Molalla Watershed Analysis

Cascades Resource Area
Salem District
Bureau of Land Management
1717 Fabry Road SE
Salem, OR 97306
503-375-5646

Mt. Hood National Forest
16400 Champion Way
Sandy, OR 97055
503-668-1700

May 1999

Team Members

Bob Ratcliffe	Team Leader	John Barber	Hydrologist
Jim Irving	Wildlife Biologist	Dave Roberts	Fisheries Biologist
Claire Hibler	Botanist	John DePuy	Soil Scientist
Dave Rosling	Riparian Specialist	Dan Schlottmann	Silviculturist
Bruce Ahrendt	GIS Analyst	Scott Brayton	Writer/Editor
Sam Caliva	Fuels Management Specialist/Fire Ecologist	Craig Edberg	Silviculturist U.S. Forest Service

Richard C. Prather ____________ Date May 14, 1999

Richard Prather, Field Manager, Cascades Resource Area

Molalla Watershed Analysis

Table of Contents

Executive Summary

The executive summary provides an overview of the entire document. It summarizes key components and findings of the analysis. It also addresses the relationship of the watershed analysis to other management authorities, plans, and prescriptions.

Watershed Analysis Area, Process, and Purpose

The Molalla River Watershed Analysis focuses on the upper portion of this large, diverse, and important watershed. This watershed is a significant resource within the region. It provides drinking water for the communities of Molalla and Canby, forest products for local mills, important recreation opportunities for Willamette Valley residents, and considerable amount of viable habitat for fish, wildlife, and botanical resources. This analysis deals with the upper reaches of the Molalla River southeast of the town of Molalla and upstream from the Dickey Prairie and Glen Avon areas. Only about one third of this forested 129,000-acre (202 square miles) watershed is under federal management and jurisdiction. General management direction for federal lands has been determined through the Northwest Forest Plan process, defining and restricting the types and range of activities allowed on most acres of Bureau of Land Management (BLM) and the U.S. Forest Service (USFS) lands within the watershed. Most of the federal lands within the watershed are designated as either Wilderness, Late-Successional Reserve (LSR), or Connectivity (CONN) lands which restrict the types and levels of forest management and timber harvest activities.

This analysis presents an overall view -- a general landscape perspective on the physical, social, and environmental conditions and trends within the watershed. Primarily it is a tool to assess the health and condition of the watershed and evaluate the effects of landscape level disturbances both natural and human caused. It provides general guidance and direction for management for BLM and USFS lands. It develops specific recommendations for future BLM and USFS resource management actions including:

< Establishes restoration and monitoring priorities that will help move watershed areas from existing to desired conditions for hydrological and water quality considerations.
< Identifies fisheries and wildlife habitat restoration opportunities and recommends Riparian Reserve widths and other scarce or unique resource protection considerations.
< Identifies opportunities for commodity outputs and general forest management actions and strategies.
< Identifies recreation and other social management actions, strategies, and developments.

The overall health of a watershed depends on the cooperation of all landowners. However, this analysis is designed only as a tool for federal agencies to decide sustainable and ecologically sound management direction and to prioritize actions for federally owned lands.

Watershed analysis is an ongoing and dynamic process. It is intended to be revised and updated as conditions, assumptions, or resource plans change and new information becomes available. This document summarizes a large quantity of information and detailed analysis of complex issues and interrelationships. It is important to note that watershed analysis is not a decision-making process, but rather a stage-setting analytical process that offers constraints and provides guidance for future management decisions.

Molalla River Watershed Key Issues and Goals

In the beginning of the watershed analysis process, the interdisciplinary team (IDT), with comment from the public, identified and distilled basic issues and goals on which to focus the analysis. The following describes the primary resources and issues that directed the analysis process. The watershed analysis recommendations reflect an effort to achieve the goals for federally managed lands.

Resource	Issue	Goal
Native Fish and Habitat	The Molalla River has native runs of anadromous fish whose numbers are low and/or declining.	Maintain and improve native anadromous and resident fish habitat in the watershed.
Water Quality	Significant portions of the Molalla River and its tributaries do not meet state water quality standards. Future land uses may further degrade water quality for this municipal water source.	Maintain and enhance water quality of the rivers within the watershed to meet or exceed state water quality standards.
Natural Resources and Wildlife Habitat	Much of the public land in the watershed is to be managed for Late Successional Reserve species and to improve wildlife habitat and conditions for other forest species.	Protect and conserve natural areas associated with river, stream and forest habitats, while seeking ways to restore habitats, reduce noxious weeds and accelerate old growth forest conditions.
Recreation Opportunities	The Molalla River area is heavily used for recreation and demand for recreation opportunities found in the watershed continues to grow as population increases.	Provide high quality recreation opportunities while protecting resources from overuse and abuse.
Illegal Activities	Dumping, litter, man-caused fire and other resource management problems affect this urban interface watershed.	Curb and reduce illegal activities and increase management presence and resource protection effectiveness.
Timber Supply	The local economy is reliant on a predictable supply of forest products from the watershed.	Provide a sustainable and predictable supply of forest products from the watershed.

How the Analysis was Conducted

Any watershed is equal to the cumulative condition of the sum of its parts. For our analysis, it was assumed that distinct sub-watersheds would have a range of conditions that would likely require somewhat different approaches and prescriptions for management. By analyzing individual sub-watersheds, we could also prioritize restoration efforts and develop strategies for more effective use of limited funds or resources. The Molalla River watershed was divided into five main tributary areas called Key Tributary Analysis Areas. These include the North Fork Molalla, Table Rock Fork, Copper Creek, Upper mainstem Molalla, and Lower mainstem Molalla drainage areas. These tributary areas were further broken down into 24 sub-watersheds for analysis purposes. This enabled the IDT team to target specific sub-watersheds with critical conditions or trends for prioritizing and implementing management strategies and restoration actions.

Molalla Watershed Condition and Trends

The story of the Molalla is one of a long history of human use and influence on the watershed. Fire, timber harvest, roads, and even recreation uses have played a role in changing the landscape. It is also a story of dynamic geomorphology with a topography of steep slopes, gorges, cliffs, and canyons combined with areas of unstable soils in a region of heavy precipitation. This has resulted in naturally caused but significant and occasionally catastrophic landslides, floods, and mass movements. These events can and have been exacerbated by human use and land management actions and activities.

Despite all these naturally existing resource considerations and a high level of human influence, the basic integrity of the watershed is still intact. The watershed continues to function in providing certain limited levels of habitat, forest products, municipal water, and recreation opportunities. However, the Molalla watershed generally is in poor to fair condition. The long-term forecast ranges from stable to slightly declining resource condition trends if past and current management practices continue. The existing conditions and trends vary widely from sub-watershed to sub-watershed. For the most part, upper reaches and headwaters of the North Fork Molalla, Table Rock Fork, and Copper Creek drainages are in better condition and show improving trends, while the lower and middle areas of the watershed analysis area are in poorer condition with varying trends. The overall findings for watershed resource conditions and trends include:

From a water quality perspective, high water temperatures and event-related turbidity are significant problems throughout the watershed. Road densities and open areas that create increased runoff and potential for erosion and sediments are at moderate to high levels in all areas of the watershed.

From a wildlife and botanical perspective, the watershed is highly fragmented but offers significant areas of good habitat. There is potential to improve extensive areas for wildlife habitat in the long term, especially in LSR and upper watershed areas.

Fisheries and riparian habitat conditions throughout the basin, especially in areas accessible to anadromous fish, are in fair to good condition on federal lands and poor to fair on other lands. Many opportunities exist to improve habitat through stream shading, placement of woody debris, and enhancement of stream structure or riparian vegetation.

High demand for recreation use and easy public access in the watershed, particularly along the mainstem Molalla, demand the development of primitive recreation facilities to mitigate and reduce recreation-caused impacts to riparian areas, special habitats, and water quality. A greater emphasis on management of recreation use and increased public education and enforcement of regulations would also help reduce and mitigate recreation-related impacts to riparian areas, wildlife habitat, and water quality. The watershed provides increasingly more important recreation opportunities for a fast growing Willamette Valley population and region.

Catastrophic fires at the turn-of-the-century, post World War II harvesting, and intense forest management activities in the 60s, 70s, and 80s resulted in large areas of younger stands of second and third generation forests throughout the watershed. Continued demand for forest products will require innovative and alternative methods and practices to provide sustainable harvest levels from public lands. Forest management prescriptions over the next decade will include thinnings, LSR and wildlife enhancement forest prescriptions, and improvement of riparian buffers with some opportunities for regeneration harvest or uneven-aged stand management on all federal lands. As forest vegetation matures over the next 20 to 30 years on federal lands, there will be greater long-term opportunities for a steady flow of timber harvest volumes of higher quality wood products. For a summary of watershed analysis findings and more information about resource conditions and trends by sub-watershed, see Table 1, *Summary of Watershed Analysis Findings by Sub-watershed for Federal Lands*.

Recommendations for Future Management Direction for the Molalla Watershed

The watershed analysis IDT, with information and assistance from interested publics, boiled down the resource management issues into four key questions. A summary of these key questions and their answers follows. For a summary of restoration and habitat improvement actions, see Table 2, *Summary of Management Recommendations by Sub-watershed for Federal Lands*.

, **Given the watershed's ownership pattern, BLM land use allocations (LUA), and resource conditions, what timber harvest pattern and silvicultural treatments can we implement while meeting all other resource objectives?**

A key issue identified by the public is the concern that harvesting timber on federal lands may possibly effect downstream water quality and exacerbate the potential for flooding and sedimentation during significant rain on snow events by increasing the extent of disturbed or open areas and road surfaces. There are 24 sub-watershed basins within the study area of the Molalla watershed. Of these, only 16 sub-watersheds have federal lands that could be potentially managed for any type of forest management activity, and only nine incorporate General Forest Management Areas (GFMA or Matrix) Land Use Allocation (LUA) where regeneration harvest could be conducted. The area available for harvest activities on federal lands represents less than two percent (2%) of the entire watershed. In addition, the forest plan requires extensive stream and sensitive area buffering along with wildlife tree and green tree retention, further reducing available acres. However, most of the sub-watersheds where BLM lands are available for forest management activities are shared with either private land owners, the state of Oregon, the USFS, or a combination of landowners. The cumulative effects of past harvesting on all lands combined with current harvesting schedules on private and state lands put most of the sub-watersheds located in the middle or lower portions of the watershed in higher risk categories. This requires the BLM and USFS to fully consider and evaluate cumulative effects within individual sub-watersheds on a project-by-project basis.

To help stabilize conditions and reduce potential cumulative impacts to water quality and improve trends in sub-watersheds with BLM or USFS lands, this watershed analysis recommends federal lands be managed to limit creation of new openings to the forest canopy for at least the next decade. This would mean some opportunities for regeneration harvest on federal lands exist in the watershed in the immediate future, especially if they are combined with alternative forest management strategies. The BLM and USFS should manage forest lands and timber stands by creating small and limited openings, conducting selective harvests with thinning from below, minimizing new road building, as well as other alternative LSR enhancement, forest stand, or habitat improvement prescriptions.

Best Management Practices (BMPs) and forest plan standards and guidelines will be implemented on all projects. All projects will be designed to minimize impacts to water quality and meet State water quality standards. Some increases in regeneration harvest could begin in the second decade in a few select sub-watersheds that have recovered. In those that are still high risk, the BLM should continue to implement limited forest management activities. Eventually an understory of conifers would develop that could allow these stands to be groomed for future uneven-aged management.

- **What and where are the restoration opportunities to improve functioning riparian conditions, maintain viable special plant populations, reduce erosion, and best retain structural components for the watershed while providing sustainable timber harvest levels?**

There are many opportunities to implement restoration activities or projects in the watershed. Certain sub-watersheds show higher potential than others for recovery and stability and would be considered a higher priority for management actions. Other sub-watersheds show higher potential for slope instability and erosion. They have also been identified for contributing to certain water quality problems and have been prioritized for prescriptive actions. Basically, restoration activities take two forms: (1) habitat restoration or enhancement actions and (2) road closure, decommissioning or storm proofing, and stabilizing erosion prone areas.

Riparian Areas

Management activities in Riparian Reserves throughout the watershed would be most effective in early to mid-seral age classes. Some older stands (greater than 80 years) that have had structure altering activities in the past would be good candidates for structural restoration work. The purpose of any project would be attainment and maintenance of the Aquatic Conservation Strategy Objectives (ACSO) by promoting, maintaining, or accelerating older forest characteristics.

Priority areas for Riparian Reserve treatments include:

- Areas where treatment would improve late-seral connectivity within the watershed and with adjacent watersheds.
- Areas where past management activities have altered forest stand structure or species composition and created a lack of stand diversity.
- Areas beside instream enhancement projects.
- Areas currently deemed to have low to moderate Large Woody Debris (LWD) recruitment potential.
- Areas beside other planned timber management activities.
- Previously thinned stands.

Botanical Resources, Special Species and Habitat

The diversity and potential of the Molalla watershed offer opportunities to protect and manage known sites of special status and special attention species of concern associated with older forest habitats. Management could include prescribed burning of dry meadow habitats that would mimic natural fires and accelerate and improve specialized habitats in the South and Middle Fork Molalla tributary analysis areas.

Throughout the watershed, management actions, restoration projects, and prescriptions would be designed to develop and accelerate old-growth like characteristics in younger age classes in Riparian Reserves, LSRs, and Connectivity areas outside Riparian Reserves. The spread of evasive and noxious weeds presents a potential significant problem in some areas of the watershed. The BLM. should monitor problem locations and work to restore native plant communities. This would be done by using the principles of integrated weed management to eradicate and prevent the spread of the new invader noxious weed infestations in all parts of the Molalla watershed.

Water Quality and Aquatic Habitat

Most of the water quality problems in the watershed result from non-point pollution occurring during the winter and spring when heavy rains wash pollutants and sediment into rivers. In addition, the entire watershed was found to have high water temperatures, primarily due to a lack of mature riparian vegetation and stream shading. Many habitat enhancement or restoration activities would directly benefit and improve water quality and temperature. Instream restoration projects to improve aquatic habitat involve log and boulder placements to increase habitat complexity. This would also create localized reductions in stream velocity, trap bedload materials, and woody debris and slow the nutrient cycling process. Sometimes, restoration or creation of secondary channels may be feasible and would act to slow and absorb water and reduce flooding. In larger streams within the watershed, such as the mainstem Molalla River, Table Rock Fork, or North Fork, large, tree-length logs with root wads could be placed in the stream by various means (yarding, pushing, blasting, or helicopter) to improve fish habitat and water quality. In smaller streams such as Lukens, Cougar, and Trout creeks, log and boulder complexes that span the entire channel width can be constructed and anchored in place. Riparian habitat enhancements or restoration projects, such as riparian release projects to improve growth of stream-side conifers, would also accelerate stream shading, reducing water temperatures and filtering runoff.

