257	220	82	563	52	797	112	105	18
11D: Scenic PR Foregrd	787	116	360	21	608	255	1178	126	194	20
14A: General Forest	7356	1808	493	89	3563	1747	7175	2814	598	335
Total Harvest Allocations	11440	2421	1271	213	6668	2687	12931	4003	1048	530

Spatial arrangement and relative abundance of seral stages can be influenced by the speed with which a stand regenerates and grows. Three factors which are known to influence regeneration and growth in this watershed are frost pockets, low regeneration potential and low site class.

Potential for regeneration is an indicator of the potential of a site to regenerate at a minimum level of stocking as set by the Forest Service. Lands with a low regeneration potential rating can be expected to be more difficult to regenerate, are more labor-intensive and expensive, and several years may elapse before an adequate stocking level is achieved. Low/moderate sites may prove difficult to regenerate, particularly if the initial planting fails and brush becomes established.

- Slightly more than 14% (6,522 acres) of harvest allocation lands are considered to have a low potential for regeneration, and another 40% (18,141 acres) has low/moderate potential for regeneration.

- 4332 acres of the low regeneration potential acres and 11,660 of the low/moderate acres are in unmanaged stands. These stands are likely to experience regeneration problems, and if harvested, may be more expensive to regenerate than sites with better regeneration potential.

Frost pockets slow regeneration in areas totaling less than 5% of the watershed. This damage occurs in patches and is most evident:

- along the headwaters of South Fork Staley Creek
- along the flats of the Middle Fork of the Willamette,
- the headwaters of Swift creek
- along the Middle Fork from the confluence with Swift Creek to Paddy's Valley.

Coarse Woody Material — Reference

The amount of coarse woody material (CWM) also referred to as large woody material is believed to have varied across the landscape. Topography, aspect, fire frequency and site climate often interplayed as determining factors in quantity of CWM on sites. Since many species which are dependent on CWM are of limited mobility, the presence of CWM in connective corridors was particularly important.

A range of CWM amounts has been correlated to plant association types. Associations which experience frequent underburning, particularly the drier Douglas-fir associations, tended to have had a low quantity of CWM over time. Cool sites and northerly aspects generally retained a higher quantity of CWM.

Coarse Woody Material — Current/Trend

Current standards for CWM as established by the ROD prescribes an interim guideline requiring a minimum of 240 lineal feet of CWM per acre. The ROD states that we should develop CWM models based on plant associations and stand types.

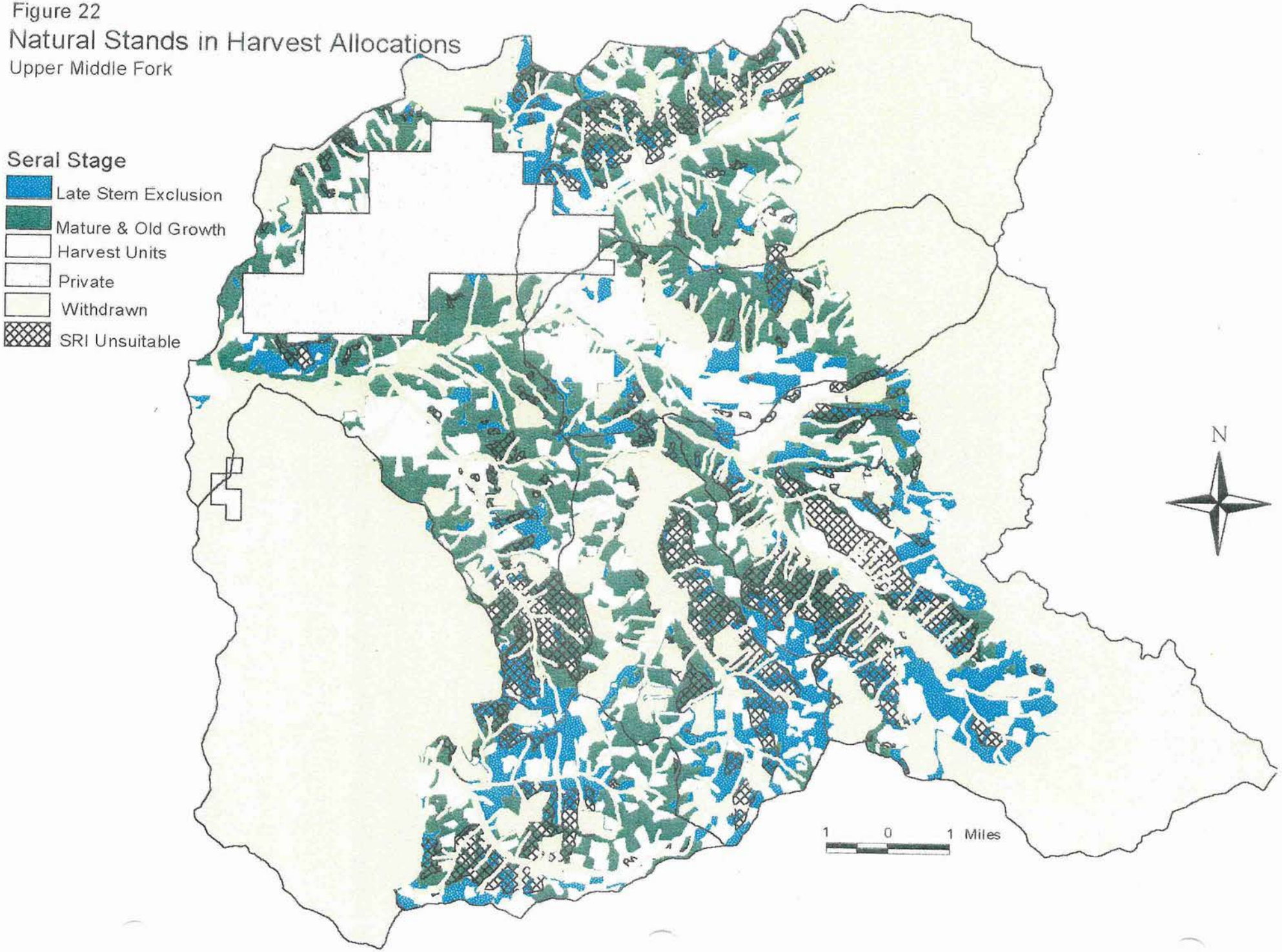
- Previous harvest practices removed CWM and no CWM source material was left. Many young stands lack appropriate amounts of CWM, particularly a concern in connectivity corridors.

Application of ROD interim S&G's for CWM results in a quantity of CWM on gentle sloped, dry plant associations that generally is higher than historic levels. This higher quantity of CWM likely would not have a measurable effect on ecological processes, although would reduce the volume of wood product which could be utilized from these dry sites within the matrix.

Figure 22

Natural Stands in Harvest Allocations

Upper Middle Fork



KQ 2 - Where and to what extent have management practices influenced fire processes?

KQ 3 - Where and to what extent have management practices influenced distribution and condition of terrestrial species habitats?

Although a number of ecological processes interact to determine vegetation patterns within the watershed, fire has historically been dominant in shaping vegetation patterns and habitat structure. Since these items are intrinsically linked, they are discussed together below.

Upland Forest — Reference

A diversity in fire behavior (see characterization, pg. 14), landform and habitat type is reflected in the presence of two distinct landscape patterns/stand characteristic partnerships described in Table 15 below.

Upland Forest — Current

Differences between reference and current conditions are linked to changes in the disturbance regime during the 20th century described in the characterization chapter, page ___. These changes were largely a shift from natural fire events to anthropogenic events and have contributed to current conditions which differ from reference conditions in the following ways:

1. Fire Severity Risk:

Fire suppression has resulted in increased fuel loading across the landscape, a condition once associated with protected refugia such as canyon bottoms, some north slopes and small pockets enclosed by cool, moist forest types (Agee, 1993). This widespread increase in fuels has increased the risk of high intensity fires. The watershed is now approximately evenly split between fuel models 8 predicting low flame lengths with occasional flare-ups, and fuel model 10 which predicts a greater fire intensity with more frequent, larger flare-ups. Many fuel model 8 locations are rapidly transitioning to fuel model 10.

- Increased fuel loading has most altered ecological processes in upslope Douglas fir stands in the large block open forest pattern area where fuel loading was once kept very low by frequent underburns. In these areas, fuel models 8 and greater are well above historical levels.
- Fuel loading is at the high end of historic conditions in western hemlock stands <affect fire behavior>setting the stage for major fire event, particularly east wind (Agee)
- High elevation silver fir and mountain hemlock stands are well above historic loading levels.
- Although fuel management has kept fuel loading of dead and down materials lighter within managed stands, the dense, small-diameter stands provide contiguous ladder and canopy fuels, and are highly susceptible to stand-replacing burns particularly in steep topography.

2. Habitat Pattern: Large Block Open Forest

Stand characteristics:

Open-forest habitat conditions are less common since exclusion of fire has left understories uncharacteristically dense:

- Fire-intolerant and shade-tolerant species in the understory have increased, both in number and in size.
- The quantity of dead and down material has increased

Although silvicultural practices now emphasize diverse stands including non-crop conifers and hardwoods, previous practices have left a legacy of stands uncharacteristically high in crop conifer species, and low in non-crop conifers and hardwoods.

- Historical stocking densities lead to stands which are uncharacteristically dense.
- Portions of the large privately owned block of land in Simpson Creek drainage have lower stocking densities in young stands and more accurately reflect naturally occurring regeneration patterns.
- Early and mid-seral stands resulting from harvest activities in riparian reserves are generally dense.

Table 15: Reference vegetation conditions by fragmentation and connectivity pattern.

Pattern/Location	Fire Regime	Resulting Habitat Characteristics
Large Block Open Forest: Large tracts of gentle slopes (<60%) associated with Simpson Creek, Swift Creek, Pioneer Creek and Staley Creek Basin	**Severity**: Predominately low to moderate; primarily burning surface fuels and understory trees; some kill of fire-susceptible overstory trees; occasional small patches of stand-replacing burn. **Size:** Underburns covered large acreages (1000+), but stand-replacing burns were relatively infrequent and typically less than 100 acres. The occasional large-scale, stand-replacing fire event occurred infrequently (500-600 year interval). **Fuel Loading:** With frequent underburning, fuel loading in Douglas fir forests was very low, approx. 40-80 t/ha. However. western hemlock are characterized by higher historical fuel loadings, and could range up to 200 t/ha (Agee, 1993).	**Stand characteristics:** Open-forest habitat, primarily of western hemlock/Douglas fir often with significant amounts of Ponderosa pine. Between fire occurrences, multi-aged canopy layers of mixed conifer and hardwood species developed. **Fragmentation pattern:** Very large blocks of interior forest. **Connectivity:** Provided large landscape connectivity across gentle terrain for dispersal and genetic interchange, and alternated in serving open-forest species after fires and dense-forest species between fire occurrences. In general, wildlife and plant species associated with crowns of the overstory were maintained across the landscape.
Mosaic: Steep, dissected slopes (>60%) associated with Echo Creek, Tumblebug Creek, and Paddy's Valley.	**Severity**: Moderate to high. Underburns were frequent, with numerous small patches of stand-replacing burns. Periodically, these areas incurred large-acreage stand-replacing fires, such as the south face of Bear Mountain which burned in the mid-1800's. **Size:** Stand-replacing burns were relatively frequent but typically 100-150 acres. Occasional large stand-replacing fires 500 acres and more in size. **Fuel Loading:** Forest types in these areas are characterized by moderate fuel loadings, ranging up to 150 t/ha, although western hemlock stands may get as high as 200 t/ha (Agee, 1993)	**Stand characteristics:** The 150-500+ acre stand replacement fires provided habitat sizes to accommodate the needs of many wildlife species. Recolonization from residual MOG stands to younger forest stands was aided by the winds and gravity in these steeper terrains. **Fragmentation pattern**: Mosaic of young and old stands which included western hemlock and grand fir stands at mid-elevations , with silver fir and mountain hemlock accounting for the bulk of high elevation stands. Majority of stands were of mature and old growth characteristics, typically with numerous 100-150 acre patches of early seral stands. Occasional large-scale burns are typically even-aged stands, becoming structurally diverse at about age 150. **Connectivity**: Provided by unburned class I and II riparian areas, and connected old growth around periphery of fire stands.

Fragmentation:

- Fragmentation as a result of timber harvest activities is most evident in loss of large, contiguous blocks of habitat in gentler sloped areas. Small-acreage dispersed cuts and associated roads on USFS lands has fragmented areas which were previously large interior forest habitats.
- Although the private block of land in the Simpson Creek drainage started as a dispersed, fragmented pattern of harvest, recent harvests (1980's) have unified this area to function as a large block of young seral stage interior forest.

3. Habitat Pattern: Mosaic

Stand characteristics:

- As a whole, managed stands are probably overstocked compared to natural conditions, although density on some north-slope natural regeneration sites may be higher than the Forest Service stocking rate.
- Canopy structure is more complex in natural stands.
- After pre-commercial and commercial thinning, managed stands are typically less dense than their natural cohorts.

Fragmentation:

- Dispersed harvest units, smaller on average than naturally occurring fire stands, have created an uncharacteristically fragmented landscape resulting in:
  1. reduced interior habitat.
  2. habitat blocks too small to support some of the larger species' home range requirements.
- The areas listed below are relatively intact mixtures of mature and old growth forest habitats, and should meet the Forest's S&G FW-202 for function as interior old growth. Additionally, these pieces play important roles in connectivity of low elevation habitats on the landscape especially between LSR0222 and the Cascade Crest. These three areas are listed in order of most to least significant in maintaining connectivity of LSR0222 and the Cascade Crest:
  - The Lighthouse Rock vicinity
  - The Bear Mountain vicinity
  - The Tumblebug Creek confluence vicinity.

4. Connectivity within the watershed:

- Connectivity through ridgeline saddles between the **eastside and the westside of the Cascade Crest** is maintained by the wilderness and the OCRA which are non-harvest allocations.
- **Upland connectivity** for mature/old growth associated wildlife species has been diminished by past timber harvest. Specific fragmented connectivity corridors are:
  1. **Connection between LSR0222 and the Cascade Crest**: During the past decade, fragmentation of mature/old growth habitat has increased compared to historical conditions, particularly in the high elevation forest habitat (Figure 23, Table 16).