Reduction of the number of roads in the watershed is a high priority and effective restoration activity. There are more than 1,000 miles of a variety of roads (surface types) in the watershed. Over 45 miles of BLM roads have been identified as priorities for decommissioning or storm proofing in the watershed. Twenty sub-watersheds (80% of the watershed) are estimated to have high road densities resulting in impacts to increasing stream flow, while only six sub-watersheds have high road related sediment impacts. Roads should be decreased by decommissioning in targeted sub-watersheds where high numbers of total roaded miles contribute flow or sediment to streams. On roads that cannot be decommissioned due to road use agreements or needed public access, several actions should be taken to reduce runoff and erosion. Actions would include upgrading culverts to handle 100-year flood events, maintaining the road surface, and leaving some vegetation in the ditch line. Maintaining proper road drainage would help reduce sediment additions to streams. Where possible, design all new roads and relocation of roads to avoid crossing unstable slopes. BLM should strive to clean culvert inlets before fall storms and avoid concentrating road runoff onto unstable slopes when designing or relocating roads. Most importantly, any forest management activities should maintain some tree cover on slopes at risk for mass movement to preserve root strength.

All future actions will consider watershed cumulative values when designing ground-disturbing activities in sub-watersheds. Where watershed cumulative effects are high, the BLM and USFS should seek opportunities to reduce the openings in the forest canopy by road decommissioning, deferring harvest, or using thinning in forest stands.

, **Given the species present, and their habitat conditions and trends, what opportunities exist to restore fish and wildlife habitat conditions?**

Fisheries Habitat

Winter steelhead trout (*Oncorhynchus mykiss*) and spring chinook salmon (*O. tshawytscha*) are the only anadromous salmonids native to the Molalla Basin. Stocks of both species may be in serious decline, and the native spring chinook may be extinct.

Much of the stream habitat in the basin is in a degraded condition from decades of forest management practices such as timber harvest, road building, and stream cleaning. Streams are generally lacking LWD which serves to create and maintain habitat complexity, increases the retention of spawning gravel and nutrients, reduces the velocity of high flows, and creates refuge areas for juvenile and adult fish.

Many opportunities to restore fish habitat conditions exist in the mainstem Molalla River, Table Rock Fork, and several tributaries. Emphasis should be placed on restoration projects on stream segments that are accessible to anadromous fish. The highest priorities for instream habitat restoration should be the mainstem Molalla River within the South Fork Molalla and Upper Mainstem Molalla Tributary Analysis Areas, and the Table Rock Fork within the Middle Fork Molalla Tributary Analysis Area.

Log and whole tree placements, riparian conifer release, and secondary channel restoration are the primary restoration activities recommended.

Wildlife Habitat

Many opportunities to restore wildlife habitat conditions exist in the Molalla watershed. Throughout the watershed, three key habitat components provide opportunities for restoration.

- Snag and down log creation throughout the watershed.
- Avoid further fragmentation and degradation of interior late successional forests and connectivity corridors. However, projects designed to improve structural diversity would be encouraged.
- Protect and enhance special habitats throughout the watershed including wetlands, dry meadows, and rocky habitats by using vehicle closures, prescribed fire, and avoidance by proposed projects.

Recreation

- **Given the social uses and trends, and resource conditions, what recreation developments or management opportunities exist to manage human activities while protecting important resources and meeting recreational demand?**

The Molalla River and watershed offer many recreation opportunities for fishing, hunting, day-hiking, dispersed camping, non-motorized boating, picnicking, and swimming/wading. The river corridor also offers exceptional opportunities for bike riding, horseback riding, and nature study. The river corridor and portions of the upper watershed are accessible by car and attract visitors from throughout the region and from areas outside the region. The river's proximity to Portland and Salem urban areas, combined with the river corridor’s broad range of recreation activity options and easy road access, make it an outstanding, very popular local and regional recreational resource. From a regional and statewide perspective, few rivers in the state offer such ease of access and variety of recreational opportunities in a relative natural and undeveloped setting so close to a major urban area. The heaviest recreation use and related resource impacts occur along the mainstem Molalla River in the mid to lower portion of the watershed.

The BLM has an obligation to manage recreation use in the Molalla watershed to reduce or mitigate resource impacts. However, growing demand for recreational opportunities requires the BLM to also provide public access and recreation facilities and enhancements such as trails, day-use, and camping areas to meet demand in the watershed. Recreation management strategies should emphasize two approaches:

- The development of primitive recreation facilities and improvements that would mitigate or reduce resource impacts from the already occurring dispersed recreation use, especially in riparian areas.
- Additional visitor information and education efforts combined with increased law enforcement and patrol presence in the watershed.

Numerous informal but heavily used camp and day-use areas exist throughout the watershed.

Many of these sites could be closed and restored if alternative camping or day-use areas with appropriate facilities were provided. In addition, both visitor safety and the quality of recreation experience could be improved through improved facilities and accessible opportunities. Emphasis should be placed on developing a few (3 or 4) primitive camping areas with designated sites and vault toilet facilities in the middle and lower portion of the watershed. The continued development of non-motorized trails that are consistent with habitat and aquatic strategies are also appropriate for the watershed. Additional mitigation possibilities and recreation enhancement opportunities include trail reconstruction and stabilization; improved trailhead parking areas; improved, hardened/limited stream access areas; installation of primitive vault or composting toilets along trails, at trailhead parking areas, or day-use areas; and improved signing and visitor information as needed to reduce cumulative impacts of numerous dispersed sites. Increased presence of law enforcement personnel, both BLM and county, and regular recreation staff patrols would reduce visitor impacts and illegal activities.

Table 1. Molalla Watershed Analysis Summary Key Findings by Sub-watershed

The Molalla River watershed has been divided into 5 assessment areas based on major drainages or tributaries and geomorphology. The 5 assessment areas are further divided into a total of 24 sub-watersheds (Map B). Assessment areas and sub-watershed acreages are listed in the Hydrology section in Chapter 5. This assessment approach provided a logical and systematic review of the condition and needs of each sub-watershed. By analyzing individual sub-watersheds, the team could better identify problem areas and develop area specific recommended actions and optimal prescriptions. In this way, agencies will be able to target certain watersheds to increase resource management effectiveness and best utilize limited funding for restoration work, water quality protection, recreation improvements, silvicultural prescriptions, habitat conservation, and timber harvest.

Table 1 summarizes the overall health and condition of each of the sub-watersheds of the upper Molalla River watershed assessment area. Several key factors were used to determine conditions and trends for each resource category. Heavy emphasis was placed on hydrological and vegetation resources in determining overall condition of a specific watershed, particularly as they relate to water quality and quantity and habitat conditions. For instance, the water quality conditions and trends are determined by the cumulative effect of a number of factors, including the water available for runoff (WAR) values, channel network expansion potential, road density, traffic levels, extent and age of harvested areas, soils and slope stability.

Table 1. Key Findings by Sub-watershed

Tributary Analysis Area	Sub-Watershed Summary of Key Findings	Water Quality Concerns and Erosion Potential[1]	Fish Habitat Conditions and Limiting Factors	Riparian Reserve Vegetation (federal lands)	Vegetation Cover and Condition[2]	Wildlife and Botanical Habitat Conditions and Limiting Factors *	Recreation Use and Opportunities
South Fork Molalla	**Nasty Rock:** This 4,426 acre sub-watershed is in poor to fair condition with trends showing improving conditions. High percentage of federal ownership (76%) combined with Late-Successional Reserve (LSR) classification provide high opportunity for recovery by reducing road density and potential for storm runoff.	• High impact to streamflow due to roads[3]. • Water Available for Run-off (WAR) value: moderate • Low Water Available for Run-off (WAR) impacts • Existing Equivalent Clear-cut Acres (ECA): moderate	• Resident fish only	• 51% classed > 80 yrs, but is fragmented • 44% classed < 80 yrs (altered stand structure) • 3% is classed mature hardwood • Physical connectivity is good, but older forest connectivity is partial. • Nasty Rock SWB is an area of connectivity concern due to lack of older forest habitat • Large Woody Debris (LWD) recruitment potential is high on 40% of acres, but low on 50% • Area is outside Range of Natural Variation (RNV) for late-seral vegetation	• 45 % <40 yrs • 28 % 40 to 80 yrs • 23 % >80 yrs Existing ECA: 17%	• Low % interior forest • Lack of connectivity habitat to the sub-basin downstream • Low open road density (1mi/sec.) • Special status plant sites	• Demand low to moderate and recreation use limited to dispersed activities. • Recreation activities concentrated on hiking and trail use in Table Rock Wilderness and along ridges. Some camping at dispersed sites along Copper Creek and some recreational mining. • Minor recreation related impacts (campsites) concentrated in riparian areas along lower portions of the Copper Creek Fork of the Molalla River. • Mitigation possibilities included ridge trail reconstruction and stabilization; improved, hardened/limited stream access areas; designated campgrounds or camping areas; improved Table Rock Wilderness trailhead parking; installation of primitive vault toilets and signing as needed.
	Ogle Creek: This 5,235 acre sub-watershed is in poor to fair condition with trends showing declining conditions. Low percentage of federal ownership (19%) and possible private land harvest activities indicate little potential to change to road densities or to decrease high runoff or sediment.	• High impact to streamflow and stream sediment due to roads. • Moderate WAR impacts • Existing ECA: moderate	• Fair habitat condition in lower reach; poor in upper. • Resident fish only		• 65 % <40 yrs • 11 % 40 to 80 yrs • 10 % >80 yrs Existing ECA- 17% 1st decade ECA- 21% 2nd decade ECA- 19%	• No interior forest - limiting • No open roads • Low >80 yrs - limiting	
	Copper Creek: This 4,367 acre sub-watershed is in poor to fair condition with trends showing improving conditions. Moderate percentage of federal ownership (22%) provides limited opportunity for recovery by reducing road density and potential for storm runoff. Moderate to high impacts from roads and past management activities are being somewhat mitigated by maturing stands of vegetation.	• High impact to streamflow due to roads • Moderate WAR impacts • Existing ECA: low	• Fair habitat conditions throughout. • Some Winter steelhead (STW) in lower 3 miles.		• 58 % <40 yrs • 26 % 40 to 80 yrs • 5 % >80 yrs Existing ECA-14% 1st decade ECA- 16% 2nd decade ECA- 24%	• Low open road density • Low % interior forest - limiting • Low >80 yrs - limiting	

[1] The mainstem Molalla River and its major tributary streams within the watershed are considered by DEQ as water quality limited for stream temperature.

[2] Equivalent Clear-cut Acres (ECA) analysis was only conducted on sub-watersheds where BLM lands were available for harvest. Projected ECA analysis assumes 50 year rotation on private lands and 80 year rotation on state lands would be available for harvest within the constraints of the existing State Forest Practices Act guidelines.

[3] Sub-watersheds are classified as having highly impacted streamflow when increases in peakflows were estimated to be greater than 20 percent due to harvesting (open areas for water available for runoff or WAR value calculations), or stream network expansion due to roads is greater that 20 percent. WAR values of greater than 15% were considered moderately impacted and less than 15% was considered low impacts. High impacts to stream sediment were listed in sub-watersheds where road erosion was greater than .01 tons of sediment per sub-watershed acre per year. Any sub-watershed with 6 or more observed recent mass movements or slope failures was listed as having many failures.

	Upper Molalla: This 8,400 acre sub-watershed is in relatively stable and fair condition with trends showing improving conditions. High percentage of federal ownership (75%) in LSR and Wilderness classification provide high opportunity for recovery by reducing road density, potential for storm runoff, increasing riparian vegetation/shading and improving fish habitat. However, a high number of slope failures and mass movements indicate steep slope instability.	• Many mass movement failures. • High impact to streamflow due to roads. • High Storm turbidities. • Low WAR impacts • Existing ECA: low	• Good pool % & frequency; poor Large Woody Debris (LWD) volume. • STW & spring chinook (CHS) habitat throughout.		• 28 % <40 yrs • 10 % 40 to 80 yrs • 52 % >80 yrs Existing ECA: 12%	• Moderate open road density • Moderate % interior forest (20) • High >80 yrs • Noxious meadow knapweed weed sites along roadsides	

Tributary Analysis Area	Sub-Watershed Summary of Key Findings	Water Quality Concerns and Erosion Potential	Fish Habitat Conditions and Limiting Factors	Riparian Reserve Vegetation (federal lands)	Vegetation Cover and Condition	Wildlife and Botanical Habitat Conditions and Limiting Factors *	Recreation Use and Opportunities
Middle Fork Molalla	**Lost Creek**: This 4,446 acre sub-watershed is in relatively stable and fair condition with slightly decreasing trends in conditions. Very high percentage of federal ownership (87%). All BLM lands are in LSR classification providing high opportunity for recovery by reducing road density and potential for storm runoff. However, FS lands are in Matrix classification allowing for greater potential harvest activity in the future. High stream turbidities and highly fragmented wildlife habitat are continuing problems.	• High impact to streamflow due to roads. • High Storm turbidities. • Low WAR impacts • Existing ECA: low	• No habitat data. • STW may be present in lower 2 miles.	• 64% classed > 80 yrs (some fragmented areas) • 29% classed < 80 yrs (altered stand structure) • 4% classed as mature hardwood • Physical connectivity is good (large blocks), older forest connectivity is good only inside the wilderness area • LWD recruitment potential is high on 44%of acres, but low on 43% • Area is outside RNV for late-seral vegetation	• 42 % <40 yrs • 6 % 40 to 80 yrs • 38 % >80 yrs Existing ECA-14% 1st decade ECA- 20% 2nd decade ECA- 15%	• Moderate open road density • Moderate % interior forest (18) • High >80 yrs • Special status plant sites	• Recreation demand is moderate with recreation use primarily limited to dispersed activities such as hiking, hunting and camping. • Recreation activities concentrated on hiking and trail use in Table Rock Wilderness and along upper ridges. Some camping at dispersed sites along Table Rock Fork and the Joyce Lake Area. • Minor recreation related impacts (campsites) concentrated in riparian areas along mainstem of the Table Rock Fork and near lakes. • Mitigation possibilities included ridge trail reconstruction and stabilization; improved, hardened/limited stream access areas; designated campgrounds or camping areas; improved Table Rock Wilderness trailhead parking; installation of primitive vault toilets and signing as needed. • Expand acreage of Table rock Wilderness as recommended in the RMP to include areas west and south of Camp Creek.
	Joyce Lake: This 3,532 acre sub-watershed is in poor to fair condition with slightly decreasing trends in conditions. Moderate percentage of federal ownership (49%).All LSR classification on BLM provides reasonable opportunity for recovery by reducing road density and potential for storm runoff and turbidity. However, FS lands are in Matrix classification allowing for greater potential harvest activity in the future. High stream turbidities and highly fragmented wildlife habitat are continuing problems.	• High impact to streamflow due to roads. • High Storm turbidities. • Low WAR impacts • Existing ECA: low	• No habitat data.		• 55 % <40 yrs • 23 % 40 to 80 yrs • 18 % >80 yrs Existing ECA- 12% 1st decade ECA- 13% 2nd decade ECA- 16%	• Low Open road density • Low % interior forest - limiting • High >80 yrs	
	Camp Creek: This 6,461 acre sub-watershed is in fair condition with trends showing somewhat declining conditions. Only a moderate percentage of federal ownership (37%) and possible private land harvest activities indicate only limited potential to decrease to road densities or to decrease high runoff or sediment. Area is a high priority for control of known noxious weed sites. Area identified as having many slope failures. High stream turbidities and highly fragmented wildlife habitat are continuing problems.	• Many mass movement failures. • High Storm turbidities. • Low WAR impacts • Existing ECA: low	• Fair habitat condition in lower reach, poor in upper. • STW present in lower 2.5 miles.		• 37 % <40 yrs • 30 % 40 to 80 yrs • 13 % >80 yrs Existing ECA 8%	• Low open road density • Low (11%) int. forest - limiting • High >80 yrs • Special status plant sites • Spotted and diffuse knapweed sites along roadsides	
	Table Rock Fork: This 8,753 acre sub-watershed is in relatively stable and fair condition with slightly improving trends in conditions. High percentage of federal ownership (74%) with a majority in LSR or Wilderness classification provide high opportunity for recovery by reducing road density and potential for storm runoff. BLM matrix lands in the west side of sub-watershed offer limited potential for harvest. However, numerous slope failures and mass movements combined with high stream turbidities and highly fragmented wildlife habitat are continuing problems. Higher levels of recreation use, good anadromous fish habitat potential and lack of stream shading offer many opportunities and high potential for mitigation, restoration and management.	• Many mass movement failures. • High Storm turbidities. • Low WAR impacts • Existing ECA: moderate	• Generally fair pool % & frequency; poor-fair LWD volume; abundant 2° channels. • CHS in lower 7 miles, STW in lower 10.		• 30 % <40 yrs • 5 % 40 to 80 yrs • 58 % >80 yrs Existing ECA- 20% 1st decade ECA- 21% 2nd decade ECA- 18%	• Low open road density • High (30%) interior forest • High >80 yrs • Known sites for Survey & Manage and Protection Buffer species • Spotted knapweed sites along roadsides	

Tributary Analysis Area	Sub-Watershed Summary of Key Findings	Water Quality Concerns and Erosion Potential	Fish Habitat Conditions and Limiting Factors	Riparian Reserve Vegetation (federal lands)	Vegetation Cover and Condition	Wildlife and Botanical Habitat Conditions and Limiting Factors *	Recreation Use and Opportunities
North Fork Molalla	**Goat Creek**: This 3,115 acre sub-watershed is in poor to fair condition with trends showing declining conditions. Low percentage of federal ownership (3%) and possible private land harvest activities indicate little potential for BLM actions to reduce road densities or to decrease high runoff or sediment.	• High impact to streamflow due to roads. • Low WAR impacts • Existing ECA: low	• No habitat data. • Resident fish only.	• 66% classed > 80 yrs, but most is fragmented • 27% classed < 80 yrs (altered stand structure) • 7% is classed mature hardwood • Physical connectivity is good, but older forest connectivity is partial. • LWD recruitment potential is high on 37% of acres, but low on 43% • Area is outside RNV for late-seral vegetation	• 11 % <40 yrs • 85 % 40 to 80 yrs • 1 % >80 yrs Existing ECA- 5% 1st decade ECA- 52% 2nd decade ECA- 73%	• No open roads • No Interior forest - limiting • Low >80 yrs - limiting	• Recreation demand is extremely low due to restricted public access. Recreation use primarily limited to dispersed activities such as hiking, hunting and camping in the upper reaches of Lukens and Dead Horse Creeks as they can be accessed from the Clackamas River Drainage and FS lands.
	Dead Horse Creek: This 4,899 acre sub-watershed is in poor to fair condition with slightly decreasing trends in conditions before conditions will begin to improve due to maturing stands of vegetation. Significant percentage of federal ownership (49%) of mostly LSR classification provide high opportunity for recovery by reducing road density and potential for storm runoff. However, high stream flows and fragmented wildlife habitat are continuing problems.	• High impact to streamflow due to roads and harvesting. • Low WAR impacts • Existing ECA: high	• Generally poor habitat conditions. • Resident fish only.		• 44 % <40 yrs • 17 % 40 to 80 yrs • 33 % >80 yrs Existing ECA- 21% 1st decade ECA- 29% 2nd decade ECA- 21%	• Low open road density • Low <10% interior forest -limiting • Mod. >80 yrs	
	Lukens Creek: This 7,700 acre sub-watershed is in stable and fair condition with slightly improving trends in conditions. High percentage of federal ownership (66%) combined with all LSR classification provide high opportunity for recovery by reducing road density and potential for storm runoff. However, FS lands are in Matrix classification allowing for greater potential harvest activity in the future. High stream flows and fragmented wildlife habitat are continuing problems.	• High impact to streamflow due to roads. • Low WAR impacts • Existing ECA: low	• Generally poor habitat conditions. • STW in lower 5 miles.		• 42 % <40 yrs • 5 % 40 to 80 yrs • 36 % >80 yrs Existing ECA- 16% 1st decade ECA- 21% 2nd decade ECA- 17%	• Low open road density • High (26%) interior forest • High >80 yrs • Known sites for Survey& Manage Component 1 species	
	Cougar Creek: This 3,963 acre sub-watershed is in poor to fair condition with trends showing declining conditions. Extremely low percentage of federal ownership (4%) and possible private land harvest activities indicate little potential for BLM actions to reduce road densities or to decrease high runoff or sediment.	• High impact to streamflow and stream sediment due to roads. • Moderate WAR impacts • Existing ECA: moderate	• Poor habitat conditions throughout. • STW in lower 3 miles. • Almost all private ownership.		• 66 % <40 yrs • 31 % 40 to 80 yrs • 1 % >80 yrs Existing ECA 15%	• No open roads • No interior forest - limiting • Low >80 yrs - limiting	
	Emerald Creek: This 5,810 acre sub-watershed is in poor to fair condition with trends showing declining conditions. Extensive stream vegetation openings and lack of shading along with high streamflows due to roads present problems. Extremely low percentage of federal ownership (2%) provide little potential for BLM actions to reduce road densities, increase shading or to decrease high runoff or sediment.	• High impact to streamflow due to roads. • Low WAR impacts • Existing ECA: low	• No habitat data. • STW in lower 5 miles. • Almost all private ownership.		• 47 % <40 yrs • 47 % 40 to 80 yrs • 2 % >80 yrs Existing ECA- 14% 1st decade ECA- 15% 2nd decade ECA- 37%	• No open roads • No interior forest - limiting • Low >80 yrs - limiting	

	Lower Dead Horse Creek: This 1,148 acre sub-watershed is in fair condition with trends showing declining conditions. Extensive stream vegetation openings and lack of shading present water temperature problems. No federal ownership (0%) provide no opportunities for BLM actions to reduce road densities, improve habitat, increase shading or to decrease high runoff or sediment.	•High impact to streamflow and stream sediment due to roads. • Low WAR impacts • Existing ECA: low	• Poor habitat conditions • STW throughout (<2 miles). • All private ownership.		• 37 % <40 yrs • 51 % 40 to 80 yrs • 4 % >80 yrs Existing ECA 7%	• No open roads • No interior forest - limiting • Low >80 yrs - limiting	

	Sub-Watershed Summary of Key Findings	Water Quality Concerns and Erosion Potential	Fish Habitat Conditions and Limiting Factors	Riparian Reserve Vegetation (federal lands)	Vegetation Cover and Condition	Wildlife and Botanical Habitat Conditions and Limiting Factors *	Recreation Use and Opportunities
	North Fork Molalla: This 7,112 acre sub-watershed is in fair condition with trends showing declining conditions. Extensive stream vegetation openings and lack of shading present water temperature problems. No federal ownership, provides no opportunities for BLM actions to reduce road densities, improve habitat, increase shading or to decrease high runoff or sediment.	•High impact to streamflow and stream sediment due to roads. • Low WAR impacts • Existing ECA: low	• Poor habitat conditions • CHS in lower 4 miles, STW in lower 12 miles. • All private ownership.		• 17 % <40 yrs • 78 % 40 to 80 yrs • 1 % >80 yrs Existing ECA 6%	• No open roads • No interior forest - limiting • Low >80 yrs - limiting	
	Glen Avon: This 2,318 acre sub-watershed is in poor to fair condition with trends showing declining conditions. Extensive stream vegetation openings and lack of shading along with high streamflows due to roads present problems. No federal ownership provides no opportunities for BLM actions to reduce road densities, improve habitat, increase shading or to decrease high runoff or sediment.	• High impact to streamflow due to roads and harvesting. •High WAR impacts • Existing ECA: high	• Generally poor habitat conditions. • Good pool % in lower 2.5 miles of NF Molalla. • STW & CHS in NF Molalla. • All private ownership in NF Molalla corridor.		• 55 % <40 yrs • 32 % 40 to 80 yrs • 1 % >80 yrs Existing ECA 24%	• No open roads • Low (<2%) int. forest - limiting • Low >80 yrs - limiting	

Tributary Analysis Area	Sub-Watershed Summary of Key Findings	Water Quality Concerns and Erosion Potential	Fish Habitat Conditions and Limiting Factors	Riparian Reserve Vegetation (federal lands)	Vegetation Cover and Condition	Wildlife and Botanical Habitat Conditions and Limiting Factors *	Recreation Use and Opportunities
Upper mainstem Molalla	**Gawley Creek**: This 5,774 acre sub-watershed is in poor condition with trends showing steeply declining conditions. The moderate to high extent of harvested areas and young vegetation combined with the high road densities indicates significant impacts to streamflow. However, the percentage of federal ownership (25%) provides some opportunity for BLM actions to reduce road densities, improve habitat, increase shading and decrease high runoff or sediment. A significant amount of Oregon State managed lands offers other public restoration opportunities.	• High impact to streamflow due to roads. • Low WAR impacts • Existing ECA: moderate	• Good habitat conditions. • STW in lower 2.5 miles.	• 28% classed > 80 yrs • 64% classed < 80 yrs (altered stand structure) • 5% is classed as mature hardwood • Physical connectivity is good along main river corridor, but older forest connectivity is poor • LWD recruitment potential is high on 9% of acres, and low on 73% • Area is outside the range of natural variation (RNV) for late-seral vegetation	• 30 % <40 yrs • 57 % 40 to 80 yrs • 10 % >80 yrs Existing ECA- 16% 1st decade ECA- 46% 2nd decade ECA- 53%	• High open road density >4.5 is limiting • Low (<1%) interior forest is limiting • Low >80 yrs is limiting	• Recreation demand is moderate to high with recreation use primarily limited to dispersed activities such as hiking, horseback/mountain bike riding, fishing, hunting, swimming, picnicking and camping. • Recreation activities concentrated on hiking and trail use along southern end of the Molalla Trail system. Extensive camping, picnicking, fishing and day use activities at numerous dispersed sites along the Molalla River. In addition, some white water boating and floating has occurred on the mainstem Molalla River. • Minor recreation related impacts (campsites) concentrated in riparian areas along mainstem of the Molalla River. • Mitigation possibilities and recreation enhancement opportunities include trail reconstruction and stabilization; improved trailhead parking areas; improved, hardened/limited stream access areas; designated campgrounds or camping areas; installation of primitive vault toilets and signing as needed to reduce cumulative impacts of numerous dispersed sites.
	Horse Creek: This 3,382 acre sub-watershed is in poor to fair condition with initial trends showing somewhat declining conditions followed by improving long-term conditions as vegetation matures. Very high percentage of federal ownership (90%) provides good opportunity for recovery by reducing road density and potential for storm runoff. Moderate to high levels of recreation use, good anadromous fish habitat potential and lack of stream shading offer many opportunities and for mitigation, restoration and management. Area is a high priority for control of known noxious weed sites.	• High impact to streamflow due to roads and harvesting. • Low WAR impacts • Existing ECA: high	**Horse Cr.**: • No habitat data; Res. fish only. **Mainstem Molalla R.**: • Good pool %; fair pool freq.; poor LWD volume. • anadromous fish throughout. • All BLM administered.		• 46 % <40 yrs • 10 % 40 to 80 yrs • 40 % >80 yrs Existing ECA- 24.7% 1st decade ECA- 27% 2nd decade ECA- 20%	• High open road density >3.5 - limiting • Mod. % interior forest • High >80 yrs • Known sites for Survey & Manage Component 1 and Protection Buffer species • Meadow and spotted knapweed sites along roadsides	
	Pine Creek: This 6,454 acre sub-watershed is in poor to fair condition with trends showing steeply declining conditions. Low percentage of federal ownership (9%) and planned increases in private land harvest activities indicate limited potential for BLM actions to reduce road densities or to decrease high runoff or sediment. High level of recreation use along mainstem Molalla in this area present BLM with opportunities to mitigate and manage recreation related riparian impacts with improved facilities and designated camp sties or day-use areas near the mouth of Pine Creek.	• High impact to streamflow and stream sediment due to roads and harvesting. • High Storm turbidities. • Moderate WAR impacts • Existing ECA: high	• Generally poor habitat conditions; good 2º channel %. • STW may be present in lower 1 mile. • All but lower 0.25 mile in private ownership.		• 54 % <40 yrs • 38 % 40 to 80 yrs • 6 % >80 yrs Existing ECA- 25% 1st decade ECA- 29% 2nd decade ECA- 40%	• No open roads • Low % interior forest - limiting • Low >80 yrs - limiting	