     Table 16. Percent and acres of MOG and SI stands in the Calapooya Ridge area.

Allocation	Total Acres	MOG		SI	
		Acres	Percent	Acres	Percent
Matrix	11,046	2,371	21	4,189	38
Non-Harvest	3,196	769	24	789	25

An important data gap to consider in analyzing the data presented above is that there are approximately 3500 acres of unknown habitat type, making these areas unattributable and

uncounted in either high elevation or low elevation type habitats. In addition, it appears that the stem exclusion stage is heavily represented in the Timpanogas Subwatershed. This is attributable to two confounding factors:

These stands are in an un-managed condition and though smaller in diameter due to site condition, stand structure is such that this area functions as MOG.

2. Connection between Juniper Ridge/LSR0221 & Bear Mountain/Diamond Peak (Figure 23):

A continuum of managed young forest habitat is present nearly the full length of the Swift Creek drainage, along FS Rd 2300. Only about 1/4 mile provides mature/old growth habitat to connect across Swift Creek from the Juniper Ridge area and LSR0221 to Bear Mountain and the Diamond Peak Wilderness. Young stands dominating private lands in the Simpson Creek and Noisy Creek drainages further interrupt this connectivity patch between Juniper Ridge and the watershed south of the river.

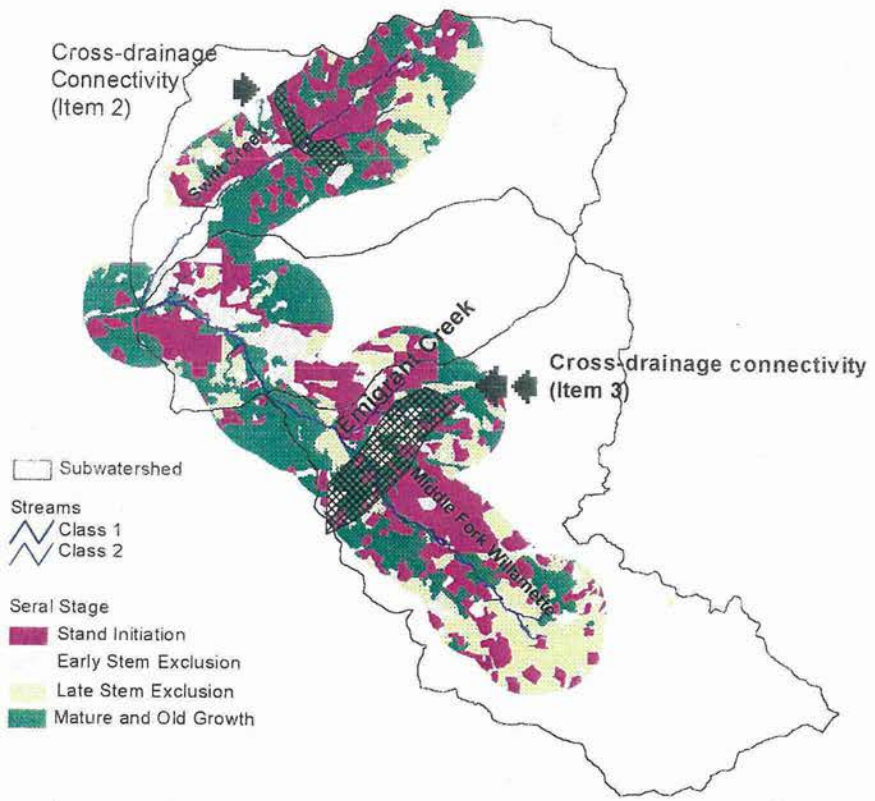
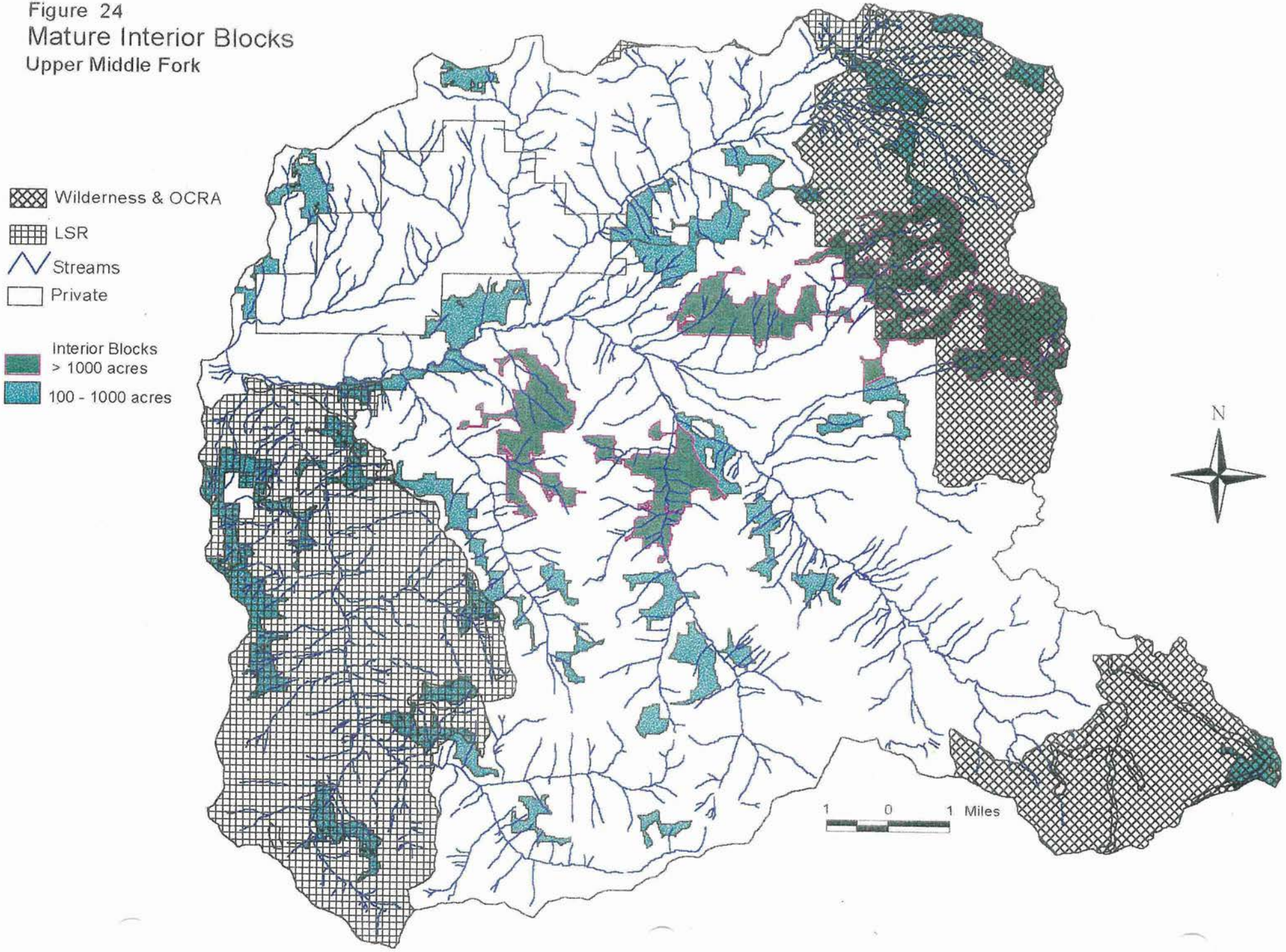


Figure 23. Cross-drainage fragmentation

3. Connection between north side of Middle Fork and south side of Middle Fork (Figure 24): The eight miles of the Middle Fork Willamette River between Swift Creek and Big Swamp in Paddy's valley, has about one mile which provides mature forest habitat connection across the river.

Figure 24
Mature Interior Blocks
Upper Middle Fork



Upland Forest

Trends

The WNF Forest Plan as amended by the ROD has significantly changed many forest management practices. In general, these changes will mitigate or improve effects of management on fragmentation, interior habitat, connectivity and stand characteristics. However, a number of specific trends remain unaddressed at this time:`

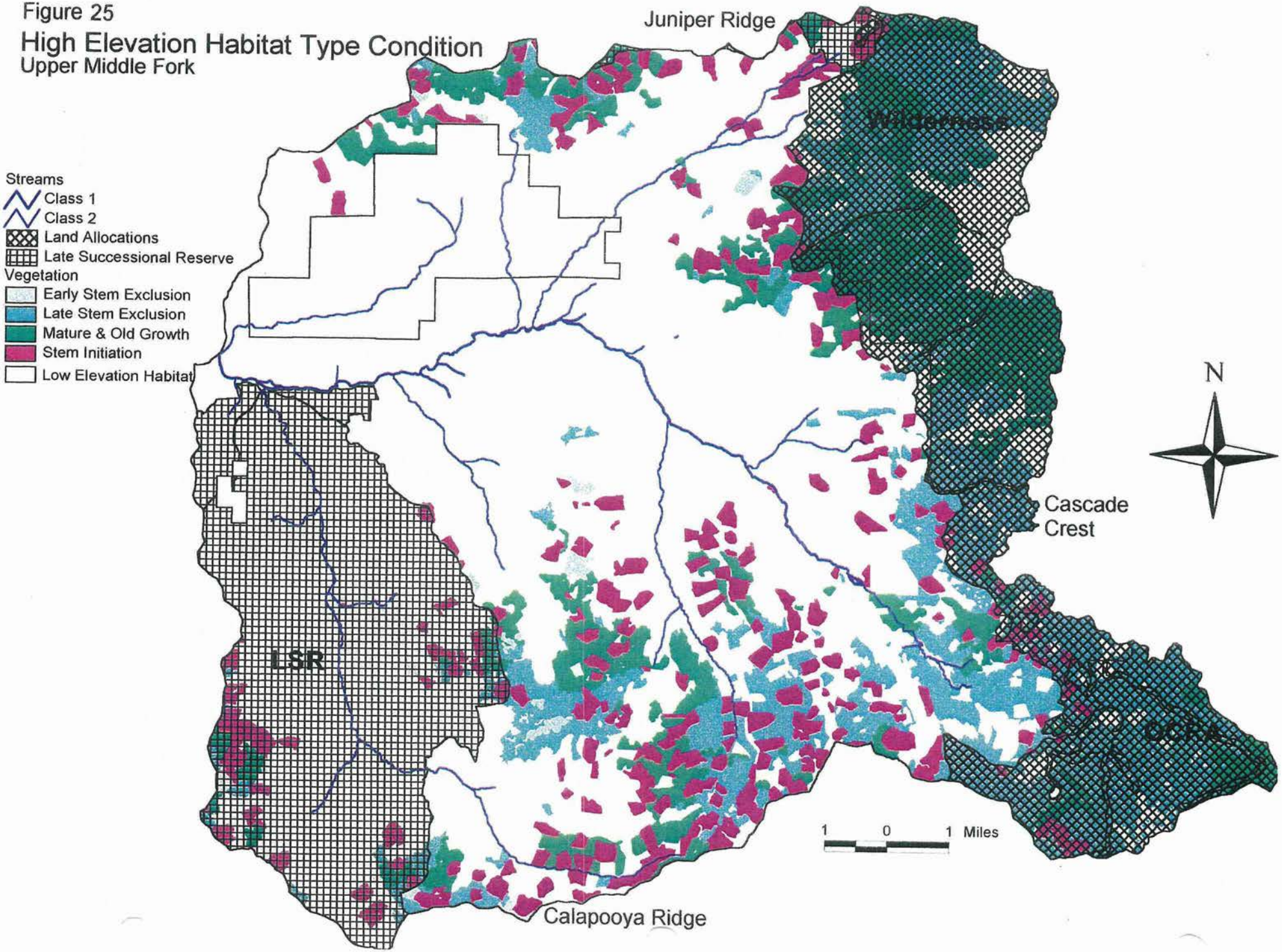
- With continued fire exclusion, fuels will continue to accumulate, increasing the probability of high-intensity fires. Natural stands will continue to be uncharacteristically dense, with a higher than natural proportion of fire intolerant and shade tolerant species. This richness of fire intolerant species results in higher mortality in fire events.
- Acreage of early seral stage open forest habitat is decreasing on NFS lands due to the emphasis on high stocking densities with planting.
- If harvest activities continue to be dispersed, interior habitat of all seral stages will continue to be lost in matrix harvest allocations.

With upland harvest, the upslope forest habitat in matrix harvest allocations will decrease in connectivity function for late successional wildlife species faster than the ingrowth of late successional habitat in the previously affected riparian habitats.

Figure 25

High Elevation Habitat Type Condition

Upper Middle Fork



Special Habitats

Non-forested Special Habitats — Reference

Approximately 2% of the watershed was non-forested special habitats, essentially the same amount as currently present. Some special habitats were somewhat stable over time and were maintained either by specific site conditions such as thin soils, hydrology or regular fire return. Other special habitats were long-term transition communities, initiated by some disturbance such as landslide.

Non-forested Special Habitats — Current/Trend

- Exclusion of fire has caused surrounding forest to encroach on many dry and mesic fire-maintained special habitats.
- Past harvest activities and associated road building has affected special habitats in the following ways:
  - a) Rock outcrop and rock garden communities have been displaced to utilize their habitat as landings, rock quarries and fuel breaks. Many species inhabiting these communities are slow growing (particularly the lichens), and altering activities have extended effects.
  - b) Soil disturbing activities in areas closely associated with dry and mesic type special habitats have allowed non-native species to invade.
  - c) Loss of surrounding forest canopy has changed temperature and humidity regimes in some mesic and wet type special habitats.
  - d) Roading and site disturbance may have altered the hydrological regime in some wet and mesic special habitat types.

Forest Plan S&G FW211 directs protection of special habitats and their ecotone which will substantially reduce future degradation, and current forest management practices will provide for re-establishment of some of the natural regimes important to maintaining a diversity of special habitats. However, the following trends remain a concern:

- With current fire exclusion levels, forest habitat will continue to encroach on fire-maintained special habitat types.
- Noxious and non-native plant species will invade dry-type special habitats. This process will be accelerated when soil disturbing activities occurs in the vicinity of the following special habitat types.

Inter-drainage Connectivity — Reference

Some riparian species are less mobile than others, and are adapted to dispersing overland between drainages, generally through ridgeline saddles. Forested connectivity between drainages for riparian species appeared to have been common across the landscape; particularly important for these species was the presence of CWM which provided thermal microsites and security from predators.

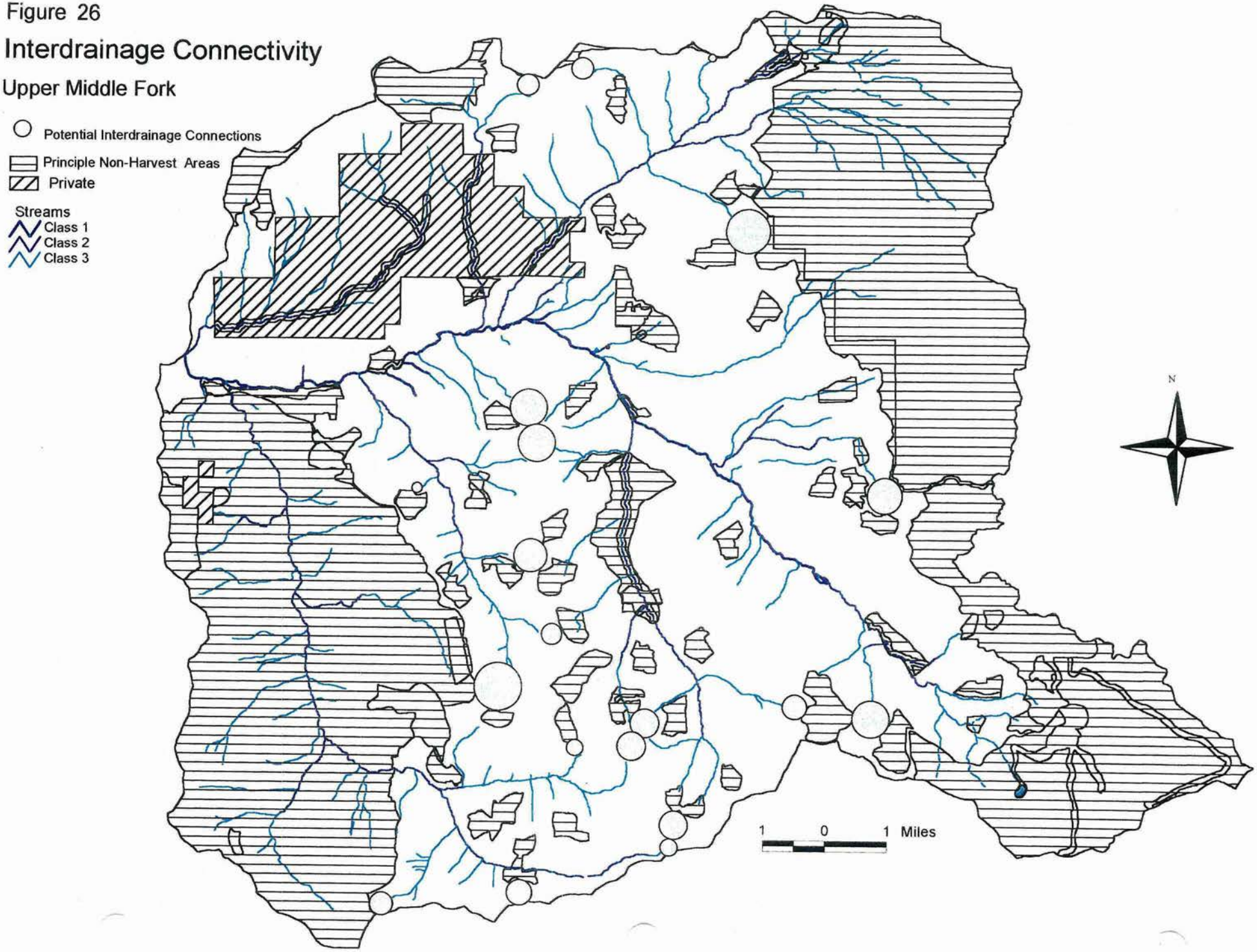
Inter-drainage Connectivity — Current/Trend

- Harvest patterns and reduction of CWM on ridgelines have fragmented many inter-drainage connections (Figure 26).
- Interdrainage connectivity will be affected by projected timber harvest with removal of overstory canopy while older managed plantations will progress toward recovery. Projected will remove the canopy, affecting the thermal microclimate while maintaining CWM. Older managed plantations, though often deficient in CWM will recover thermal microclimate regime.

Figure 26

Interdrainage Connectivity

Upper Middle Fork



Riparian Reserve Vegetation Condition & Connectivity Reference

Lands now allocated to Riparian Reserves were historically characterized by a relatively stable seral class distribution. Mature and old growth stands dominated, particularly along class I and II streams which were least affected by fires. These mature stands provided shade and a source of large woody material. Periodic floods and channel changes maintained a hardwood component; some studies suggest that as much as 20% of the riparian landscape was maintained as pure hardwood stands.

Riparian Reserve Vegetation Condition & Connectivity Cur/Trend

The process which has most altered riparian vegetation condition from reference conditions has been past timber harvest. Harvest units in riparian areas have less shading and less source material for large woody debris when compared with non-harvested areas. Effective riparian connectivity has decreased. Current riparian condition varies from historical in the following ways (Figure 27; Table 17):

- Riparian Reserves are 41% mature/old growth condition. These stands can provide source material for large woody debris.
- Almost 35% of riparian stands have been harvested. These stands do not provide shading adequate to maintain historical temperature regimes and contribute to fragmentation of the riparian connectivity.
- Riparian connectivity for mature and old growth associated wildlife species has been diminished by past timber harvest. Densely stocked young stands in riparian reserves inhibit the connectivity function of these areas.
- Swift Creek drainage has the least amount (25 percent) of mature and old growth stands along class I, II and III streams (31 percent with Class IV streams included).
- Although aggregate seral distribution figures for Swift Creek drainage appears equivalent to other subwatersheds, these figures become a concern when broken down by reserve and non-reserve lands. Most of the natural, large diameter stands (76%) are located in the Diamond Peak Wilderness. Riparian Reserve lands outside the wilderness are almost 54% SI and ESE, 10% higher than any other Subwatershed. Some of the implications are that:
    1. large main-stem class 2 streams have less shade than in any other Subwatershed.
    2. headwaters of Swift Creek are in natural stand condition
- Managed stands are typically denser than natural stands.
- Excluding fire in natural stands has permitted an increase in shade-tolerant understory species and an increase of forest floor large woody material, particularly along smaller tributaries in steep topography.

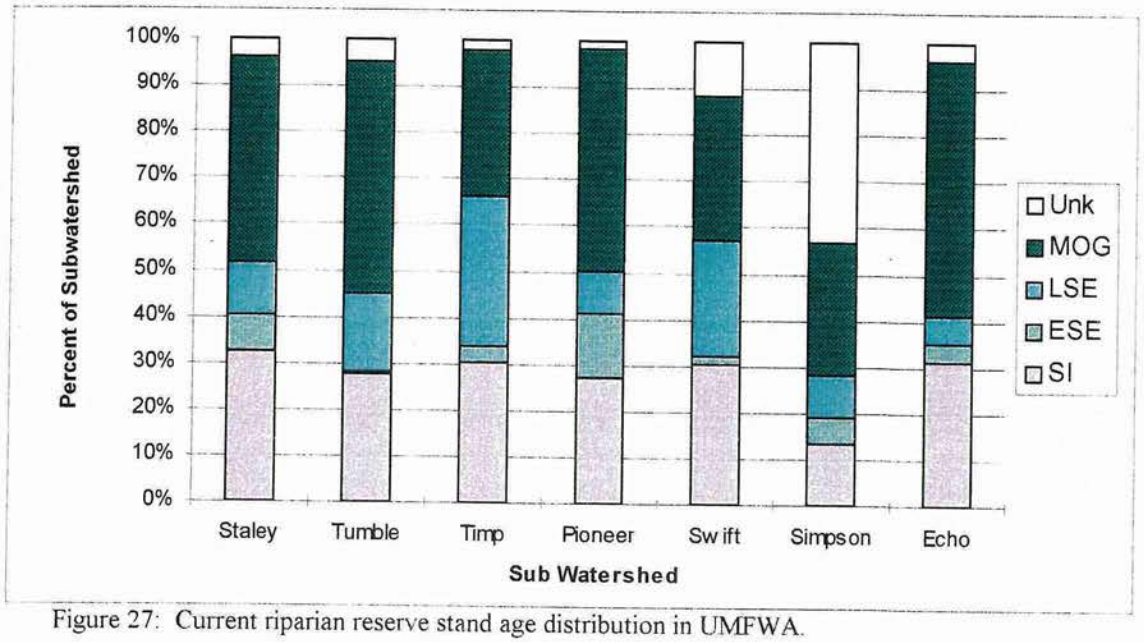


Figure 27: Current riparian reserve stand age distribution in UMFWA.

Table 17: Riparian reserve stand age distribution by Subwatershed.

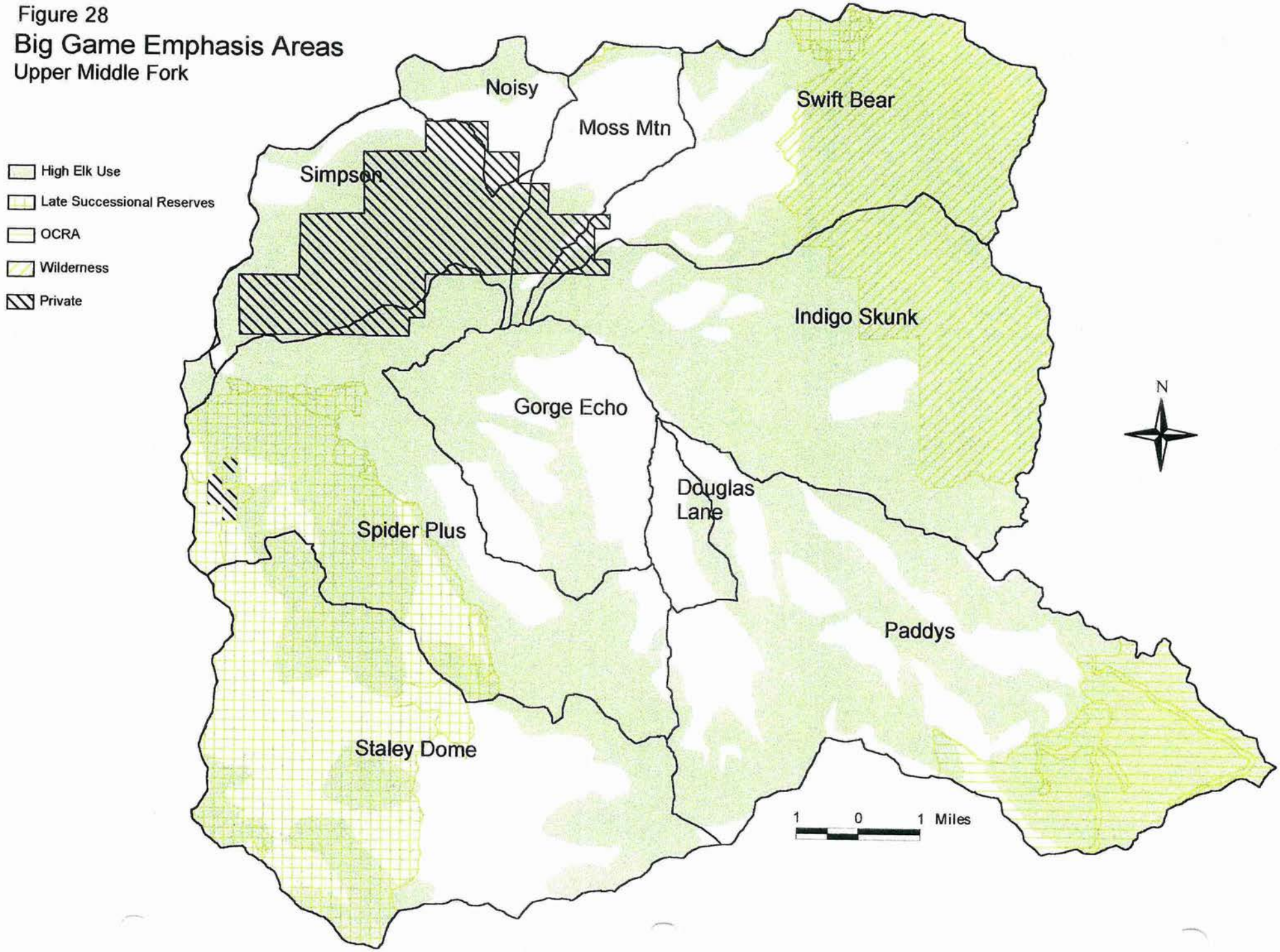
	SI		ESE		LSE		MOG		Unknown		TOTAL
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Ac
Staley	1592	32	396	8	564	11	2194	44	188	4	4,935
Tumble	462	28	3	0	283	17	829	50	81	5	1,659
Timp	876	31	89	3	941	33	902	31	63	2	2,870
Pioneer	496	27	255	14	163	9	873	48	32	2	1,819
Swift	933	30	54	2	776	25	960	31	356	12	3,079
Simpson	205	13	91	6	140	9	435	28	669	43	1,539
Echo	541	31	65	4	107	6	953	55	66	4	1,731
WA23	5105	29	953	5	2974	17	7146	41	1455	8	17,632

The Forest Plan as amended by the ROD discourages future regeneration harvest in Riparian Reserves. However, if previously harvested stands are not silviculturally treated, overstocked young stands will result in:

1. Stands which lack vertical and horizontal structural diversity.
2. Trees which decrease in crown to height ratio as they mature leading to a thin canopy less effective in shading streams.
3. Depauperate understories which inhibit connectivity and do not provide habitat useable to a wide variety of wildlife.
4. Trees that are uncharacteristically slow in gaining diameter, slowing the development of CWM source within the stand.