	Bear Creek: This 7,238 acre sub-watershed is in poor to fair condition with slightly improving long-term trends in conditions. High percentage of federal ownership (57%) provides high opportunity for recovery by reducing road density and potential for storm runoff. Moderate to high levels of recreation use, good anadromous fish habitat potential and lack of stream shading along the mainstem Molalla River offer many opportunities for mitigation restoration and recreation management.	• High impact to streamflow due to roads and harvesting. • High WAR impacts • Existing ECA: high	**Bear Cr.**: • Good habitat. cond. in lower reaches. • STW may be present in lower 1 mile; access for fish is difficult. **Mainstem Molalla** (all BLM administered): • Good pool %; fair pool freq.; poor LWD volume. • anadromous fish throughout.		• 63 % <40 yrs • 12 % 40 to 80 yrs • 18 % >80 yrs Existing ECA- 28% 1st decade ECA- 32% 2nd decade ECA- 23%	• Low open road density (1.4) • Low % interior forest - limiting • Mod. <80 yrs • Meadow knapweed sites along roadsides	

Tributary Analysis Area	Sub-Watershed Summary of Key Findings	Water Quality Concerns and Erosion Potential	Fish Habitat Conditions and Limiting Factors	Riparian Reserve Vegetation (federal lands)	Vegetation Cover and Condition	Wildlife and Botanical Habitat Conditions and Limiting Factors *	Recreation Use and Opportunities
Lower Molalla	**Lower Molalla:** This 6,972 acre sub-watershed is in poor to fair condition with stable to slightly declining long-term trends in conditions. Significant percentage of federal ownership (31%) provides some opportunity for recovery by reducing road density and potential for storm runoff. Very high levels of recreation use, good anadromous fish habitat potential and lack of stream shading along the mainstem Molalla River offer many opportunities for habitat restoration, improvement to stream shading and recreation management. Areas along mainstem Molalla present BLM with opportunities to mitigate and manage recreation use with improved facilities and trails as well as designated camp sties or day-use areas.	• High impact to streamflow due to roads and harvesting. • High WAR impacts • Existing ECA: moderate	•Generally good habitat conditions; poor LWD volume. • STW & CHS throughout. • Private ownership in lower 7 miles.	• 18% classed > 80 yrs • 74% classed < 80 yrs (altered stand structure) • 2% classed as mature hardwood • 2% classed as young hardwood • Physical connectivity is good along main river corridor, but older forest connectivity is poor • LWD recruitment potential is high on 7% of acres, and low on 77% • Area is outside RNV for late-seral vegetation	• 57% < 40 yrs • 40% = 41-80 yrs • 3% > 80 yrs Existing ECA- 19% 1st decade ECA- 33% 2nd decade ECA- 32%	• Low open road density • No interior forest - limiting • Low >80 yrs - limiting	• Recreation demand is moderate to high along mainstem Molalla River especially in the upper reaches of the analysis area. Recreation use primarily limited to dispersed activities such as hiking, horseback/ mountain bike riding, fishing, hunting, swimming, picnicking and camping. • Recreation activities concentrated on hiking and trail use along southern end of the Molalla Trail system. Extensive camping, picnicking, fishing and day use activities at numerous dispersed sites along the Molalla River. In addition, some white water boating and floating has occurred on the mainstem Molalla River. • Minor recreation related impacts (campsites) concentrated in riparian areas along mainstem of the Molalla River. • Mitigation possibilities and recreation enhancement opportunities include trail reconstruction and stabilization; improved trailhead parking areas; improved, hardened/limited stream access areas; designated campgrounds or camping areas; installation of primitive vault toilets and signing as needed to reduce cumulative impacts of numerous dispersed sites.
	Trout Creek: This 9,335 acre sub-watershed is in poor to fair condition with long-term trends showing stable conditions as vegetation matures. Stream vegetation openings and lack of shading along with high streamflows and sedimentation due to roads present problems. Extremely limited federal ownership (.01%) provides virtually no opportunities for BLM actions to reduce road densities, improve habitat, increase shading or to decrease high runoff or sediment.	• High impact to streamflow and stream sediment due to roads. • Low WAR impacts • Existing ECA: low	• Generally poor habitat cond.; good pool % and freq. in lower 0.25 mile. • STW in lower 2 miles. • All private ownership.		• 52 % <40 yrs • 36 % 40 to 80 yrs • 3 % >80 yrs Existing ECA 14%	• Low open road density • No interior forest - limiting • Low >80 yrs - limiting • Special status plant sites	
	Russell Creek: This 4,630 acre sub-watershed is in poor to fair condition with trends showing stable to declining conditions. Low percentage of federal ownership (13%) combined with higher residential, agricultural and private land harvest activities indicate only limited potential for BLM actions to improve habitat, reduce road densities, or to decrease high runoff or sediment.	• High impact to streamflow and stream sediment due to roads and harvesting. • High WAR impacts • Existing ECA: low	• No habitat data. • Resident fish only.		• 37 % <40 yrs • 57 % 40 to 80 yrs • 0 % >80 yrs Existing ECA- 10% 1st decade ECA- 21% 2nd decade ECA- 37%	• No open roads • No interior forest - limiting • Low >80 yrs - limiting	
	Dickey Creek: This 3,831 acre sub-watershed is also in poor to fair condition with trends showing stable to declining conditions. Extremely low percentage of federal ownership (1%), combined with higher residential, agricultural and private land harvest activities indicate very little potential for BLM actions to improve habitat, reduce road densities, or to decrease high runoff or sediment.	• High impact to streamflow and stream sediment due to roads and harvesting. • High WAR impacts • Existing ECA: low	• No habitat data. • Resident fish only.		• 22 % <40 yrs • 29 % 40 to 80 yrs • 3 % >80 yrs Existing ECA- 13% 1st decade ECA- 15% 2nd decade ECA- 28%	• Low open road density • Low >1% int. forest - limiting • Low > 80 yrs - limiting	

Table 2. Molalla Watershed Analysis Summary Management Recommendations by Sub-watershed for Federal Lands

The Molalla River watershed has been divided into 5 assessment areas based on major drainages or tributaries and geomorphology. The 5 assessment areas are further divided into a total of 24 sub-watersheds. (Map B). Assessment areas and sub-watershed acreages are listed in the Hydrology section in Chapter 5. This assessment approach provides a logical and systematic review of each sub-watershed, allowing for optimal prescription and use of limited management resources. In this way agencies will be able to target certain watersheds to increase resource management effectiveness and best utilize limited funding for restoration work, water quality protection, recreation improvements- silvicultural prescriptions, habitat conservation, and timber harvest.

Table 2 summarizes management considerations, recommendations, and general prescriptions for each of the sub-watersheds of the upper Molalla River watershed assessment area. Management recommendations will be used by the BLM in determining appropriate types and levels of management actions to conduct within the watershed to help improve conditions and trends.

Note: Final forest management prescriptions will be dependent upon actual (not predicted) harvest levels and extent on non-federal lands at the time they are proposed for each sub-watershed. Every future federal action will require additional environmental evaluation (NEPA) for site specific and cumulative effects. Road decommissioning is dependent on private land access rights and requirements .

Table 2. Management Recommendations by Sub-watershed for Federal Lands

Tributary Analysis Area	Sub-Watershed Summary of Key Recommendations	Management Contraints and Parameters	Water Quality and Municipal Watershed Protection	Timber Harvest Activities and Silvicultural Treatments	Fish Habitat Restoration Potential	Wildlife and Botanical Habitat Restoration Potential	Riparian Reserve Vegetation Treatments	Transportaion System and Road Management	Recreation Management Opportunities
South Fork Molalla	**Nasty Rock** • High priority for vegetation restoration as set by Late Successional Reserve (LSR) assessment • Not a priority for recreation improvement or management actions.	• 75.6% Federal ownership • All Late Successional Reserve (LSR).	• Reduce roaded miles near streams and on unstable slopes. • Stabilize road cut and fill slopes. • Upgrade culverts to handle 100 year flows.	• Silvicultural (silv.) treatments in stands <80 years to achieve late successional characteristics.	• Low restoration potential (resident fish only and poor access).	• Follow LSR assessment guidelines and promote old growth characteristics. • Continue monitoring for lynx habitat • Burn ridge openings to maintain meadow habitat • Protect and manage Special Status Species (SSS) at known sites	• High priority to promote late-seral and dispersal habitat connectivity. • Currently a moderate amount of mid-seral density management potential exists. Nasty Rock and Copper Cr SWB show highest priorities • Assess younger age class (< 40 yrs) thinning potential	• Decommission 7 miles of road • Storm proof and close 2 miles of road • No additional public access planned	• Very limited dispersed use in most of analysis area • Batty Butte to Nasty Rock ridge trail reconstruction, stabilization and signing. • Moderate levels of dispersed recreation use primarily along mainstem and Table Rock Wilderness trails. • Develop 20 to 30 unit primitive campground at confluence with Table Rock Fork. • Improve existing Table Rock Trailheads with vault toilets, expanded parking areas and signage. • Improve old skid trail into hiking trail into Table rock Wilderness from Rooster Rock Road near Scorpion Ck.
	Ogle Creek • Moderate priority for road closures and erosion control activities	• 18.6% Federal ownership • Connectivity (CON) and LSR	• Reduce roaded miles near streams and on unstable slopes. • Stabilize road cut and fill slopes. • Upgrade culverts to handle 100 year flows.	• Limited harvest options first decade • Commercial thinning in Matrix • Silv. treatments in LSR stands <80 years to achieve late successional characteristics.	• Low restoration potential (resident fish only).	• Avoid fragmentation • Survey & protect mines for bat habitat.			
	Copper Creek • Some opportunity for regeneration harvest • High priority for road closure/erosion control actions	• 21.9% Federal ownership • All CON	• Reduce roaded miles near streams and on unstable slopes. • Stabilize road cut and fill slopes. • Upgrade culverts to handle 100 year flows.	• Regeneration (regen) harvest options available on BLM • Commercial thinning	• Low restoration potential (fair current conditions and mostly private ownership).	• Avoid fragmentation			

	Upper Molalla • High priority for recreation campground and trailhead improvements near confluence • Highest priority for stream restoration actions • High priority for road closure/erosion control activities • High priority for willing seller/inholding exchange or acquisition to consolidate federal lands.	• 73.0% Federal ownership • All LSR or Wilderness	• Reduce roaded miles near streams and on unstable slopes. • Determine sources of turbidity during storms. • Stabilize road cut and fill slopes. • Upgrade culverts to handle 100 year flows.	• Silv. treatments in stands <80 years, outside of wilderness, to achieve late successional characteristics.	• High restoration potential (good supply of riparian trees in lower 3 mi. and good access).	• Create snag and CWD habitat. • Burn Rooster Rock Meadow to maintain habitat. • Eradicate or control meadow knapweed at all sites			

Tributary Analysis Area	Sub-Watershed Summary of Key Recommendations	Management Constraints and Parameters	Water Quality and Municipal Watershed Protection	Timber Harvest Activities and Silvicultural Treatments	Fish Habitat Restoration Potential	Wildlife and Botanical Habitat Restoration Potential	Riparian Reserve Vegetation Treatments	Transportaion System and Road Management	Recreation Management Opportunities
Middle Fork Molalla	**Lost Creek** • High priority for road closure for wildlife • Resolve BLM/FS inconsistency in management land use allocations of LSR vs. Matrix in sec. 31	• 87.2% Federal ownership. • LSR for BLM • Matrix for USFS	• Reduce roaded miles near streams. • Determine sources of turbidity during storms.	• Regen harvest options in first decade on USFS • Silv treatments in LSR stands <80 years to achieve late successional characteristics. • Commercial thinning in Matrix	• No habitat data. • Low restoration potential (limited anad. fish use; mostly private land within anad. zone).	• LSR - promote old growth characteristics • Burn Baty Butte Trail meadows to maintain habitat. • Protect and manage SSS at known sites	• High priority to promote late-seral and dispersal habitat connectivity. • Currently a limited mid-seral density management potential exists. • Assess younger age class (< 40 yrs) thinning potential	• Decommission 16 miles of road • Storm proof and close 10 miles of road • No additional public access planned	• Moderate levels of dispersed recreation use primarily along mainstem and Table Rock Wilderness trails. • Mitigation possibilities included ridge trail reconstruction and stabilization; improved, hardened/limited stream access areas; designated campgrounds or camping areas; improved Table Rock Wilderness trailhead parking; installation of primitive vault toilets and signing as needed. • Expand acreage of Table Rock Wilderness as recommended in the RMP to include areas west and south of Camp Creek.
	Joyce Lake • Moderate priority for recreation management improvements near Joyce Lake • Moderate priority for road closure for wildlife	• 48.8% Federal ownership • LSR for BLM • Matrix for USFS	• Reduce roaded miles near streams and on unstable slopes. • Determine sources of turbidity during storms. • Stabilize road cut and fill slopes. • Upgrade culverts to handle 100 year flows.	• Regen harvest options in first decade on USFS. • Silv treatments in LSR stands <80 years to achieve late successional characteristics. • Commercial thinning in Matrix	• No habitat data. • Low restoration potential (limited anadromous. fish use).	• Same as above			
	Camp Creek • High priority for road closure for landslide stabilization and wilderness expansion proposal (RMP) • High priority for snag and coarse woody debris enhancement • high priority for noxious weed eradication/control actions. • Eradicate spotted and diffuse knapweed at all known sites.	• 36.6% Federal ownership • All LSR or wilderness	• Reduce roaded miles near streams and on unstable slopes. • Determine sources of turbidity during storms. • Stabilize road cut and fill slopes. • Upgrade culverts to handle 100 year flows.	• Silv treatments in stands <80 years, outside of wilderness, to achieve late successional characteristics.	• Mod. restoration potential (fair habitat. conditions within main anadromous. use area).	• LSR - promote old growth characteristics • Emphasis on snags and CWD • Survey Table Rock for peregrine eyries • Protect and manage SSS at known sites • Eradicate spotted and diffuse knapweed at all sites			

	Table Rock Fork • high priority for landslide stabilization • moderate priority for road closure/erosion control activities • Moderate priority for dispersed recreation camp site improvements • Eradicate spotted and diffuse knapweed at all known sites.	• 74.1% Federal ownership • All LSR or wilderness	• Reduce roaded miles near streams and on unstable slopes. • Determine sources of turbidity during storms. • Stabilize road cut and fill slopes. • Upgrade culverts to handle 100 year flows. • Improve riparian canopy cover.	• Silv treatments in stands <80 years, outside of wilderness, to achieve late successional characteristics.	• Mod. restoration potential in lower 7 mi. (good access)	• Same as above • Protect and manage Survey & Manage (S&M) and protection buffer Component 1 species at known sites • Eradicate spotted knapweed at all sites			

Tributary Analysis Area	Sub-Watershed Summary of Key Recommendations	Management Constraints and Parameters	Water Quality and Municipal Watershed Protection	Timber Harvest Activities and Silvicultural Treatments	Fish Habitat Restoration Potential	Wildlife and Botanical Habitat Restoration Potential	Riparian Reserve Vegetation Treatments	Transportaion System and Road Management	Recreation Management Opportunities
North Fork Molalla	**Goat Creek** • Minimal federal land opportunities	• 3.1% Federal ownership • All matrix	• Reduce roaded miles near streams.	• Limited harvest options first decade. •Commercial thinning only	• Low restoration potential (res. fish only & all private land).	N/A	• High priority to promote late-seral and dispersal habitat connectivity. • Currently mid-seral density management potential is lacking. • Assess younger age class (< 40 yrs) thinning potential	• Decommission no miles of road • Storm proof and close 11 miles of road • No additional public access planned	Recreation demand is extremely low due to restricted public access. Recreation use primarily limited to dispersed activities such as hiking, hunting and camping in the upper reaches of Lukens and Dead Horse Creeks as they can be accessed from the Clackamas River Drainage and FS lands. • Very limited dispersed use, no recreation management or enhancement actions, other than watershed wide general education and information, and enforcement actions are recommended.
	Dead Horse Creek • Moderate priortiy for road closure on steep slopes	• 48.7% Federal ownership • LSR for BLM • Matrix for USFS	• Reduce roaded miles near streams. • Limit increases in canopy openings. • Improve riparian canopy cover.	• Limited harvest options first decade. • Silv treatments in LSR stands <80 years to achieve late successional characteristics. • Commercial thinning in Matrix	• Low restoration potential (resident fish only and poor access).	• LSR - promote old growth characteristics • Emphasis on snags and CWD			
	Lukens Creek • Moderate priority for road closure on steep slopes and landslide stabilization • Opportunity for limited USFS regen harvest • Resolve BLM/FS inconsistency in management land use allocations of LSR vs. matrix in Secs. 7, 17 &19	• 66.2% Federal ownership • LSR for BLM • Matrix for USFS	• Reduce roaded miles near streams and on unstable slopes. • Stabilize road cut and fill slopes. • Upgrade culverts to handle 100 year flows.	• Regen harvest options on USFS first decade • Silv treatments in LSR stands <80 years to achieve late successional characteristics. • Commercial thinning in Matrix	• High restoration potential (good access).	• Same as above • Protect and manage for the Survey & Manage (S&M) Component 1 species at the known sites			
	Cougar Creek • Minimal federal land opportunities	• 4.3% Federal Ownership • All LSR	• Reduce roaded miles near streams. • Limit increases in canopy openings. • Improve riparian canopy cover.	• Silv treatments in stands <80 years to achieve late successional characteristics.	• High restoration potential on pvt. land in lower 3 mi.	N/A			
	Emerald Creek • Minimal federal land opportunities	• 1.6% Federal ownership • LSR for BLM • Matrix for USFS	• Reduce roaded miles near streams.	• Regen harvest options on USFS first decade. • Commercial thinning in Matrix. • Silv treatments in LSR stands <80 years to achieve late successional characteristics	• Mod. restoration potential on pvt land in lower 5 mi.	N/A			

	Lower Dead Horse Creek • No federal land opportunities	• No Federal ownership	N/A	• None	• Moderate restoration potential on pvt. land in lower 1.75 miles (good access in lower 1 mile).	N/A			

	Sub-Watershed Summary of Key Recommendations	Management Constraints and Parameters	Water Quality and Municipal Watershed Protection	Timber Harvest Activities and Silvicultural Treatments	Fish Habitat Restoration Potential	Wildlife and Botanical Habitat Restoration Potential	Riparian Reserve Vegetation Treatments	Transportaion System and Road Management	Recreation Management Opportunities
	North Fork Molalla • No federal land opportunities	• No Federal ownership	N/A	• None	• High restoration potential on pvt. land in lower 4 mi. (good access).	N/A			
	Glen Avon • No federal land opportunities	• No Federal ownership	N/A	• None	• High restoration potential on pvt. land in lower 2 miles of NF Molalla (good access).	N/A			

Tributary Analysis Area	Sub-Watershed Summary of Key Recommendations	Management Constraints and Parameters	Water Quality and Municipal Watershed Protection	Timber Harvest Activities and Silvicultural Treatments	Fish Habitat Restoration Potential	Wildlife and Botanical Habitat Restoration Potential	Riparian Reserve Vegetation Treatments	Transportaion System and Road Management	Recreation Management Opportunities
Upper Mainstem Molalla	**Gawley Creek** • Moderate opportunities for road closure/erosion control actions	• 24.7% Federal ownership • All Matrix	• Reduce roaded miles near streams and on unstable slopes. • Stabilize road cut and fill slopes. • Upgrade culverts to handle 100 year flows.	• Limited harvest options first decade • Commercial thinning	• Low restoration potential (good habitat conditions and poor access).	• Avoid fragmentation • Promote snags and CWD • Reduce number of open roads	• High priority to promote late-seral and dispersal habitat connectivity. • Currently a limited mid-seral density management potential exists. Gawley Cr and Bear Cr SWB show some potential. • Assess younger age class (< 40 yrs) thinning potential.	• Decommission 1.5 miles of road • Storm proof and close no miles of road • No additional public access planned	• Moderate to high levels of dispersed recreation use primarily along mainstem and Molalla primitive camp areas near Molalla River at several locations. • Maintain existing designated primitive camp areas near Molalla River at several locations until suitable alternative camp grounds or areas are developed. • Improve existing Molalla River Trailheads with vault toilets, expanded parking areas and signage. • Continue to develop south end of the Molalla River trail system, crossing Gawley Creek and Horse Creek near mouth with footbridges. • Continue to develop limited Molalla River trail system on south end.
	Horse Creek • Moderate opportunities for road closure/erosion control actions • Moderate opportunities for recreation site/primitive camping improvements along mainstem • High priority for instream restoration projects along mainstem • High priority for willing seller inholding exchange or acquisition • Eradicate spotted knapweed at all sites.	• 90.0% Federal ownership • Matrix and LSR (All BLM)	• Reduce roaded miles near streams. • Limit increases in canopy openings.	• Limited harvest options first decade • Commercial thinning in Matrix • Silv treatments in LSR stands <80 years to achieve late successional characteristics	**Horse Cr.**: • Low restoration potential (resident fish only). **Mainstem Molalla R.**: • High restoration potential (low LWD loading with anadromous fish throughout and good access in parts, fair to poor in others).	• Reduce number of open roads • Promote snags and CWD • Reduce OHV impacts • Protect and manage Survey & Manage species (S&M) Component 1 and Protection Buffer species at known sites • Eradicate or control meadow and spotted knapweed at all sites			
	Pine Creek • Moderate opportunities for recreation site/primitive camping improvements along mainstem Molalla at Pine Ck. confluence.	• 8.7% Federal ownership • All Matrix	• Reduce roaded miles near streams. • Limit increases in canopy openings. • Determine sources of turbidity during storms.	• Limited harvest options first decade • Commercial thinning	• Low restoration potential (steep gradient; limited use by anad. fish and mostly private land).	• Survey and protect bat habitat			

	Bear Creek • High priority for road closure for wildlife (golden eagle) • Moderate opportuntiy for trail development on south side of mainstem • Moderate opportunities for recreation site/primitive camping improvements along mainstem • High priority for instream restoration projects along mainstem • High priority for willing seller inholding exchange or acquisition	• 57.1% Federal ownership • All Matrix	• Reduce roaded miles near streams. • Limit increases in canopy openings.	• No regen harvest first decade • Commercial thinning only	**Bear Cr.**: • Low restoration potential (fair-good hab. cond.; difficult access for/limited use by anad. fish). **Mainstem Molalla R.**: • High restoration potential (low LWD loading with anadromous fish throughout and good access in parts, fair to poor in others).	• Avoid fragmentation • Promote snags and CWD • Reduce OHV impacts • Eradicate meadow knapweed at all sites			

Tributary Analysis Area	Sub-Watershed Summary of Key Recommendations	Management Constraints and Parameters	Water Quality and Municipal Watershed Protection	Timber Harvest Activities and Silvicultural Treatments	Fish Habitat Restoration Potential	Wildlife and Botanical Habitat Restoration Potential	Riparian Reserve Vegetation Treatments	Transportaion System and Road Management	Recreation Management Opportunities
Lower Mainstem Molalla	**Lower Molalla** • high priority for trail development and day use recreation sites • Moderate priority for primitive camp site improvements • Moderate priority for road closures/erosion control actions	• 31.0% Federal ownership • All Matrix	• Reduce roaded miles near streams. • Limit increases in canopy openings. • Improve riparian canopy cover.	• Limited harvest options first decade • Commercial thinning	• Moderate restoration potential (low LWD volume with anadromous fish throughout and good access; private land in lower 7 miles, BLM in upper 3).	• Protect golden eagle habitat • Reduce OHV impacts	• High priority to promote late-seral and dispersal habitat connectivity. • Currently a limited mid-seral density management potential exists. Lower Molalla and Russell Cr SWB show some potential. • Assess younger age class (< 40 yrs) thinning potential.	• No decommissioning or storm proofing of road identified • No additional public access planned	• Moderate to high levels of dispersed recreation use primarily along mainstem and Molalla River trails. • Maintain existing designated primitive camp areas near Molalla River at several locations. • Improve existing Molalla River Trailheads with vault toilets, expanded parking areas and signage. • Continue to develop and maintain Molalla River trail system on north end.
	Trout Creek • Extremely limited federal land opportunities	• 0.1% Federal ownership • All Matrix	• Reduce roaded miles near streams.	• Limited harvest options first decade • Commercial thinning	• Moderate restoration potential on private land in lower 2 mi.	• Protect and manage SSS species at known sites			
	Russell Creek • High priority for willing seller/inholding exchange or acquisition to consolidate federal lands.	• 12.6% Federal ownership • All Matrix	• Reduce roaded miles near streams. • Improve riparian canopy cover. • Limit increases in canopy openings.	• Limited harvest options first decade • Commercial thinning	• Resident fish only.	N/A			
	Dickey Creek • Minimal federal land opportunities	• 1.4% Federal ownership • All Matrix	• Reduce roaded miles near streams. • Improve riparian canopy cover. • Limit increases in canopy openings.	• Regen harvest options first decade • Commercial thinning	• Resident fish only.	N/A			

Chapter 1 Introduction

Watershed Analysis

The purpose of a watershed analysis is to give a federal agency a comprehensive and systematic analysis of a landscape. It is used to guide planning and management of federal lands and analyze cumulative effects of past, present, and future activities on all lands. This helps guide land management activities to successfully meet the intent of the *Northwest Forest Plan* as it applies to this watershed.

Watershed analysis is ecosystem analysis at the watershed scale. This analysis is one of the principal analyses for application of the Aquatic Conservation Strategy (ACS) as described in the *Northwest Forest Plan Record of Decision (ROD) for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl* (USDA, USDA 1994). It is also a principal means used to meet ecosystem management objectives identified in the *Salem District Resource Management Plan/Final Environmental Impact Statement* (RMP/FEIS).

Watershed analysis develops and documents a scientifically based understanding of the ecological structures, functions, processes, and interactions within a watershed. In doing so, this analysis process identifies trends, conditions, and restoration opportunities. The information contained in this report will help in making sound resource management decisions for federal lands contained within the watershed. This analysis also develops restoration and monitoring priorities. This will help move landscape units from existing to desired conditions, identify commodity outputs, identify recreation and other social management recommendations, and recommend Riparian Reserve widths and other ecological considerations.

By developing and documenting a scientifically based understanding of the processes and interactions occurring within a watershed, an interdisciplinary team (IDT) can establish geomorphically and ecologically appropriate Riparian Reserves. It can also provide a common framework for evaluating and managing the federal land within the landscape. The watershed analysis will serve as the basis for developing site-specific proposals and monitoring and restoration needs for a watershed. Cooperation with other landowners is necessary since the analysis addresses the entire watershed. The analysis is designed as a tool for federal agencies and will not be used to direct other owners on the management of their lands.

Watershed analysis is an ongoing and dynamic process. It will be revised and updated as conditions, assumptions, or resource plans change and new information becomes available. This document summarizes a large quantity of information and detailed analysis of complex issues and interrelationships. Full reports and any new information will be added to the Molalla River Watershed Analysis file maintained in the Cascades Resource Area, Salem District Office.

Watershed analysis is not a decision-making process. It is a stage-setting analytical process that offers constraints and provides guidance for future management decisions. The report can only document current watershed conditions and trends. The results can be used to:

* Develop ecologically sustainable programs to produce water, timber, recreation, and other commodities.
* Help program and budget development by identifying and setting priorities for social, economic, and ecological needs within and among watersheds.
* Establish a consistent, watershed-wide context for project-level National Environmental Policy Act (NEPA) analyses, management activities evaluation, Endangered Species Act application, and water quality issues.

How this Document is Organized

The organization of this document was based on guidance contained in the document *Ecosystem Analysis at the Watershed Scale: Federal Guide for Watershed Analysis* August 1995, version 2.2.

Executive Summary. Overviews of the scope of analysis and findings of this watershed analysis.

Chapter 1 - Introduction. A description of watershed analysis, its purpose and intent. Overview of how the document is organized.

Chapter 2 - Characterization. A brief description of the watershed ecosystem.

Chapter 3 - Issues and Key Questions. Reviews the issues and concerns considered when doing this analysis.

Chapter 4 - Historical Conditions. Presents a historical perspective of the past influences and processes that occurred in this ecosystem.

Chapter 5 -Current Conditions. Describes the current condition of the resources of the watershed, according to terrestrial, aquatic, social, and other issues.

Chapter 6 - Potential Conditions and Trends. Projects possible future trends of ecosystem processes in the watershed with application of resource management plans and assumptions on private land management. This incorporates the synthesis and interpretation of all available data and information about the watershed.

Chapter 7 - Management Recommendations. Recommends guidelines for ecosystem management within this watershed based on the findings of the analysis.

Chapter 8 - Data Gaps, Inventory, Monitoring. A list of where information gaps were found during the analysis and what information should be collected in the future.

Appendices include additional reports by specialists, tables, charts, and maps that are not specific to the issues but may provide other useful information and other reference information cited in the analysis.

Scoping

The issue identification and scoping process are a two-phased approach. The first step involved scoping through the IDT of scientists and resource professionals from the BLM and the USFS. Primary team members are staff within the Cascades Resource Area. Secondary members include specialists from other state and federal agencies who have an interest or jurisdictional authority in the Molalla River watershed. The second phase involved sending letters of interest and questionnaires to watershed landowners, other local, county, state, and federal agencies, and interested individuals and organizations. Notices and news releases requesting public ideas and opinion were published in local papers. These individuals, groups, and organizations were encouraged to complete our questionnaire and return it to our office. Continuing public involvement was dependent on returning the questionnaire or notifying the BLM of interest. (See Appendix A for summary of the comments received.)