In addition to overstocked stands, on occassion it may be necessary to fell some of the trees in a natural riparian stand to facilitate channel recovery from past management or flood.

Figure 28
Big Game Emphasis Areas
Upper Middle Fork



KQ 4 - Where and to what extent have management practices influenced distribution and condition of terrestrial species?

TE & S Species — Reference

Several species that are now listed as either threatened or endangered inhabited this watershed. They include:

- The Grizzly bear inhabited a variety of habitats within this area. This species was extirpated from the Oregon Cascades in the late 1930's or early 1940's
- The Gray Wolf was known to inhabit this watershed. A federal eradication program during the late 1800's and 1900's is believed to have extirpated the wolf by the mid-1940's.
- Northern spotted owls inhabited mid to low elevation mature and old growth forests of conifer and mixed conifer-hardwood.
- Peregrine falcons are assumed to have inhabited the watershed, though few in numbers. Foraging habitats included major riparian and the upland forests, which were predominately of mature and old growth habitats.
- Bald eagle likely did not nest in the watershed, but potentially used the watershed for foraging, utilizing the river and early seral habitats which offered occasional carcasses of big game.

TE & S and Management Indicator Species — Current/Trend

Intact interior forest habitat and connectivity is important for the following list of species as well as others.

- The grizzly bear is still absent from the Oregon Cascades, and no efforts have been made to reintroduce this species.
- The gray wolf is presumed still absent from the Cascades. However, wolf-like canines have been observed in this watershed during the last three to four decades, but no confirmations have been made as to species.
- There are 43 spotted owl activity centers known in the watershed: Wilderness: One activity center. LSR 0222: 12 activity centers. Matrix: 30 activity centers, each with a 100-acre supplemental LSRs delineated.
- One peregrine falcon site (OR-23) exists within the watershed. A Management Plan is in preparation for this species, which will establish a three-tiered management zone. Compared to historic conditions, foraging habitat surrounding the falcon site is altered to a higher percentage of SI and SE habitats.
- Bald eagles are observed foraging, but no nesting sites are known for the watershed. From Swift Creek confluence with of the Upper Middle Fork Willamette, a 200-ft distance on each side of the river is designated for maintaining perch trees to facilitate eagles' foraging needs.

Species of Special Consideration — Reference

Prior to anglo-settlement, population numbers of elk were assumed lower than current levels. Populations were maintained by lower amounts of forage and perdition from grizzlies and gray wolves. After settlement, unregulated hunting further depleted population numbers until the early 1900's. Between the period of 1900 and 1930, hunting was prohibited to permit a recovery of the population.

Species of Special Consideration — Current/Trend

Elk population numbers have steadily increased and are believed to be leveling as they approach carrying capacity. Habitat is managed under two directions:

1. The Forest Plan established and provides standards and guidelines for Elk Emphasis Areas (EEA) which are rated High (HEEA), Moderate (MEEA) and low (LEEA). According to the Forest Plan, open road densities in HEEA should be equal to or less than 1.9 miles/sq. mile, and 2.8 miles/sq. mile in MEEA.
2. A 1990 verbal agreement between Rigdon Ranger District and the Oregon Department of Fish and Wildlife established High Elk Use Areas (HEUAs) within moderate and low EEAs. The agreement was that these HEUAs should receive "best management practices for elk habitat", reflective of the standards and guides for the HEEA (Figure 28), and would be based on 1.9 miles of open roads per square mile of HEUA.

Population numbers are not likely to increase substantially, but may actually decline as forage stands decrease. With the establishment of LSR's, landscape distribution of Elk habitat is going to change. Specific areas where habitat is or can be projected to be a concern and/or outside of management guidelines are:

- Spider Plus, Swift Bear, Noisy, Paddy's, Staley Dome and Simpson emphasis areas exceed road density standards and guidelines.
- HEUAs in Douglas Lane, Gorge Echo and Moss Mt. emphasis areas exceed road density standards and guidelines as established by verbal agreement between Rigdon RD and ODFW.
- Habitat Effectiveness for thermal cover is below desired future condition in Indigo-Skunk HEEA.
- Majority of winter range in the Spider Plus HEEA is within LSR0222 and scenic allocation along FS road 21; forage in this area will decrease as managed stands mature.
- As private lands in Simpson Creek drainage mature, there will be an extended period (approx. 40 years) when forage is substantially reduced in that area.

Botanical Species

Current/Trend

The current distribution of sensitive and rare plant populations is assumed to be generally similar to that of the historical with the exception of two species which are dependent on moderate intensity fires for germination: Woodland milkvetch (*Astragalus umbraticus*) and branching Montia, (*Montia diffusa*). The assumption is that there were more populations of these plants scattered through the watershed when fires were allowed to burn.

A major factor in maintaining viable sensitive plant populations is locate and maintain the habitats in which they are found. Approximately 10-15% of the Forest Service land in the watershed has been surveyed for sensitive plants, mostly in conjunction with proposed timber sales and other projects. No surveys for rare plants have been done on private lands in the watershed.

Factors which could be altered by management activities thus contributing to population decline are::

- alterations of hydrologic regime
- introduction of noxious weeds
- alteration temperature regime

In general, changes in forestry practices which protect special habitats will improve the outlook for sensitive plants. Additionally, many of the recommendations to maintain habitat and connectivity for wildlife species will help preserve sensitive plant habitats. However, the following trends continue to pose a threat to plant species:

- Invasion by non-native weeds is currently a potential concern, particularly for the Lewisia and Bolander's hawkweed sites.
- With so little of the landscape surveyed, it is very likely that some sensitive plant populations may not have been located, and may be vulnerable.

KQ 5 - Where and to what extent have management practices influenced erosion process, hydrologic recovery, and channel processes and condition?

The predominant processes related to vegetative change are erosion, hydrologic recovery, and channel condition. Erosion processes have been evaluated through landslide occurrence. The potential effect of increased landslide activity on stream channels, as well as reference conditions for landslides, was discussed under Road Density, Age and Location effects on channel process. Only the change in landslide frequency as related to vegetation condition is presented here.

Erosion Processes

Landslide Occurrence — Reference

Reference conditions were previously presented under Roads Density, Age, and Location Issue.

Landslide Occurrence — Current/Trend

Clear-cut harvesting on steep slopes with shallow, rocky soil reduces root strength and increases groundwater height until such time as the area recovers vegetatively (approximately 5 to 20 years) (USDA Forest Service, 1991). During this window of time, the probability of shallow, rapid slope failure on steep ground is significantly increased (see Reference Condition under Issue 1).

Approximately 50% of the Watershed Analysis area is characterized by steep ground with shallow, rocky soil. Air photo reconnaissance indicates that approximately 77% of harvest related debris slides occur in this geomorphic setting (Table 18).

Between 1950 and 1996, approximately 14,200 acres have been harvested in this geomorphic setting using clear-cut methods (including Private land). Approximately 6000 of these acres have been harvested since 1980 and are in some stage of redeveloping pre-harvest root strength and groundwater levels. A small percent of these acres are at an elevated risk of producing a debris slide.

Table 18. Natural versus harvest related debris occurrences by year.

Photo Year	Natural Debris Slide Occurrences	Harvest Related Debris Slide Occurrences
1959	7	0
1967	22	5
1972	2	6
1980	0	1
1990	0	1

Hydrologic Recovery — Reference

Hydrologic recovery for the reference condition is thought to have ranged as low as 73%.

The hydrologic recovery values are not aggregate values of varying degrees of recovery age like ARP, but are an all inclusive group considered regardless of age within the stem initiation and early stem exclusion size class. Therefore aggregate hydrologic recovery values may be as much as 5 percent higher than the unaggregated values. Another difference between ARP and hydrologic recovery is that ARP has traditionally used the 4,000 foot elevation as the upper boundary, whereas the hydrologic recovery includes harvest at all elevations (exclusive of OCRA and wilderness, which are non-harvest allocations).

Hydrologic Recovery — Current/Trend

The percent of hydrologically unrecovered area by Subwatershed for the reference and current conditions are shown in Figure 29. The hydrologically unrecovered areas are categorized as either young stands, and roads, or as "natural" meaning naturally unrecovered such as, rock outcrops, wetlands, meadows, et cetera.

The hydrologic recovery for the Watershed as a whole is currently 69 percent, or conversely 31 percent hydrologically unrecovered. The standard and guideline for the Mid Point ARP is 68 percent for this watershed, slightly below the reference condition low of 73%. Table 18 shows the trend of area unrecovered, the hydrologic recovery, and the Mid Point ARP value.

Presently, Paddy's Valley, Pioneer Creek, and Simpson Creek Subwatersheds exceed the recommendations for ARP by 1 to 2 percent. The hydrologic recovery indicates that all the Subwatersheds are below the estimated natural state of 26 percent unrecovered ranging anywhere from 1 to 17 percent. Pioneer, Swift and Simpson exhibiting the greatest change at 12, 16 and 17 percent, respectively (Table 19).

Table 19. Percent Area Unrecovered, Hydrologic Recovery, & Mid Point ARP Values.

Subwatershed	Reference % Hydrologic Recovery (estimate)	Current % Hydrologic Recovery	% Change	Mid-Point ARP
23-1 Staley	73	65	9	67
23-2 Tumblebug	73	71	3	68
23-3 Paddy's Valley	73	68	3	69
23-4 Pioneer	73	62	12	70
23-5 Swift	73	56	16	66
23-6 Simpson (North)	73	57	17	70
23-6 Echo (South)	73	67	7	67.5
Total	73	65	9	68

The percent of hydrologically unrecovered area is given by Storm Response Category for the entire Watershed in Figure 30. This pie chart shows that the greatest amount of harvest has occurred within the high and moderate Storm Response areas. The result is that where young stands are present on high and moderate Storm Response areas, there is a greater accumulation of snow available for melting with a warm front or precipitation event.

By definition high storm response drainages contribute more water to road ditches and stream systems within a shorter amount of time than what might be expected elsewhere, increasing peak flows.

Continued recovery is expected as the young stands grow to full crown closure. However, continued harvest will create additional hydrologically unrecovered areas. Continued hydrologic recovery of riparian areas and LSRs is expected under current management direction.

Note that in the Staley Watershed Analysis of 1995 the aggregate Hydrologic Recovery was calculated at 75%. The 75% value is likely high due to the number of acres considered recovering well in the high elevations of South Fork Staley, are in fact very slow in recovering.

Most of the High Storm Response Area in this Subwatershed is in the Wilderness. The Pioneer Drainage area is below recommendations for recovery. A minimum recovery period of 15 years will facilitate function of hydrologic processes. Similarly, Swift Creek area is below guidelines for recovery. A minimum recovery period of 10 years will facilitate functioning of hydrologic processes. Timelines until recovery given in percent of total unrecovered area is an ocular estimate from a one inch to a mile LandSat Image of the Rigdon District taken in 1994

There 5,980 acres of private land within the Simpson Subwatershed representing roughly 45% of the area. Recovery period is dependent on management of private land. Roughly two-thirds of the private land is considered hydrologically unrecovered as seen in 1967 air photos. These photos showed one-third of the land harvested by 1967.