Not all issues initially identified were carried through the analysis process. Some issues were deferred due to lack of information. Other issues were not addressed because they are not covered by federal law or jurisdiction or appropriate to this scientific analysis of the condition and trends of the Molalla River watershed.

Management Direction - Federal Land Use Allocation

Federal lands within the Molalla watershed are managed by the Salem District of the BLM and by the Mt. Hood and Willamette national forests of the USFS. The BLM manages approximately 43,100 acres and the USFS about 2,500 acres. Approximately 33 percent of the 129,300-acre Molalla watershed is in federal ownership.

Land use is allocated according to the *Northwest Forest Plan* and the BLM/USFS planning documents. The primary allocations within this watershed are Matrix, Late-Successional Reserve (LSR), and Riparian Reserves. The BLM further defines Matrix into General Forest Management Areas (GFMA) and Connectivity (CONN). Overall, the Matrix lands are to be managed for planned timber harvest, and the LSR's for habitat development and preservation. More detailed objectives and management actions/direction for these land allocations are discussed in the *Northwest Forest Plan* and in the agencies planning documents.

Riparian Reserves overlay the Matrix and LSR. They have been identified as a buffer along all standing and flowing water, intermittent stream channels, ephemeral ponds, and wetlands. They are managed to contribute to the attainment of the ACSO as stated in the *Northwest Forest Plan*. The reserves were designated to help maintain and restore riparian structures and functions, benefit fish and riparian-dependent non fish species, enhance habitat conservation for organisms dependent on the transition zone between uplands and riparian areas, improve travel and dispersal corridors for terrestrial animals and plants, and provide greater connectivity of late successional forest habitats. The width of the protection buffer varies depending on stream class and the height of site potential trees. All fish-bearing streams have a minimum width that is the average height of two site potential trees. On non- fish bearing streams, this width is the average height of one site potential tree. Since not all these streams are mapped, some adjustments will be made as site-specific areas are mapped. For this watershed analysis, site tree height was designated as 220 feet for the lands less than 1500 foot elevations, 200 feet for elevations between 1500 and 3000 feet, and 180 feet for all elevations above 3000 feet. Riparian Reserves in the Molalla watershed account for about 19,745 acres or 43.3 percent of the federal lands.

Table 3 Land Use Allocations of Federal Land with/without Riparian Reserves

Land Use Allocation	Riparian Acres	Outside Riparian	Total Acres
LSR	12,848	16,373	29,221
Matrix/GFMA	6,377	8,820	15,196
CONN	520	660	1,180
Total	19,745	25,853	45,597

Chapter 2 Characterization

This chapter describes the dominant physical, biological, and human processes or features of the watershed that affect ecosystem functions or conditions. It includes a review of the most important land allocations, plan objectives, and regulatory constraints that influence resource management. This chapter provides a general overview or "snapshot" of the upper Molalla River watershed.

Location

The upper Molalla River watershed is in northwest Oregon, seven miles southeast of the city of Molalla. The watershed is almost entirely contained within Clackamas County; a very small portion of the headwater of Copper Creek is in Marion County. The analysis area incorporates the entire upper watershed of the Molalla River upstream of the mouth of Cedar Creek (mile 24). Cedar Creek enters the Molalla River from the southwest 1.8 miles downstream from the Glen Avon Bridge near Dickey Prairie. The watershed comprises five distinct analysis areas or sub watersheds: 1) The North Fork Molalla River, 2) Middle Table Rock Fork Molalla River, 3) South Fork Molalla/Copper Creek, 4) Upper and Lower mainstem Molalla River, and 5) Lower Molalla River drainages (Pine, Trout, Horse, Gawley, Bear, Russell, Dickey, and Cedar Creek systems). The watershed is approximately 129,300 acres (202 square miles).

The watershed analysis area includes the upper headwaters of the Molalla River. It flows from the western foothills of the Cascade Range through the communities of Molalla and Canby before joining the Willamette River upstream from Oregon City. The Willamette River Basin is part of the Columbia River subregion. See Map A.

Ownership

Near Cedar Creek, the watershed begins at an elevation of 460 feet and extends southeast to its headwaters at an elevation of 4800 feet. It includes approximately 80,035 acres (62%) of private land; 43,087 acres (33%) of Bureau of Land Management land; 2,511 acres (2%) of national forest land; and 3,666 acres (3%) of land owned by the state of Oregon. About 1/3 of the watershed is in federal ownership. Just more than 6,000 acres are included in the Table Rock Wilderness (TRW) area. Several major forest industrial landowners own significant blocks of land constituting 53 percent (68,968 acres) within the watershed. See Map B.

Current ownership patterns are reflected in Figure 1.

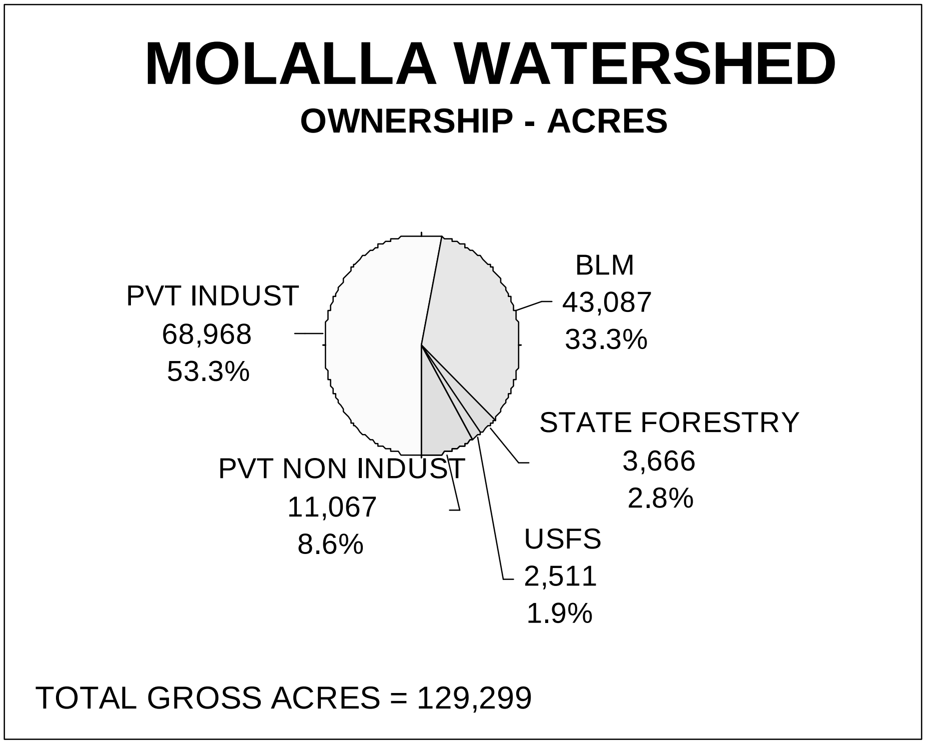


Figure 1

Physical and Biological Characteristics

The upper segments of the Molalla River flow through coniferous forest tracts of varying age classes. When the watershed's tributaries flow by the TRW, the steepness of the stream grade decreases. The mainstream of the river then has a moderate grade, flowing over boulders, passing through narrow gorges created by unusual geologic features, and through wide areas with flat riffles. Below its confluence with the North Fork of the Molalla River, the river flows on a gentle slope through semi-forested and agricultural lands to the Willamette River.

The river area includes portions of two major physiographic zones - the Willamette Valley and the western Cascades. These regions lie between the Clackamas River drainage basin to the north and the North Fork of the Santiam River to the south. This setting supports many native and relict populations of plants and important habitat for many animal species (Franklin and Dyrness 1973).

Dickie Prairie and the Willamette Valley lie at the southwest end of the watershed. This area supports a limited woodland of Oregon white oak and Douglas-fir with bigleaf maple, Oregon ash, and red alder, especially in the riparian areas. This end of the watershed is mainly used for forest operations, farmland, or small rural home sites. From the edge of this valley bottom land up to approximately 3000 feet, the western hemlock (*Tsuga heterophylla*) zone (Franklin &

Dyrness, 1988) is dominated by Douglas-fir, western hemlock, and western red cedar. Above 3000 feet the cooler Pacific silver fir zone (*Abies amabilis*) is composed of mixed stands of noble fir, silver fir, Douglas-fir, and western hemlock. Because of the proximity to the Willamette Valley, the Molalla River watershed basin exhibits ecological characteristics of the Willamette Valley and the western Oregon Cascades. The watershed has many special habitat areas and some older forests. All the water, plants, animals, land, and people within this diverse area make up the watershed ecosystem.

The Clackamas River drainage and its many tributaries are north of the watershed and include the town of Estacada and high rural interface zones. To the west are the Willamette Valley and the communities of Scotts Mills, Silverton, Mt. Angel, and Woodburn. South of the Molalla River, the North Santiam River watershed exhibits scattered federal ownership patterns similar to the Molalla watershed; while to the east, the Forest Service-managed Collawash River and Fish Creek drainages offer extensive recreation opportunities, older forest areas, and the Bull of the Woods Wilderness.

Land Use Allocations

Most of the federal land (29,221 acres) in the North Fork Molalla drainage (Lukens Creek) and immediately to the south and east of the confluence of Copper Creek and the Table Rock Fork is designated LSR. Some acreage (1,180 acres) has been identified as connectivity habitat areas. The remainder of federal lands, about 15,196 acres, is classified as GFMA. In addition, all lands are overlaid with 360-440-foot-wide Riparian Reserves to buffer stream, river, and wetland habitats. This accounts for about 19,745 acres (43%) of federal lands in the watershed.

LSR’s are forests managed for late-successional forest characteristics. Connectivity habitat areas are lands that provide habitats for breeding, feeding, dispersal, and movement of late successional and old-growth wildlife and fish species. GFMA’s are forest lands managed on a regeneration harvest cycle of 70-110 years. A full description of the land use allocations is contained in Chapter 6.

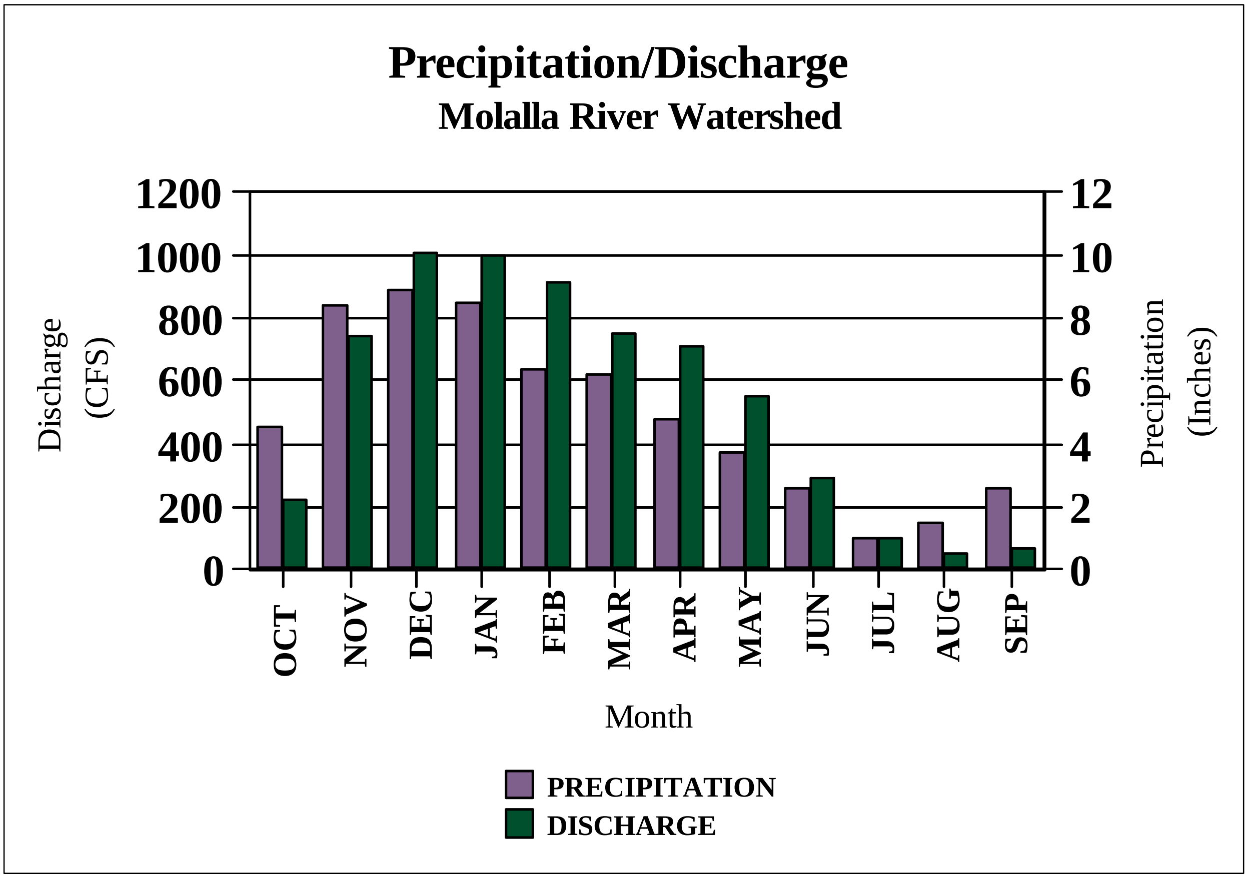
Hydrology and Water Quality

Hydrology

River Profile and Character

The Molalla River is a tributary to the Willamette River, draining a northeast section of the Willamette River Basin in Clackamas County. The headwaters of the 49-mile Molalla River are on the forested lower west slopes of the Cascade Mountains at elevations up to 4800 feet. From its origin in Cascade volcanic deposits of andecite, basalt, and ash, the river flows northwest where it enters the Willamette River at an elevation of 70 feet (USDA-SCS 1985). The stream gradient is mild along the entire river, with the upper 28 miles of the Molalla averaging approximately 1.2 percent, decreasing to .25 percent on the lower 21 miles.

Most of the Molalla sub-basin has been managed as forest land, with the exception of the 6,028-acre TRW in the headwaters. Most of the remaining watershed has been logged and is in younger aged stands of trees. Agriculture is the main land use along the lower elevation Willamette Valley reaches.



: **Figure 2 Average Monthly Precipitation and Discharge for the Molalla River.**

The United States Geologic Survey (USGS) has divided the Willamette River Basin into hydrologic units and assigned each a hydrologic unit code. The Molalla River watershed analysis encompasses the upper Molalla fifth field hydrologic unit 1709000906 and a small portion of the lower Molalla fifth field hydrologic unit 1709000902. For analysis purposes, the Molalla watershed analysis area has been divided into 24 sub-watersheds which will be discussed later in this document.

Climate and Discharge

The climate in the upper elevations of the Molalla sub-basin is characterized by cool temperatures and heavy winter snowfall. The lower elevation Willamette Valley portion is characterized by wet and generally mild winters and dry, moderately warm to hot summers. Average annual precipitation in the sub-basin ranges from approximately 100 inches in the mountains to 40 inches on the valley floor, with the greatest precipitation occurring November through January and the least occurring June through September (Oregon State University 1998). Average total annual stream discharge past a USGS gaging station on the Molalla River near the Trout Creek bridge is 386,500 acre-feet, or 125 billion gallons. The lowest average monthly discharges normally occur June through October, averaging 53 to 293 cubic feet per second (cfs). The highest average discharges occur during December through February, averaging 917 to 1003 cfs (figure 1). Snow pack plays a minor role in overwinter storage of precipitation in the Molalla River watershed. This is shown by the correlation of precipitation and discharge in Figure 2, where changes in discharge mirror changes in precipitation with little seasonal variation in the relationship. Precipitation values used in the graph is from the nearest National Weather Service precipitation station in Estacada, Oregon.

Extreme high flows occur during major storms or rain on snow events and extreme low flows during periods of drought. The maximum discharge recorded at the USGS gaging station from 1936 to 1993 was 24,300 cfs in December 1964, while the minimum recorded was 16 cfs in October 1992 (Hubbard et al. 1994). While the extremes seem dramatic, most of the time stream flow occurs within a narrower range of values (see existing condition section).

Water Quality

Although recent improvements in water quality have been achieved, the Oregon Department of Environmental Quality (ODEQ) recently identified the protection and enhancement of water quality in the Willamette River Basin as one of the most critical long-range resource management issues currently facing the state of Oregon (Tetra Tech 1993).

In the ODEQ publication, *1988 Oregon Assessment of Non-point Sources of Water Pollution* (ODEQ 1988), also known as the 319 Report, water quality in the upper Molalla River is listed as moderately affected by sediment additions. The probable causes include landslides, land uses, and road related runoff. The impacted beneficial uses are fisheries and municipal water sources. The lower section of the Molalla River from the mouth of the river to the city of Molalla is listed as having severe turbidity and erosion and moderately severe low dissolved oxygen, sediment, and low flow problems. Probable causes include landslides, road-related runoff, water withdrawals, dredging, and altered stream physical characteristics.

Oregon's 1998 Water Quality Status Assessment Report (ODEQ 1998), also known as the 305b Report, is a compilation of streams that do not meet the states' water quality standards. The Molalla River is listed as not meeting dissolved oxygen, fecal coliforms, pH, and chlorophyll at river mile 3.5. The affected beneficial uses include municipal water use, water contact recreation, aesthetics, and aquatic life.

Vegetation

Satellite imagery of this watershed reveals a landscape significantly altered over the last century or more. The watershed is crisscrossed by hundreds of miles of roads and a patchwork pattern of timber harvests; 50 years of forest management activities and remnants of past catastrophic fires. Approximately 1/3 of the watershed can be characterized as early seral and 2/3 as early to mid seral stage. This current pattern of vegetation is primarily a result of past logging activities and forest management. Logging began on private lands in the 1930s, accelerated following WWII, and continues today on public and private lands.

There is an equal amount of large and small scale disturbances. Private land owners concentrated their logging in large contiguous blocks while federal lands fragmented their forests with patch clear cuts.

The largest dominant feature is a uniform stand of 40- to 50-year-old conifers that encompass most of the private lands in the North Fork and Lower Molalla sub-basins. This is where logging and forest management first began. This early logging was probably in the largest concentration of old growth close to civilization. It gives us some clues to the fire history of the area. This was probably one of the few unburned areas in the watershed during the settlement era.

The second most dominant feature is the TRW; mostly uncut forest about 100 years old along an east-west oriented ridge. These stands resulted from wildfires during settlement times.

The rest of the landscape can be characterized by patch cutting of 100-year-old stands on public lands, more recent large clearcuts on private lands, and remnant old-growth stands on public lands. These occur at high elevation along the east and southeast boundaries of the watershed. Along the lower Molalla River, some residential areas, farms, and fields are evident.

Geology and Soils

Geologically, the basic parent material of the watershed basin is layered igneous (volcanic) rock. It can be classified into two main groups: hard, weather resistant rock such as basalt or andesite and softer pyroclastic rocks. The alternating layers of basalt/andesite and pyroclastic rocks can create unstable slope conditions that are apparent in the upper Molalla drainage.

Soils

Typical soils in the watershed formed in colluvium (material rolling downhill) from andecite, basalt, and volcanic ash. Soils in river flood plains formed in alluvium (water transported materials). Upper elevation soil series include: Highcamp very gravelly loam and Kinzel very gravelly silt loam. The Soil Conservation Service publication *Soil Survey of Clackamas County Area, Oregon* (USDA-SCS 1985) described these series as deep cold soils found on mountainsides. Lower elevation soil series include: Klickitat stony loam, Kinney cobbly loam, McCully gravelly loam, Fernwood very gravelly loam, Zygore gravelly loam, and Wilhoit gravelly loam. These soils are moderately deep to deep, well drained soils on rolling hills and mountains (USDA-SCS 1985).

Landslides and Erosion

Chronic mass soil movement is an ongoing process. Some landslide activity has been accelerated by forest management activities, especially road building, over the last forty years. Several major geologic hazards exist in the Molalla River sub-basin which effect streams and water quality (Jackson and Anderson 1979). Earth flows and slumps occur in large scattered areas of the sub-basin, resulting in the delivery of soil material to streams through streambank erosion of the toe of the failure. Slope failures occur in steep, mountainous terrain and include rock slides, debris avalanches, and flows. Failures are often rapid and can deliver large quantities of unconsolidated materials to major drainage ways in a short period. Slope erosion including sheet, rill, and gully erosion occurs on exposed slopes, producing increased sediment loads and higher turbidities. Stream erosion and deposition are common within the sub-basin. This also causes higher turbidity, siltation of salmon spawning gravels, and a decrease in channel stability.

Riparian Reserves

- Federal Riparian Reserves are found on BLM and a small amount of USFS land within the Molalla watershed. Riparian Reserve acreage totals 19,745 acres that equates to 43 percent of all federal ownership in the watershed. Of the total, 19,108 acres are on BLM land, and 637 acres are on national forest land.

- The primary human disturbances to the Riparian Reserves have been road building and logging. As a result:

    - Approximately 9,929 acres (50%) of the federal Riparian Reserve stands are older than 80 years. It is estimated that as much as 25 percent of these age classes have had some structure altering by past management as commercial thinning or mortality salvage.

    - Approximately 7,066 acres (36%) of the federal managed stands are younger than 40 years old. These areas are concentrated along the lower main Molalla River on the west side of the watershed and in two large blocks in the higher elevations along the east side of the watershed.

    - Approximately 912 acres (5%) of the federal Riparian Reserves are hardwood dominated.

- Stand structure and, sometimes, species composition, have been altered through these past management practices. Many stands under age 80 and some older-managed stands exhibit a shortage of down LWD and snags in decay classes I and II. Some conifer-dominated acres have been inadvertently converted to hardwoods through past management activities. This is evident in many areas along roaded corridors.

- Because of the blocked ownership pattern of BLM land in this watershed, the Riparian

Reserve network exhibits good physical connectivity within large portions of the watershed and to some adjacent watersheds.

Fisheries and Aquatic Habitat

Winter steelhead trout (*Oncorhynchus mykiss*) and spring chinook salmon (*O. tshawytscha*) are the only anadromous salmonids native to the Molalla Basin. Stocks of both species may be in serious decline, and the native spring chinook may be extinct. Outplanting of hatchery stocks of both species (including summer steelhead) has been extensive in the basin. This has probably been detrimental to the native stocks due to hybridization and competition with the hatchery stocks.

Stream habitat in the basin is in a degraded condition from decades of forest management practices such as timber harvest, road building, and stream cleaning. Streams are lacking large woody debris (LWD). LWD serves to create and maintain a complex habitat, increases the retention of spawning gravel and nutrients, reduces the velocity of high flows, and creates refuge areas for juvenile and adult fish.

Wildlife

Native wildlife species and habitats are typical of the western Oregon Cascades Province. The western portion of the watershed is primarily rural residential and agricultural with some elements (habitats and species) typical of the Willamette Valley Province.

Human Uses and Activities

Cultural

Historically, timber in the lower portions of the Molalla Basin was harvested early in this century after settlement. The area has scattered blocks of recently harvested forest mixed with some mid age and older age forests. The upper reaches were unroaded older forests which were commercially harvested beginning in the late 1950s and 1960s. Most of this upper basin is, therefore, in a younger vegetation age class for the private lands, with federally owned lands having more of the remnant older forest types.

Recreation

A wide range of recreational opportunities and experiences exist in the upper Molalla River watershed. Opportunities range from primitive wilderness areas to slightly developed roaded areas. The environment is a predominately natural forest. There is moderate evidence of human modification associated with timber harvest and road construction activities. No developed recreation facilities exist in the watershed. The watershed is heavily used for dispersed activities. Primary recreational activities include hunting, fishing, hiking, mountain biking, horseback riding, target practice, camping, and some off-highway vehicle (OHV) use.

Most of the roads in the watershed are surfaced with rock and passable by the average vehicle. Public access is restricted to only BLM roads and public lands. Many private roads are closed to public vehicle use by gates. The paved Molalla Forest Road is the primary access artery and parallels the river from Glen Avon Bridge to the confluence of Copper Creek. Many miles of forest and spur roads are maintained by private landowners.

Chapter 3 Issues and Key Questions

The watershed analysis process begins by identifying significant resource issues. These issues are addressed by asking basic and fundamental key questions. These questions focus the analysis on cause-and-effect relationships and on conditions as they relate to the ecological processes occurring in the watershed. The questions have been grouped into three resource categories:

- Terrestrial
- Aquatic
- Social

The issue questions for each category focus on a basic analysis of ecological conditions, processes, and interactions at work in the watershed. This basic analysis is addressed in all watershed analyses. It focuses on the major elements and their relationships in the watershed. This first step in the process should answer the question *What is the condition of the watershed and how did it get this way?* An attempt to answer these questions is done by gathering the current available or identifying data gaps. Current and reference condition/ trends and causal relationships are examined to the extent practicable for each of the resource issue categories.

Considerable overlap and interaction occur among these ecosystem components. For instance, sedimentation is an erosional process, but it affects the water quality. The grouping into categories was used as an organizational aid for easing analysis and promoting easier reading.

Issues and Questions

Terrestrial: Human activities have modified the watershed resulting in changes in quantities**,** distribution, and patterns of occurrence of habitat and species.

Vegetation

What is the array and landscape pattern of plant communities and seral stages in the watershed? What processes and human activities have caused these patterns?

Riparian Condition

What is the condition of riparian areas within the watershed?

Species and Habitats

What is the relative abundance and distribution of terrestrial species of concern that are important in the watershed? What are the distribution and character of their habitats?

Aquatic: Human activities have modified the watershed resulting in declining fish runs, water quality and aquatic habitat degradation, and acceleration of erosional processes.

Erosion Processes

What erosion processes are dominant within the watershed? Where have they occurred or are they likely to occur?

Hydrology

What are the dominant hydrologic characteristics (total discharge, peak flows, minimum flows) and other notable hydrologic features and processes in the watershed?

Stream Channel

What are the basic stream morphological characteristics and the general sediment transport and deposition processes in the watershed?

Water Quality

What beneficial uses dependent on aquatic resources occur in the watershed and what water quality problems exist?

Aquatic Species and Habitats

What are the relative abundance and distribution of aquatic species that are important in the watershed? What are the distribution and character of their habitats?

Social: People depend on social and economic uses of the watershed.

Human Uses

What are the major human uses and use trends in the watershed and where do they occur? What makes this watershed important to people?

Key Questions

The key questions represent the primary purpose of the watershed analysis -- answering the ultimate question, *What are the primary concerns for watershed health and condition and how should BLM and Forest Service lands in the watershed be managed in the future?*

The answers to questions in the initial analysis provide the baseline information needed to address key questions unique to the Molalla River watershed. The answers to the key questions are the heart of the watershed analysis -- providing guidance and recommendations for ecologically sound management of federal lands within the watershed.

There are four primary key questions for the Molalla River watershed:

- Given the watershed's ownership pattern, BLM land use allocations, and resource conditions, what timber harvest pattern and silvicultural treatments can we start while meeting all other resource objectives?

- What and where are the restoration opportunities to improve functioning riparian conditions, maintain viable special plant populations, reduce erosion and best retain structural components for the watershed while providing sustainable timber harvest levels?

- Given the species present, and their habitat conditions and trends, what opportunities exist to restore fish and wildlife habitat conditions?

- Given the social uses and trends and resource conditions, what recreation developments or management opportunities exist to manage human activities best while protecting important resources and meeting recreational demand?

Chapter 4 Historical Conditions

This chapter presents a historical perspective of the past influences and processes that occurred in this ecosystem.