Figure 29. Percent Hydrologically Unrecovered Area

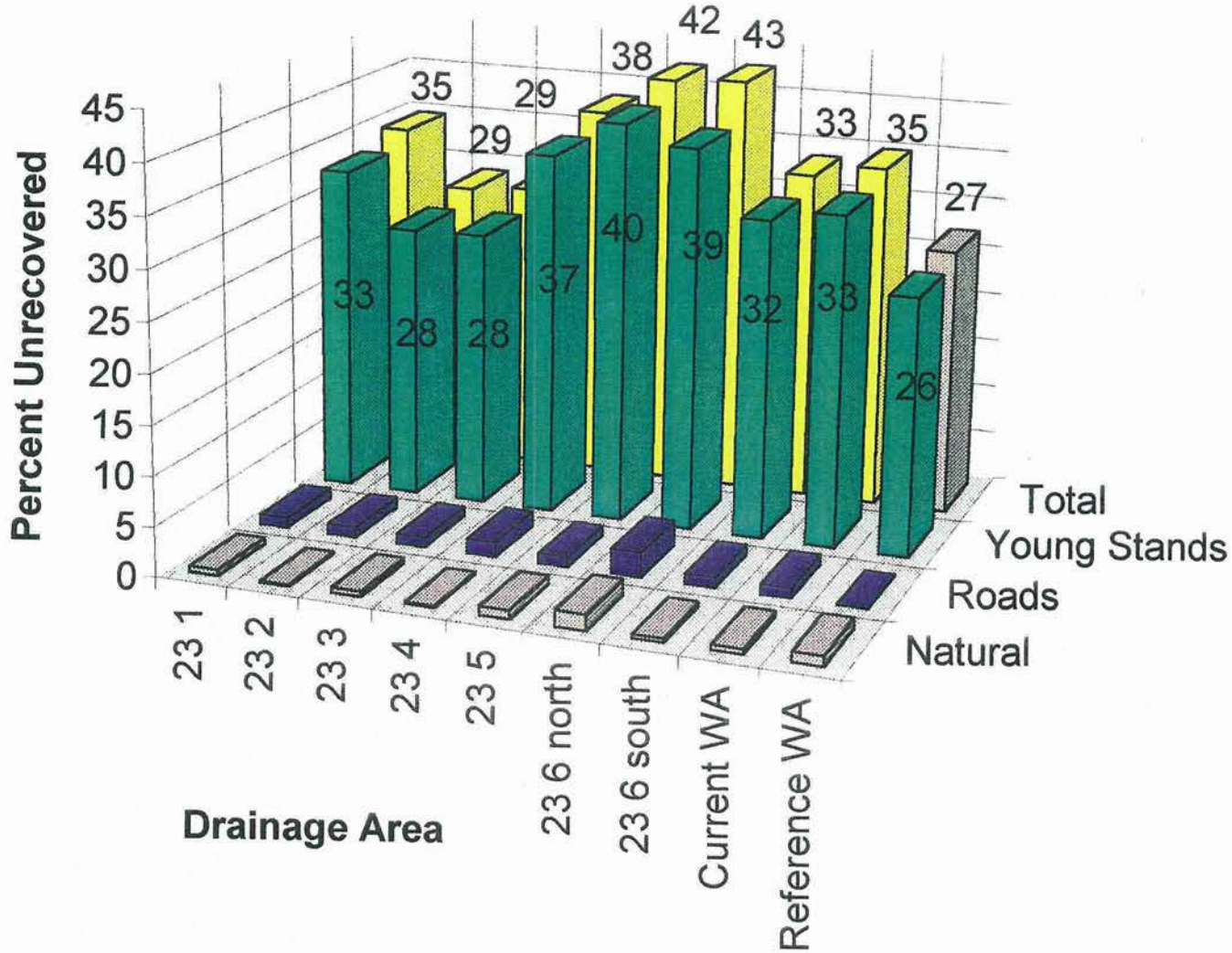
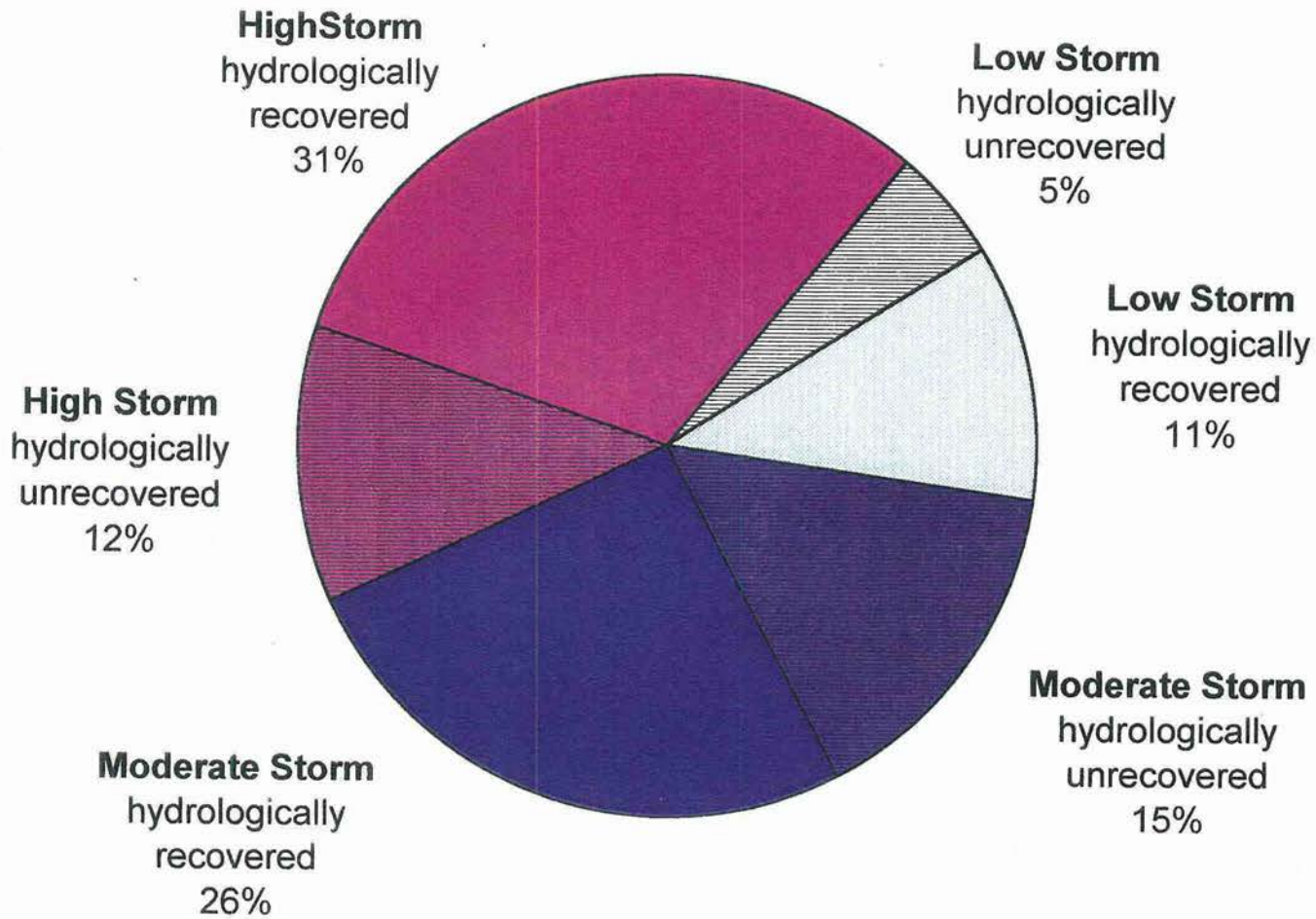


Figure 30. Hydrologic Recovery By Storm Response, % Area of WA 23



Channel Processes and Condition

Response Channel Segments — Reference

Reference conditions for channel segments is presented under the Road Density, Age and Location Issue.

Response Channel Segments — Current/Trend

Response to Increased Peak Flows

In the MFW Reach 4-7 and Staley Reach 1 (F3/C), erodible bed and bank material and wide flooplains provide ample opportunity for morphologic adjustment to peak flows. Peak flows in the past have caused channel widening from bank erosion, loss of riparian vegetation, and deposition of excess sediment. Frequent bank erosion was noted in field surveys of all segments. Over time, an increase in the frequency of bankful flows, combined with an increase in the wetted width associated with the bankful flow, may have contributed to a net loss of CWM from these segments.

Staley Reach 2-4 (V4/B), experienced significant channel widening as a result of bank erosion and riparian vegetation loss during the 1964 flood. The banks of Staley Reach 2 and 4 are less sensitive to future peak flows as roughly 65% of the banks in these reaches are non-erodible. CWM loss is a likely peak flow response in these reaches. Staley Reach 3 is more sensitive with 87% of the banks stabilized by vegetation and S. Fork Staley Reach 4 is highly sensitive with sand as the bank material and little woody riparian vegetation.

In Noisy Reach 1, Swift Reach 1, and Echo Reach 1 (U1/C and U2/B), mildly constrained channels are formed in unconsolidated valley fill. Lateral channel adjustments in response to peak flows are likely. There is evidence of channel widening in MFW 10 after the 1964 flood through photo interpretation. Sand is a major component of the bank material in MFW 12 and Swift 4 and riparian vegetation is dominated by small size classes in all segments. Addition of woody debris ,mostly smaller pieces from adjacent riparian vegetation, is a likely peak flow response in these segments.

In Noisy Reach 1, Swift Reach 1, and Echo Reach 1 (F4/B), a variety of responses to the 1964 flood were documented. Dramatic widening occurred in Swift 1 due to bank erosion and loss of riparian vegetation. Widening also occurred in Echo 1 to a lesser degree. Both segments likely experienced a loss of CWM during the flood. Much of the CWM in place at the time was logging slash, generally shorter, transportable pieces. Noisy 1 did not apparently experience significant effects in 1964. However, the current condition of the basin above this reach makes it vulnerable to peak flow - related disturbance in the future.

- In general, response reaches express high to moderate sensitivity to peak flows. Changes after the 64 flood included: channel widening, bank erosion, loss of riparian vegetation, loss of inchannel CWM. Sensitivity to future increases in peak flows varies by location in the watershed, and the stability of streambank and bed materials.

Response to changes in Riparian Vegetation

Changes in channel conditions and riparian vegetation have been interpreted from aerial photos and various stream surveys. In MFW Reach 4-7 and Staley Reach 1 (F3/C), riparian vegetation is critical for stability of erodible banks and bars, maintaining side channels, and as an additional source of CWM. A shift from reference conditions toward more deciduous species and smaller size classes in the inner riparian zone has affected these functions. Short term woody debris recruitment from these segments

may contain a greater proportion of small, less persistent pieces. Size and location of marginal and mid-channel bars may be more variable.

Staley Reach 2-4 and SF Staley Reach 4 (V4/B), a decrease in large conifers compared to reference conditions has occurred in all reaches. Sensitivity to riparian vegetation for CWM input and retention is highest in Staley 3, but also important in Staley 2, where riparian vegetation helps create and maintain small alluvial flats in between bedrock outcrops. Sensitivity to riparian vegetation for bank stability varies with erodibility of bank materials.

In MFW Reach 10-12, Swift Reach 4 (U1/C and U2/B), riparian vegetation is critical for stabilizing erodible banks, maintaining side channels, and for providing a source of CWM to these segments in the upper portion of the drainage network. Effectiveness for these functions is currently reduced due to a decrease in large conifers in the riparian zone compared to reference conditions.

In Noisy Reach 1, Swift Reach 1, and Echo Reach 1 (F4/B), riparian vegetation helps stabilize banks, form side channels, and is the primary source of CWM. Approximately 90% of the banks in Swift 1 and Noisy 1 are vegetation stabilized. A decrease in the large tree size class has occurred in each segment compared to reference conditions. This has likely contributed to the loss of side channels in Swift 1.

Transport Channel Segments

Current/Trend

Possible increased frequency of flows > or = bankful may be increasing fine sediment delivery to step/pool dominantes streams in moderate slope bound valleys (M1/B). Either vertical or lateral adjustment, in addition to CWM loss, is likely as sand and gravel is a major component of both bed and banks in these segments. The small size of most of the riparian vegetation along these segments also increases sensitivity.

Response to Increased Peak Flows

In MFW Reach 9, Tumblebug Reach 1, and Simpson Reach 1 (V1/B segments), some channel widening occurred in response to the 1964 flood in three segments (). Others showed little or no change. Cobble and larger substrate, including bedrock comprises most of the bank material in these segments, reducing the likelihood of large-scale bank erosion. Channel confinement reduces the opportunity for lateral adjustment. Riparian vegetation removal and woody debris input are likely responses to peak flows.

In MFW Reach 8, Simpson Reach 2, Swift Reach 2, Echo Reach 2, Noisy Reach 3-4, Tumblebug Reach 3-4 (V1/A segments), the input of peak flows is generally coupled with fine sediment. The impact of the high energy, sediment laden flows, has been loss of riparian vegetation and channel widening in Simpson Reach 2, Swift Reach 2, and Echo Reach 2. Bank substrate among the segments ranges from resistant bedrock to erodible cobble/gravel.

In Noisy Reach 2, Swift Reach 2, and Bear Reach 1 (V2/A channels), banks in are primarily non-erodible material. Bank material in N. Fork Staley is partly erodible. Riparian vegetation removal is a likely response in most of these segments where small tree sizes dominate. Some re-working of debris jam deposits and bed load is expected, but large-scale morphologic adjustment is unlikely in all but extreme flows. Debris flow deposition and/or transport in response to a major flood event would cause significant adjustment.

- In general, transport reaches are located in moderate to high storm response areas and unstable soils. This location creates an environment more sensitive to peak flows than expected. The channel sensitivity is generally moderate to high, varying on stream bank and bed materials. Channel changes have included: vertical or lateral adjustment if possible; loss of riparian vegetation and channel widening; and loss of CWM.

Response to changes in Riparian Vegetation

Riparian vegetation is important for bank stability, as a source of CWM, and as a resistant element for the formation of lateral scour pools in step/pool dominanted streams in moderate slope bound valleys (M1/B). These functions are currently reduced by the dominance of small trees in the riparian zone of these segments.

Riparian vegetation is important primarily as a source of CWM in step/pool habitat in v-shaped moderate gradient valleys (V1/B) and secondarily for bank stabilization. Large conifers dominated the riparian zone in all segments under reference conditions. and still constitute most of the riparian vegetation except in MFW Reach 9 and Simpson Reach 1. The on-site source of CWM in these reaches is reduced until regrowth occurs.

In cascade dominant streams in v-shaped moderate gradient valleys (V1/A), riparian vegetation has little influence on channel morphology in reaches characterized as a bedrock gorge (MFW Reach 8 and Tumblebug Reach 3). In other reaches, riparian vegetation is the primary source of CWM. In Simpson Reach 2 and Noisy Reach 3 & 4, the majority of bank area is vegetation stabilized. This function is less important in Swift Reach 2, where most of the bank material is currently non-erodible, perhaps as a result previous scour.

In cascade dominant streams in v-shaped high gradient valleys (V1/A), riparian vegetation is important as a source of CWM, and to a lesser extent for bank stability. These functions are reduced in Noisy Reach 2, Swift Reach 3, and Bear Reach 1 where there has been a significant decrease in large conifers in the riparian zone.

- In general, riparian vegetation is critical for stability of erodible banks and bars, maintaining side channels, and recruitment of CWM into the stream channels. A shift from reference conditions toward more deciduous species and smaller size classes in the inner riparian zone is affecting these functions and ultimately stream channel. Sensitivity of channels varies with the stability of streambank and bed materials.

KQ 5 Where and to what extent have management practices influenced stream temperatures?

Stream Temperature

Reference

Air temperature has been continuously monitored since 1931 at the Oakridge Fish Hatchery approximately 20 miles north of the watershed boundary. With the exception of a few years (including 1993), the warmest air temperatures usually occur in July or August. Monthly average maximum air temperatures range from 92 degrees in warm years to about 80 degrees in cool years. The variation between years is generally about five degrees. Since 1990, the average maximum air temperature has not exceeded 85 degrees in July and August (Figure 31).

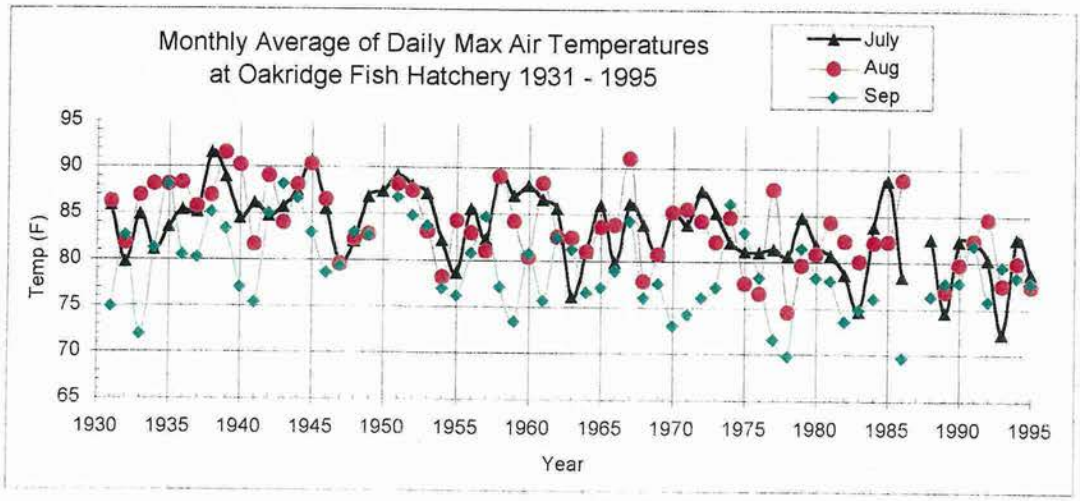


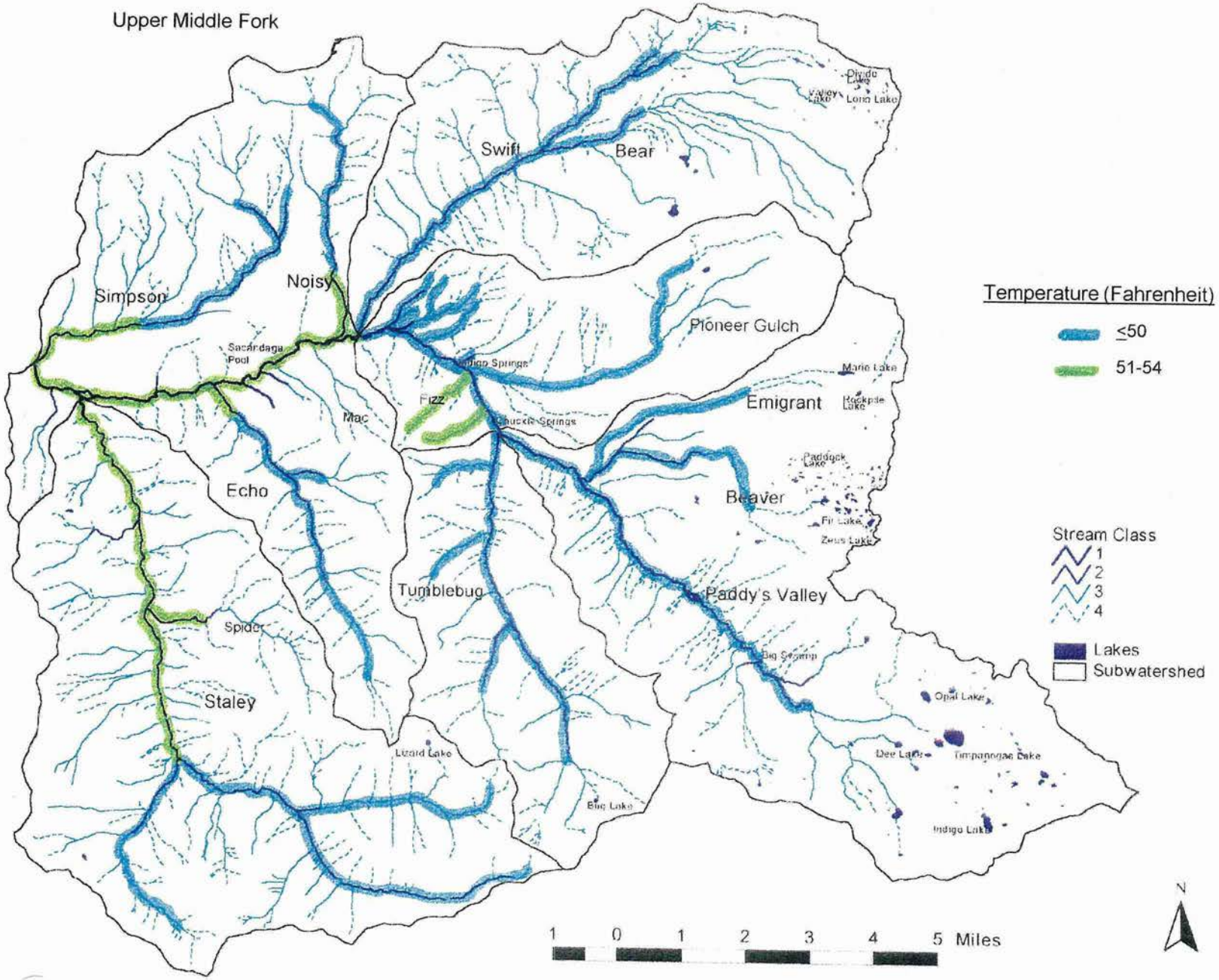
Figure 31. Monthly average of daily maximum air temperatures at Oakridge Fish Hatchery over time.

In 1937, stream temperatures in this watershed were measured in September when the average maximum air temperature was 80 degrees. In August 1964, the average maximum air temperature was 81 degrees. These earlier conditions correspond fairly closely to climatic conditions in the 1990's. Since there is no evidence of a significant increase in average air temperatures, this climatic factor does not explain the observed increase in water temperatures.

The reference stream temperatures for the UMFWA is given in Figure 32. Essentially the watershed depicted the cool glacial valleys typical of the Western Cascades. Water temperatures were generally less than 50 degrees Fahrenheit in the upper elevations and between 51 and 54 degrees in the lower, main stem reaches.

Figure 32. Historic Stream Temperatures

Upper Middle Fork



Stream Temperatures

Current/Trend

Figures 33 and 34 below present a concise view of the observed water temperatures in the mainstem MFW. Colors represent data from different years and points on this graph represent data values. Lines connecting points provide visual continuity only and should not be interpreted as representing intermediate data values. In general, the data reveals the expected trend of decreasing temperatures in the upstream direction. The exception occurs near river mile 26-27 which is an area of cold water input from several springs.

Although stream temperatures in the upper MFW mainstem remain below state water quality limits, this evidence of increased temperatures is a significant causal factor in the cumulative effects of elevated downstream temperatures. Lower reaches of the mainstem MFW currently exceed state water quality standards (Lower MFWA, 1995).

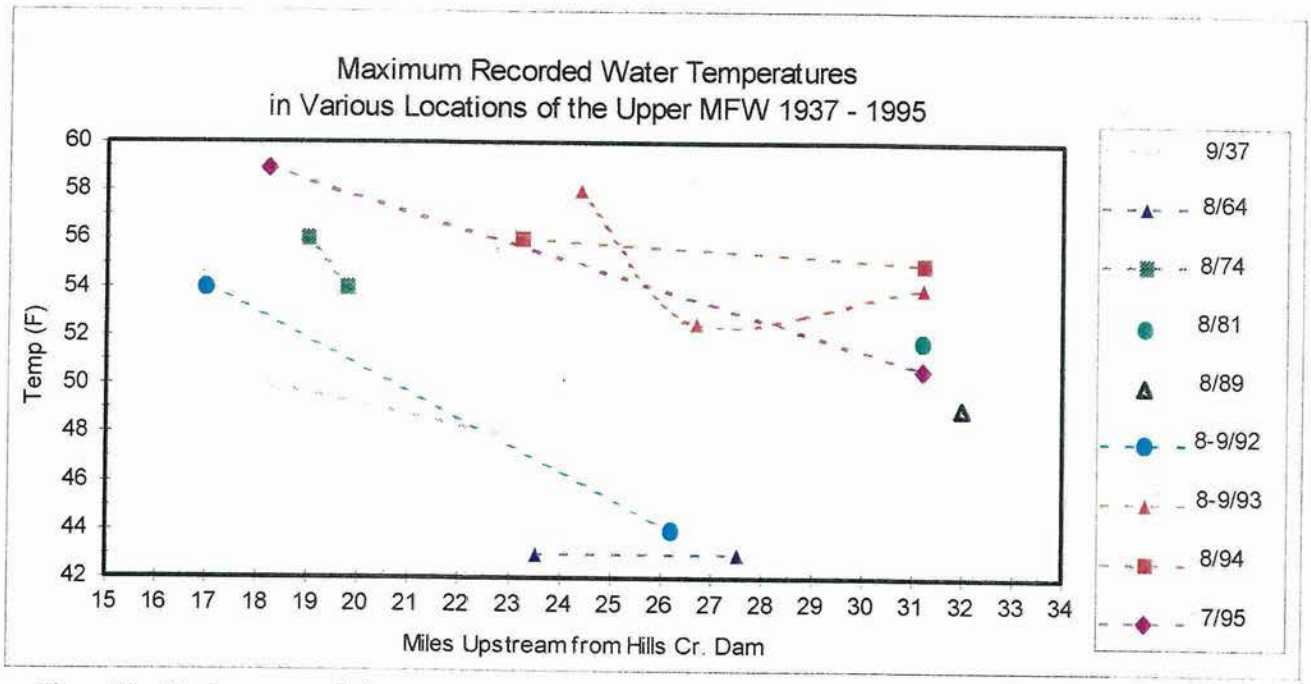
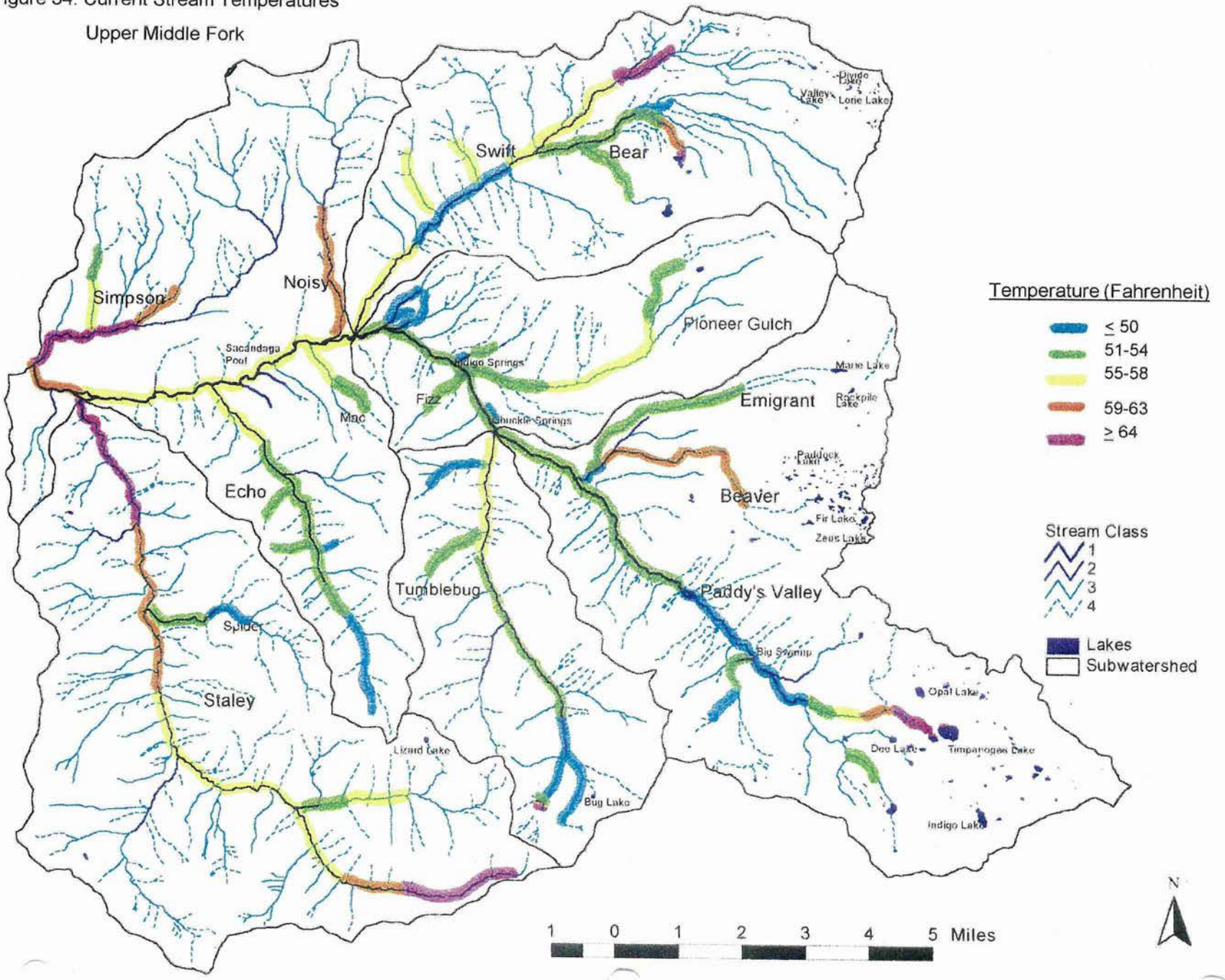


Figure 33. Maximum recorded water temperatures in various locations in the Upper MFW over time.

Figure 35 displays the contrasting temperature regimes of Staley and Swift creeks, two of the largest tributaries to the Upper MFW. An increase in stream temperatures of approximately 10 degrees has occurred in both creeks and has persisted for roughly 15 years. Both sub-basins currently have about 20% of the perennial riparian reserve in shrub and small tree size classes. This riparian condition has likely influenced stream temperatures. As growth of riparian overstory continues, a trend toward decreasing temperatures should develop, assuming a major flood doesn't occur in the meantime.

Figure 34. Current Stream Temperatures

Upper Middle Fork



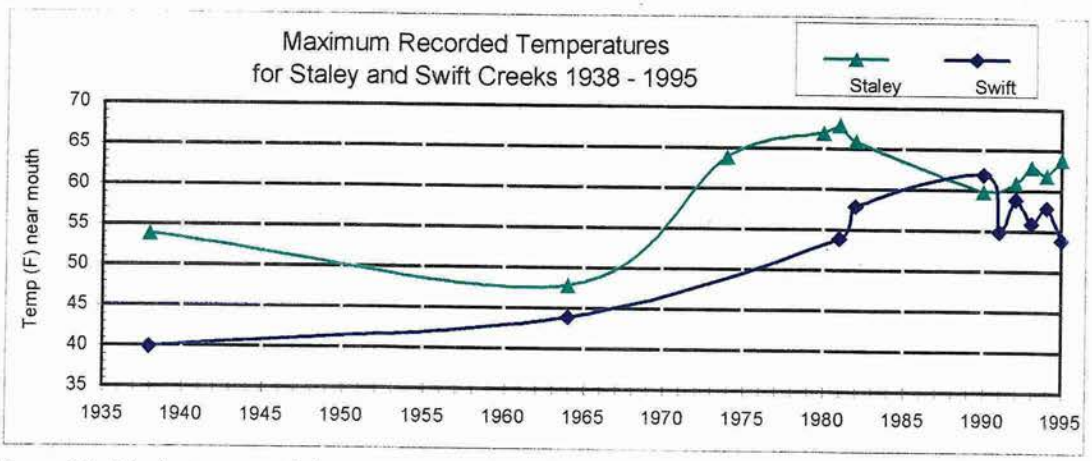


Figure 35. Maximum recorded water temperatures for Staley and Swift Creeks over the years.

Figures 36 and 37 display temperature data for the remaining four major tributaries in the UMFW. Figure 36 displays historic data which represents the reference condition. Figure 37 displays recent data and outlines the range of the reference values.

Earlier values all fall within a 6 degree range between 47 and 53 degrees. Recent data shows increases of 10 - 15 degrees in Simpson and 5 - 10 degrees in Noisy creeks. The percentage of shrub and small tree size classes in riparian reserves in this sub-basin is about 20%.

Stream temperatures in Echo and Tumblebug creeks have remained below 60 degrees, but have increased 4 - 8 degrees from earlier conditions. Riparian vegetation data indicates the percentage of small size classes in these sub-basins is 13 - 17%.

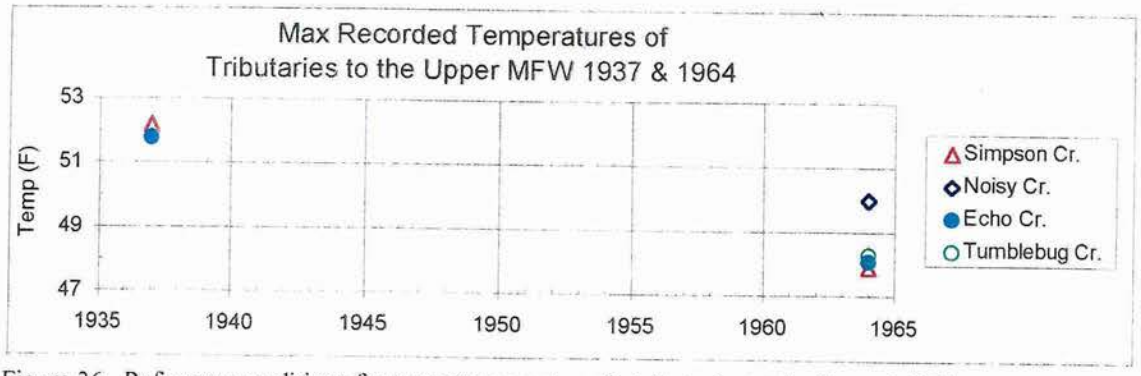


Figure 36. Reference conditions for water temperatures in tributaries to the Upper MFW

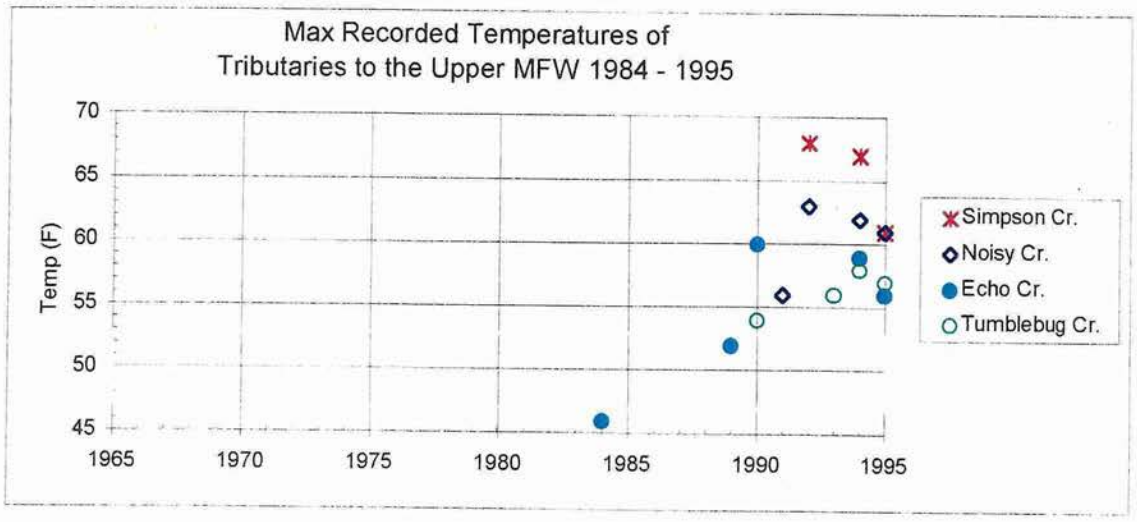


Figure 37. Current conditions for water temperatures in tributaries to the Upper MFW

KQ 6 - Where and to what extent have management practices influenced distribution and condition of aquatic species and their habitats?

The predominant biological processes in the watershed influenced by timber harvest is fish species distribution and habitat complexity. Fish distribution is influenced primarily by water temperature. Habitat complexity in terms of CWM in channel and pool formation will influence habitat capacity to support fish and an adequate food base

Anadromous and Resident Fish Species — Reference

Reference conditions are presented under the Road Density, Age and Location Issue.

Anadromous and Resident Fish Species — Current/Trend

Historic information shows adults Spring Chinook spawning in Staley and Swift Creeks and in the Middle Fork up to the mouth of Tumblebug. The majority of spawning took place in the labyrinth of side channels between Hills Creek and Simpson Creek where redds were protected from high energy flows and thermal radiation.

- Optimum spawning, egg development and fry rearing conditions for Spring Chinook are in waters that do not exceed 55°F.

Fluvial bull trout spent most of their life in the main stem of the MFW, predominantly in cool side channels in Lower MFW (between Hills Creek and Staley) and in the Upper MFW in cold, spring-fed areas possibly as high in the watershed as Big Swamp Falls, in upper Paddy's Valley, and probably Emigrant Falls, near the confluence of the MFW and Beaver Creek.

- Healthy bull trout populations persist in water temperatures below 50°F and tolerate temperatures upward to 54°F

Squawfish are exclusively piscivorous and invasive. Currently, they have been seen as high as Big Pine Openings and Simpson Creek and will likely succeed in water with warmer temperatures (55°F plus). Current temperature conditions could allow squawfish to inhabit the MFW up to Swift Creek, utilizing the lower reaches in several tributaries: Simpson, Staley, Echo, Noisy and Swift creeks. Similarly, dace have been found as high as Simpson Creek. They are another indicator of warm water temperatures. These populations use Hills Creek Reservoir as refuge.

- Increased water temperatures and degraded habitat have allowed non-native species to invade and in some cases proliferate in downstream waters.

Habitat Complexity in Response Segments — Ref/Cur/Trend

Current channel conditions were derived from a variety of stream surveys. Pool numbers were recalculated to fit PACFISH definitions. In pool/riffle dominanted streams in wide mainstem valleys (F3/C), CWM, transported from upstream or derived from the banks and floodplain, is important for forming and maintaining pools and side channels. Effectiveness of CWM for these functions is greatest when piece length is = or > active channel width. Survey and photo data generally indicate a decrease in the amount of CWM in these segments (Table 20). District records also show that cleanout and salvage of CWM from some segments occurred in the 1970's and early 80's.

In step-pool dominant habitats in alluviated mountain valleys channel types (V4/B), CWM is a significant pool-forming agent particularly for creating low-energy dammed and backwater pools. Survey data indicates a decrease in the frequency of deep pools and in the amount of CWM compared to reference conditions in Staley Reach 3. When surveyed, S. Fork Staley Reach 4 had a very low frequency and CWM amount (no reference available), however a restoration project in this reach has

recently added large amounts of CWM. The channel should readily adjust to the addition of this material.

Pool frequency is relatively stable in Staley Reach 2 due to deep trench pools in bedrock. In this reach CWM, currently low compared to reference conditions, is more important for dissipating energy and for trapping and cleansing gravel. CWM loading has apparently remained stable in Staley 4, though pool frequency may have declined, perhaps in response to increased coarse sediment input mentioned above.

In step/pool and pool/riffle dominant streams in U-shaped valleys (U1/C and U2/B), CWM aids in the formation and maintenance of deep pools in these segments and is generally highly effective since piece length usually exceeds channel width in these smaller streams. The frequency of deep pools and the amount of CWM has likely decreased in all segments except perhaps MFW Reach 12. Survey data indicates that most of the present CWM is functioning in debris jam formations rather than as single pieces.

CWM also aids formation of the many side channels noted in these segments by deflecting flow against banks. Swift Reach 4 was completely lacking CWM at the time of the field survey, but many large pieces have recently been added through an enhancement project. The channel morphology should readily adjust both laterally and vertically to these large roughness elements.

In step/pool streams in alluvial/colluvial fans (F4/B), CWM is important for dissipating energy via steps, trapping sediment, and creating lateral scour pools and side channels by deflecting flow. Early field surveys noted many log jams in these segments. Current CWM loading ranges from 9 to 48 pieces per mile. Except for Swift Reach 1, there is little data on changes in pool frequency, but it is likely that less CWM has resulted in fewer pools in these segments, although it is not the only pool-forming agent. Field surveys indicate a significant loss of side channels in Swift 1.

Table 20. Characteristics of Response Reaches in the UMFWA including CWM and Pools per Mile.

Stream Segment	Reach	River Mile	% Gradient	Ave. Wetted Width Ft	CWM/ Mile	Pools/ Mile	% PACFISH Pool Standard	Survey Type
MFW at (What)	4	3.7	1	66.0	8.1	4.3	19	R6 1992
(Staley)	5	4.6	2	58.0	15.4	5.4	23	
(Swift)	6	1.4	2	46.6	30.7	10.7	41	
	7	1.9	3	45.2	38.4	8.4	32	
MFW (Beaver)	10	1.3	3	28.0	23.1	49.2	189	R6 1992
	11	1.8	2	25.6	26.7	10.8	42	
	12	1.2	2	23.3	33.3	35.8	76	
Staley	1	2.5	2.8	21.3	3.2	23.2	49	ODFW 1991
	2	2.8	3.1	20.3	3.6	27.5	58	
	3	1.1	3.4	22.3	2.7	19.1	41	
	4	2.4	5.0	17.4	99.2	27.1	48	
S.Fk. Staley	4	1.8	4	6.8	41.4		-	R6 1994
Noisy	1	0.8	4.3	11.8	10.5	51.3	92	ODFW 1991
Swift	1	1.8	3	25.0	33.9	8.9	19	R6 1991
	4	1.0	4	8.6	5.0	35.0	36	R6 1991

Response channel segments comprise 49 percent of the fish habitat in the UMFWA. All the surveyed segments are below the PACFISH standards of 80 pieces of wood per mile and the number of pools per mile (Table 21) except Staley 4. 50 percent of the PACFISH standard for pools is reached or exceeded in the UMFW River, in Staley Creek and in Noisy Creek.

Table 21. PACFISH standards for pools per mile.

Wetted channel width	0-10	11-20	21-25	26-50	51-75	76-100
Pools/mile	96	56	47	26	23	18

- If this information is coupled with stream temperatures, hydrologic recovery and potential for peak flows, stream embeddedness and fish passage, it is apparent that the most important response reach refugia area for salmonid fish occurs in the UMFW River in the Timpanogas Subwatershed.
- The Staley Subwatershed, while it is recovering, accounts for 25 percent of the total response reach segments in the watershed and is therefore very important to protect and restore for aquatic spawning and rearing life stages, particularly cutthroat trout.

Habitat Complexity in Transport Segments Ref/Cur/Trend

CWM loading is currently very low in M1/B segments. Pool frequency is correspondingly low for these small high gradient reaches. Additional CWM would likely increase the frequency of plunge pools associated with small steps. This additional roughness element would also likely store additional coarse and fine sediment in the active channel. Amounts of CWM sufficient to reduce travel time through these and upstream segments could conceivably alter the complex surface-groundwater relationship in this area (Table 22 and Figure 38).

In step/pool streams in V-shaped moderate gradient valleys (V1/B), CWM contributes to pool formation, energy dissipation, and sediment storage in these segments. Other roughness elements also provide these functions. Little data is available to assess changes in pool frequency over time, but the frequency is highest in Tumblebug Reach 2 where the amount of CWM is greatest. Other segments, (S. Fork Staley Reach 2 & 3 and Simpson Reach 1) have a low pool frequency and low to very low CWM amounts.

In cascade streams in similar valleys (V1/A), CWM contributes to pool formation, energy dissipation, and sediment storage in these segments. Other roughness elements also provide these functions. Effectiveness of CWM is also reduced by the fact that pieces may remain suspended above the flow in these constrained channels for long periods of time. Little data is available to assess changes in pool frequency and CWM loading over time except in Simpson 2 where a significant decrease in both characteristics has occurred since 1964 (pre-flood).

In cascade streams in V-shaped high gradient valleys (V2/A), CWM is important primarily for energy dissipation and sediment storage in these segments and secondarily for pool formation. Boulders also provide these functions. Shorter pieces are also effective in theses narrower channels. The frequency of deep pools is similar in all reaches (3 to 6 per mile > 3 feet deep), and CWM loading is moderate . Most CWM in these segments is functioning as debris jams trapping and sorting sediment.

A distributional overlay of CWM is given in Figure 40. The streams which exceed the recommended number of pieces of wood per mile include: Spider, Royal, Fizz and Tumblebug Reach 1,2 and 4. Spider, Fizz, Royal, and Tumblebug Reach 4 are all V2/A segments located in v-shaped, high gradient valleys. The primary role of CWM in these channels is energy dissipation. Spider Creek, in addition, may be an important cool water refugia for the Staley Subwatershed.

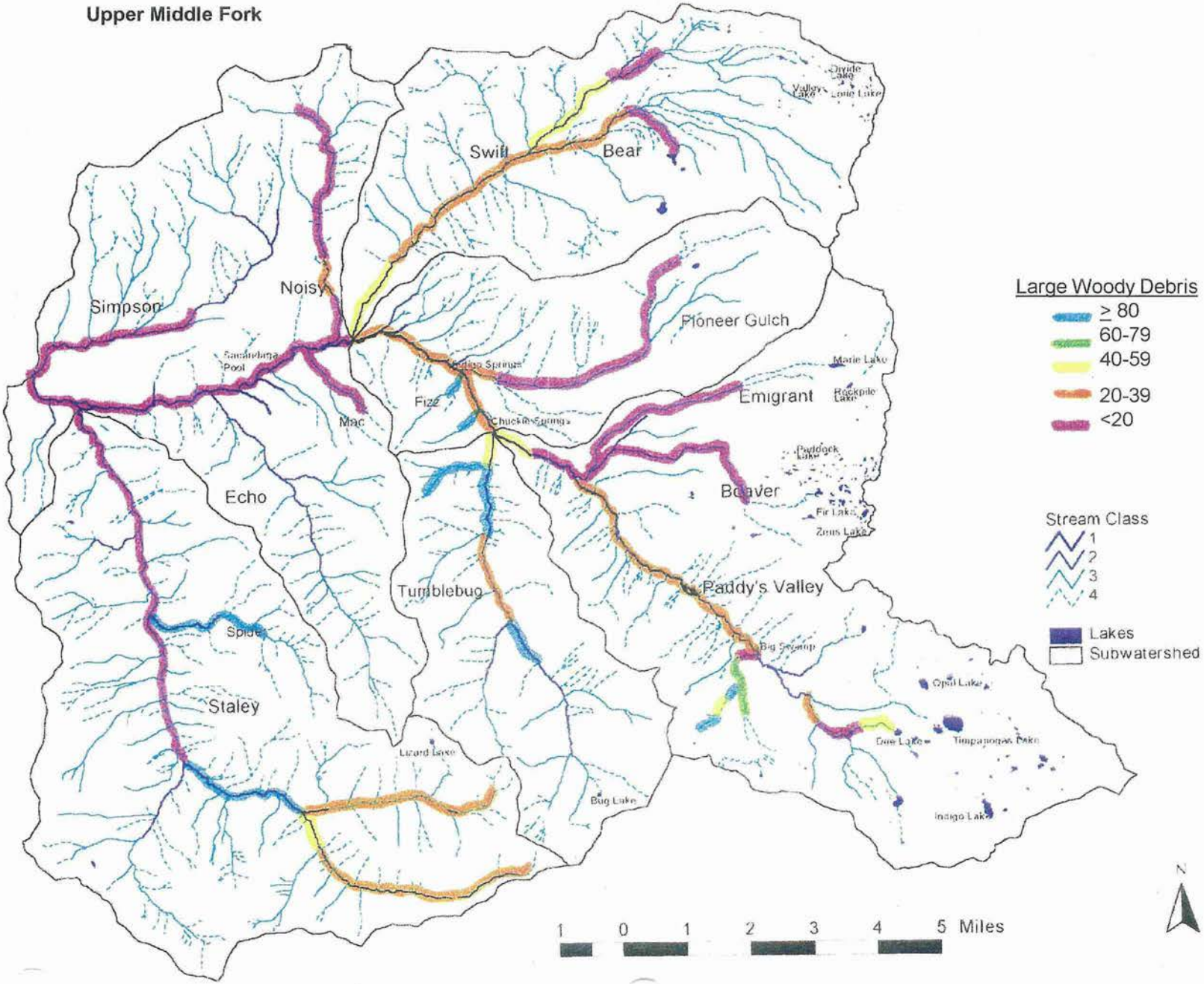
- Tumblebug Reach 1 and 2 is a V1/B segment, with moderate gradient with less confinement than other transport segments. In these reaches, CWM contributes to pool formation, energy dissipation, and sediment storage. The relatively cool water in this Subwatershed makes these reaches important transport refugia for salmonid fish

Table 22. Characteristics of transport reaches in the UMFWA including CWM and pools per mile.

Stream Segment	Reach	River Mile	% Gradient	Avg. Wetted Width Ft	CWM/ Mile	Pools/ Mile	Survey Type
MFW at (Tumblebug)	8	0.7	6	36.2		24.3	
	9	0.9	4	31.8		**31.1**	
Simpson	1	2.0	5.3	16.1	1.3	32.0	ODFW 1991
	2	1.0	3.6	10.2		10.0	
Spider	1	0.3	6	14.4	175.0	13.3	ODFW 1991
	2	0.7	11	11.0		8.6	
	3	0.5	10	10.1		22.0	
	4	0.7	13	13.3		12.9	
S.Fk. Staley	1	0.7	7	16.1	29.5	11.4	GP
	2	0.7	7	12.3			
	3	1.2	7	9.6			
N.Fk Staley	1	0.9	10	15.9	27.4	7.8	
	2	2.2	10	12.0			
Mac	2	0.7	22	2.8			
Noisy	2	0.3	11.9	12.1		30.0	
	3	1.9	6.4	9.8		22.6	
	4	1.1	10.7	9.2		27.3	
Swift	2	2.4	4	24.6		8.3	
	3	1.7	6	15.9		49.4	
Bear	1	2.0	8	15.1	21.6	23.5	R6 1991
	2	1.2	13	8.3		29.2	
Fizz	1	0.1	13	3.2	166.7	50.0	GP 1990
	2	0.1	26	4.3		60.0	
	3	0.1	8	3.5		40.0	
Royal	1	0.3	18	3.8	200.0	56.7	GP 1990
	2	*0.1*	*30*	*4.9*		*20.0*	
Tumblebug	1	0.9	3	17.7	69.3	34.3	R6 1990
	2	1.3	4	18.7		43.7	
	3	1.4	4	13.2		26.0	
	4	0.7	5	10.6		32.9	
Emigrant	2	1.3	12	2.1		86.2	
Beaver	2	0.8	15	9.5		77.1	
	3	1.5	5	3.0		**140.0**	
Spring Meadow	1	0.3	10	10.4	41.4	16.7	GP 1990
	2	0.4	18	11.9		**65.0**	
Tami	1	0.1	32	8.2	76.7	60.0	GP 1990
	2	*0.3*	*37*	*9.3*		*13.3*	
	3	*0.2*	*27*	*5.7*		***105.0***	
Dee	1	0.2	6	9.0	25.5	25.0	GP 1990
	2	0.6	21	9.9		10.0	
	3	0.3	10	6.5		43.3	
Mac	1	0.6	12	5.3	15.4		
Pioneer Gulch	1	0.4	10	5.3	14.6	37.5	Mod. R6 Level II 1995
	2	3.3	6	3.7		13.6	
Emigrant	1	2.1	10	2.6	8.8	61.9	Mod. R6 Level II 1995
Beaver	1	0.9	8	10.3	7.2	44.2	R6 1995

Figure 38. Current LWD Distribution

Upper Middle Fork



ISSUE 3: INTRODUCTION OF NON-NATIVE SPECIES

KQ 1 - Where and to what extent has management influenced presence and distribution of non-native species? What are the known effects on native species?

Non-Native Wildlife Species — Reference

The barred owl is the only non-native wildlife species of concern. The barred owl was absent in this area.

Non-Native Wildlife Species — Current/Trend

Current fragmentation patterns favors barred owl utilization. One pair is known to be presently in the UMFWA. The primary concern is the displacement and genetic dilution of spotted owl populations by the barred owls.

Non-Native Botanical Species — Reference

Non-native plant species in this watershed have increased dramatically during the 20th century and are associated with ground-disturbing activities. Early vectors of introduction included activities around the military road, and associated uses such as the way station at Rigdon Meadows. Later vectors included erosion control plantings, forage seeding, ground disturbance associated with timber harvest and road building, vehicle traffic, and use of domestic pack animals. In addition, many species invade as contaminants in pack animal feed, erosion control and road building materials.

Non-Native Botanical Species — Current/Trend

Species classified as new invaders on the Willamette National Forest noxious weed list are given the highest priority for control. New invaders are those species which are in the early stages of invasion, occur at levels which can be eradicated, and have not naturalized to the point that resource damage is occurring. New invader noxious weed species in this watershed are spotted, diffuse and meadow knapweeds, and yellow toadflax. Invasive exotic species which are new invaders include:

- non-native blackberries which are presently limited to roadside populations
- Fuller's teasel which is associated with road-side ditches and wet special habitats.
- Mullein species, occupying low-elevation dry meadow habitats

Several species occur at levels considered to be established infestations, having spread to the point that eradication is impossible. Established noxious and non-native include the thistle species, tansy, scotch broom and common St. John's wort.

Many non-native species are commonly associated with ground-disturbing activities. Although noxious weeds can colonize harvested stands immediately after disturbance, conifers usually become established and displace the sun-dependent non-native species in managed stands. In addition, the lower levels of timber harvest and associated road building called for in the Forest Plan as amended by the ROD will likely decrease the spread of those non-native species that require disturbance and high levels of light.

Anadromous and Resident Fish Species — Reference

Headwaters - Brook Trout, Coastal Cutthroat Trout, and Bull Trout

With the completion of the Oregon Military Wagon Road in 1868, a route was made to provide access to the Upper Middle Fork. This also provided an opportunity for avid anglers to release their favorite species. In the late 1800's Rocky Mountain hybridized cutthroat trout were shipped west to seed

Cascade streams. Rainbow trout from California were shipped north. Evidence of early stocking is best represented by stocking records on Indigo Lake, a source lake to the Middle Fork. Rainbow trout were found residing in the lake when state biologists visited the Timpanogas Basin for the first time in 1932. Before then, rainbow trout were not known to exist in elevations higher than 2,400 feet in the watershed. Indigo Lake is at an elevation of greater than 5,900 feet. The first official stocking of non-native rainbow trout in the watershed was in 1933.

Eastern brook trout were first observed in the watershed in 1947 when 2,000 brook trout were stocked in Lower Timpanogas Lake, a source lake to the MFW. Brook trout were stocked in Timpanogas Lake in 1968. Over time the brook trout migrated upstream to the headwaters to Indigo Lake. In 1967, Dee Lake was stocked with brook trout. These lakes became the seed base for brook trout as they moved down the system into the MFW, occupying the low gradient areas of Paddy's Valley.

In 1962 golden trout were stocked in Divide, Lorie and Valley lakes in the Swift Creek headwaters without survival.

Mainstem - Steelhead, Spring Chinook, Rainbow Trout, Coastal Cutthroat Trout, Northern Squawfish

Steelhead were introduced to Lookout Point Reservoir in 1954 and were able to spread throughout the basin until the completion of Hills Creek Reservoir in 1962. 80,000 Coho salmon were also stocked in Lookout Point in 1955 without success.

Early stocking practices, after the completion of Hills Creek Reservoir in 1962, introduced several non-native strains of cutthroat, steelhead, and rainbow trout into the MFW river. Often these fish spawned during the same time period in the spring, resulting in hybridization and dilution of the native genetic strains.

Squawfish historically were not inhabitants of the Upper Middle Fork Willamette watershed. They had a minimal impact as a predator species prior to eradication attempt and completion of Hills Creek Reservoir dam system. They were found primarily in warmer waters, lower in the system, but may have migrated as high as Buck Creek.

Anadromous and Resident Fish Species — Current/Trend

Headwaters - Brook Trout, Coastal Cutthroat Trout, and Bull Trout

In the Timpanagos Subwatershed, in the headwaters of Beaver Creek, Zeus, Fir and Paddock lakes are currently stocked with brook trout. These lakes are more shallow and have intermittent outlets. Continual stocking allows this species to persist and move down Beaver Creek during spring melt and winter storms. The cold, spring-fed sections of the MFW, however, combined with increased stream gradient prevents further downstream migration of brook trout.

In areas where brook trout and cutthroat trout coincide, brook trout dominate in degraded areas, while cutthroat trout persist in more pristine reaches. For example, cutthroat trout once inhabited the lower half mile of Beaver Creek, but may have since been pushed downstream by brook trout that have escaped from lakes in the Beaver headwaters. Coastal cutthroat trout still continue to reside in these waters, but in spotty patches where habitat is more intact and water conditions are cooler, below the cold water influence of Beaver springs.

- Stocking of lakes in the Beaver and Timpanogas Basins has allowed downstream migration of brook trout.

Eastern brook trout are highly competitive and may outcompete native species of cutthroat trout and bull trout in more degraded habitat areas. In areas where brook trout and bull trout potentially overlap, brook trout may hybridize with the bull trout, yielding sterile offspring. Since bull trout are "functionally" extinct in the watershed there are not any known areas of interbreeding that are a concern, however, it is possible that a remnant population may exists in the headwaters of the MFW.

Mainstem - Steelhead, Spring Chinook, Rainbow Trout, Coastal Cutthroat Trout, Northern Squawfish

Current stocking practices use varieties of rainbow trout that are sterile and do not spawn and rarely survive through the winter months. Thus the amount of genetic diffusion through current stocking

practices should be minimal. However, the assumption of winter survival has not been thoroughly monitored.

Due to a natural migration barrier and intermittent flow, portions of Pioneer Gulch and Emigrant Creek are believed to host isolated populations of coastal cutthroat trout. The Pioneer Gulch cutthroat are likely to be a pure genetic strain. The Emigrant Creek population may have interbred with cutthroat that were introduced into Marie and Rockpile lakes.

Warm water fish species, such as the Northern squawfish, continue to expand their range upstream in the MFW. Currently they have been sighted as high as Simpson Creek. The decline of another predator species (bull trout) and increasing stream temperatures allows squawfish to move into this upstream habitat.

In general:

- Non-native strains of rainbow trout are stocked annually and monthly (during fishing season) in high-use areas of the watershed for recreation purposes.
- These stocking practices may deplete local food base for native species.
- Current strains of stocked rainbow (Cape Cod and Roaring River) rarely survive over winter and thus, are unlikely to spawn.
- Rainbow trout are native to the basin but due to continual hatchery stocking since the turn of the century, they may not represent the native genetic strain
- Cutthroat trout are found throughout the watershed and become more dominant over introduced species in colder waters with moderate to high gradient