Soils

The Molalla River watershed is in the western Cascade Range. These valleys were carved in the Oligocene to Miocene era volcanic flows and tuffs that have become mineralized. (Baldwin 1984)

Geologic History Overview

Creation of the Cascade Mountains began 40 million years ago during the Eocene era. The curved oceanic Farallan plane began under thrusting the North American continental plate. Early volcanism followed, and lava flowed from a volcanic chain found immediately east of the Pacific continental margin. These small, low volcanoes spaced along a northeast/southeast belt deposited thick accumulations of andesitic tuffs and lava flows that form the base of the western Cascade Mountains. This broad belt shows the subducting Farallan plane was undercutting the continental plate at a shallow angle and at a rapid rate (3 inches/year). During the Eocene (53.5 to 37.5 million years ago) and the Oligeocene (37.5 to 22.5 million years ago) eras, the coastline angled in this northwest/southeast direction through the Willamette Valley to just west of the volcanic vents of the western Cascades. Volcanic ash was flushed out of the vents into marine basins along the coast. Upper continental shelf sands were the final marine sediments to be deposited along the retreating shoreline. During the Oligeocene era, many eruptions of andesitic lavas and siliceous tuffs are interspersed with oceanic sediments in the eastern margins of the valley. (Orr et al. 1992) (Heilman and Anderson 1981)

During the mid-Miocene periods (22.5 to 5 million years ago), more tilting and folding from subduction were followed by volcanic lava flows along with the development of the western Cascades volcanic arc. The growth of the range was modest as the volcanic accumulations sank almost as fast as they piled up. Concurrently with other areas of Oregon, violent eruptions from volcanic cones 13 to 9 million years ago left accumulations unmatched today. However, by 7 million years ago, the belt had narrowed to a band as wide as the present day High Cascades Range. Cascade volcanism is the result of tectonic forces deep in the crust. On the North American plate, the western Cascades were rotated clockwise into their present position. As the rotation began and the angle of the Farallan descending slab became flatter, volcanic activity moved from west to east. This is illustrated by the fact that the oldest rocks in the Cascades are 42 million years old and the youngest are ten million years old on the west edge of the High Cascade Range. Over time, more than six times as much material has erupted in the west

Cascades as in the east. Convergences are slowing from three to one-half inch per year with more slanting angles and less subducting. This slowing down began in the Miocene era and continues to this day. Additional uplift, mild folding, and faulting began 4.5 million years ago during the Pliocene epoch. (Orr et al.1992) (Heilman and Anderson 1981)

Geologic Material--Present Condition

The basic geology and the soils derived from the Molalla watershed are igneous rocks. Sedimentary rock and marine deposits occur in minor amounts. There are two main groups of igneous rocks that occur in the Molalla watershed: (1) extrusive volcanic such as basalt and andesite and (2) extrusive igneous pyroclastic rocks. A third group is the intrusive rocks that have cooled from molten masses beneath the earths surface. This intrusive material is most often found in the Coast Range where intrusions into sedimentary rocks result in erosion of the sedimentary rock and leave the harder igneous rock exposed.

The western portions of the Cascades are underlain by layer of hard extrusive igneous rocks, mainly basalt and andesite, which became crystallized at or near the earth's surface. Andesite has an intermediate composition while basalt has a mafic, darker, more dense composition (COPE 1992). These are exposed along the northern portion and in the higher elevations in the south. Pyroclastic rock is a type of extrusive rock composed of rock fragments erupted from volcanic vents and transported through the air, as if shot through a cannon. (COPE 1992) The material is partially molten when ejected, and individual pieces may fuse to form a weak, porous rock. More often, the pieces are deposited with volcanic ash and form volcanic breccia. These are coarse, angular fragments ¼ to 2 inches in diameter within a matrix of volcanic ash of tuff. The pieces are less than ¼ inch in diameter when imbedded in the ash. The hardness of pyroclastic rocks is dependent on the fusion and compaction of individual pieces at the time of deposition. Usually pyroclastic rocks are soft, and the ash weathers to form clay. Volcanic ash, tuff, and breccia are present throughout the Molalla watershed. Extrusive igneous rocks such as basalt and andesite are often intermixed with pyroclastic rock and considering the two together is often preferable. (Burroughs et al. 1976)

Few places in the Molalla watershed exist where the groundwater is high and sag ponds and hummock ground occurs. Tipped and jack strawed trees and hydrophytic plants are the vegetative indicators for high ground water. Erosion of the base between benches and the stream results in steepening of the slopes and increases the possibility of failure. Tension cracks are occasionally seen at the edge of these benches. (Burroughs et al. 1976)

Alternating layers of extrusive and pyroclastic rocks can have stability problems. If andesite and/or basalt overlies pyroclastic rock, the softer pyroclastic material, especially when wet, would move and slump. This would remove the base of support for the basalt and andesite material above and cause the collapse of large portions of land. Pyroclastic material overlying basalt/andesite may also cause unstable conditions as ground water infiltrates through the pyroclastic material and moves along the contact zone exposed; pyroclastics may slide out onto the road. The height of this zone may make conventional road support structures impractical.

(Burroughs et al. 1976)

Progressive slope failure has been identified in the watershed and can occur in deep soils on steep slopes (such as Kinney gravelly loam) in extrusive igneous material. The first failure may be a bank slump on a road. The loss of support could cause failure of the next block of soil immediately upslope and so on until eventually a series of slumps will occur up to the ridge top. (Burroughs et al. 1976)

Pyroclastic material includes tuffs derived from volcanic ash and breccias of coarse texture and contains angular fragments of hard material. These materials weather rapidly to clay and occur in isolated pockets, extensive deposits, or in layers between other layers of extrusive rock. Because of their rapid weathering and role in slope failure, their location is important to the stability of the area. (Burroughs et al. 1976)

Relationship To Soil Stability

Pyroclastic materials range from dark reddish purple through light yellow to green. While these materials have poor stability, some have observed the green tuffs and breccias to be extremely unstable, although there is not universal agreement on this. Soil color can provide a key to the color of the underlying pyroclastic materials. Clays with a 2.5 Y and 10 YR Munsell color hues generally come from greenish rock. Soils with a 7.5 YR generally are derived from yellowish and reddish rock and are more stable. (Paeth et al. 1971) The relationship between pyroclastic rock and slope stability was done in a USFS study on the H.J. Andrews Experimental Forest by Dyrness. In this study, 94 percent of mass soil movement events occurred on the 37 percent of the area made up of pyroclastic material, and 64 percent of mass soil movement events were on the 8 percent of the area made up of green tuff and breccias. (Dyrness 1967) One field test for identifying pyroclastic material is immersion in water after which a clod will completely disintegrate when testing positive for pyroclastic presence. In addition, many soil types have been identified as derived from breccias and tuffaceous rock. (Burroughs et al. 1976)

Comparative rates of soil movement from various land uses have been inventoried over a twenty-five-year period in the experimental forest in the Cascade Range. Mass erosion rates were calculated to be 0.87 cubic meters per hectare per year for undisturbed forests (based on 32 landslides); 2.45 cubic meters per hectare per year for clearcuts (based on 36 landslides; and 26.19 cubic meters per hectare per year associated with roads (based on 71 landslides). In a summary of several studies, McNutt and McGreer (1985) calculated natural slumping rates of 0.0224 per square mile per year; or one slump in 45 years per square mile in areas of undulating topography with slope gradients of less than 60 percent. Natural failure rates of areas of steep to extremely steep slopes (70 to 100%) occur in old-growth Douglas-fir stands. Based on observations in the H. J. Andrews, slide erosion decreases to undisturbed forest rates 10-15 years after logging and associated activities have ceased. Slide erosion rates decrease for roads as well but at a much slower rate. The slide erosion rate continues to be many times greater than the undisturbed forest rate for more than 20 years after construction, although the decrease does occur after the first few large storms that follow construction and/or reconstruction activities.

Geomorphology

The Molalla watershed comprises an Eola geomorphic surface and the Looney unit. The Eola surface is in the eastern areas of the watershed in the crests and saddles of low foothills. This surface occurs on the remnants of the oldest stable geomorphic surfaces in the area. Extensive erosion during the Pleistocene and Holocene ages after the surface left these remnants. The surface was thought to have originated during the early to middle Pleistocene age. Jory, Bellpine, and Nekia occur at the elevations of 600 to 1,200 feet, and Honeygrove and Peavine occur at elevations of 1200 to 2800 feet. These soils are Ultisols (low base forest soils that have undergone extensive weathering and leaching of bases) which are some of the most productive forest soils in the Molalla River watershed. (SCS 1982)

The Looney unit is in the western half of the watershed. It is not a geomorphic surface because of the variability in age but is used for geomorphic mapping of mountainous terrain. This unit usually adjoins the Eola surface in western Oregon. The terrain is completely dissected and steeply sloping, and geomorphic surfaces are not always recognizable. Erosion is active on most of the unit, and mass soil movement is also evident. The soils were formed in glacial till and colluvium and derived from andesite and basalt mixed with volcanic ash. The soils in Molalla watershed include Keel, Hummington, and Highcamp in the areas above 3000 feet, and Kinney, Klickatat, Quartzville, Blachly, Honeygrove, and Peavine at 1200 to 2800 feet. Three significant breaks are present in the Looney unit: stable, metastable, and active slopes. On stable surfaces with annual precipitation of 60 to 90 inches per year, Honeygrove and Peavine series have developed where Quartzville and Blachly have developed on stable slopes with annual precipitations of 85 to 120 inches. Soils such as Kinney, Harrington, and Klickatat are on the more steeply sloping, metastable, and active slopes. (SCS 1987)

Vegetative Patterns and Wildlife Habitat

The departure from historic disturbance regimes addressed in the following sections has affected the abundance and distribution of wildlife species throughout the Molalla watershed. Species that find their optimum habitat in components of late seral stage forests have been adversely affected through fragmentation, degradation or elimination of preferred habitat. Although this is evident throughout the watershed, it is most obvious in the lower elevations and on private lands. Examples of species affected include the Oregon slender salamander, pileated woodpecker, northern spotted owl, and American marten. Conversely, species such as the black-tailed deer, mountain quail, great horned owl, and the golden eagle may have benefitted from edges and forest openings resulting from the change in disturbance regimes.

Some species present during historic times have been greatly reduced in numbers or extent or have been extirpated due to direct human impacts (primarily hunting, trapping and predator control, and habitat modification). The effects of these practices in combination with the changing disturbance regimes which may have led to changes in use patterns by predators would have had a direct affect on prey species. Predator species including the fisher, martin, gray wolf, and the western rattlesnake have been eliminated, their populations greatly reduced or ranges restricted. Nonnative species such as the bullfrog, starling, house sparrow, opossum, Norway rat, eastern cottontail, and nutria have displaced some native species.

The tree species present are the result of the weather and disturbance factors. From the fire aspect, Douglas-fir develops thick bark, attains great height, and a deep-rooting habit. These characteristics allow tree survival of light to moderate intensity fires. Today's Douglas-fir forests, especially industrial forest on short rotation, are young trees with thin bark that will not resist a moderate intensity ground fire.

Disturbance Regimes and Ecological Effects

Many disturbance factors operate within this watershed. These factors include wind, fire, floods, insects, disease, and humans. Today, humans are the agents of greatest disturbance in the landscape. When human population levels were low, fire was the primary disturbance force. Native Americans used fire to manipulate the ecosystem for beneficial uses through planned ignitions, while in nature, fire occurred naturally, primarily from lightning. Whether planned or not, fire affected a broad range of ecosystems from a few acres to many thousands of acres.

Native Americans recognized the benefits of fire and became accomplished practitioners of prescribed fire. The Kalapuya Indians burned the Willamette Valley for thousands of years before Euro-settlement. This use of fire to manipulate their environment extended up major river drainages such as the Molalla River and extended into the foothills of the Cascades and Coast Range (Boyd 1985). The use of fire maintained an oak-savannah ecosystem. This began changing back to a forested ecosystem (if not plowed) after settlers eliminated the Native American prescribed burning culture with their removal to reservations in the 1850s.

Fire is the primary disturbance factor over the landscape and causes the greatest ecological effects over space and time. Understanding fire ecology terminology is helpful in understanding forest ecology from a historical perspective. A fire regime is a generalized description of the role fire plays in an ecosystem. It is the combination of fire frequency, predictability, intensity, seasonality, and extent characteristics of fire in an ecosystem. There are many descriptions, but the one used here is based on fire frequency and fire intensity (Agee 1981, Heinselman 1981). Fire frequency is the return interval of fire. Fire intensity/severity is the ecological impact of a fire, such as mortality of plant or animal species, changes in species composition, and other ecosystem characteristics.

Wind also has the capacity to disturb large areas of the landscape and on a historical basis has done so approximately every 25 years (Teensma 1987). The last extensive large wind event in Oregon was the Columbus Day storm of 1962, which blew down 11 billion board feet of timber in Oregon and Washington, 98 percent of which was west of the Cascade crest. Other major wind events occurred in December 1996, March 1963, February 1958, April 1957, November 1953, January 1921, and January 1880. (Lynott and Cramer 1966; Hemstrom and Logan 1986). Wind has more influence on coastal forest dynamics than on the forests of the Cascades. Wind is also associated with patch-size disturbances over the landscape as are insects and disease. These three disturbance factors add small complex changes over large spatial and temporal scales and have direct and indirect influences on fire ecology.

The Molalla watershed occupies the dry to wet western hemlock plant association, the warm silver fir plant association, and silver fir/mountain hemlock plant association. There are multiple fire regimes in these zones based on the physical factors of elevation, aspect, orientation of land forms on the landscape, climate, and weather patterns. These factors have significant effects on fire behavior (fire regimes) and therefore fire history (Teensma 1987).

The multiple fire regimes are: 1) infrequent severe surface fires (more than 25 year intervals), 2) long return interval crown fires and severe surface fires in combination (100-300 year return intervals), and 3) small amounts of very long interval crown fires and severe surface fires in combination (over 300-year rotation return intervals). The primary sources of fire ignitions are lightning and humans.

Occurrence or patterns of lightning fires are determined by regional climate, land forms, elevation, aspect, and fuel type. Human-caused ignitions are caused by industrial or land management activities (logging, welding, road building, escaped prescribed burns, etc.), arson, carelessness (debris burning, campfires), and structural fires in the forested landscape. In the Molalla watershed, lightning starts occur occasionally at the higher elevation east portion of the watershed. Human-caused ignitions occur at the lower elevation west portion of the watershed, primarily in the Molalla River recreation corridor.

Fire effects resulting from these fire sources are varied. An infrequent severe surface fire burns on the soil surface, and active burning does not involve the tree crowns. This fire regime would typically occur in places prone to lightning starts and low fuel accumulations (ridges and south slopes). The effects could include: maintaining Douglas-fir as primary tree species by removing thin-barked trees and promoting thick-barked trees; maintaining low amounts of downed wood because of fuel consumption with more frequent burning; and maintain species that sprout and can live under a tree canopy. This fire regime is less dependent on changes in weather patterns (drought) than other fire regimes.

Crown fires and severe surface fires every 100-300 years are more dependent on changes in weather patterns. In this instance, the forest ecosystem accumulates fuel over time. Wind and disease interact more often and contribute to patch dynamics. Legacy trees from the previous disturbance and natural mortality help create a multistoried canopy. Intolerant tree species dominate the lower canopy. As the stand ages, more sunlight reaches the forest floor, and the shrub and herb layer diversifies. Under normal conditions, fire starts cannot develop enough energy to do extensive damage to the landscape because of the required energy to evaporate the high amounts of internal water in the combustion phase of burning carbon-based fuels. With drought conditions and less water to evaporate, fire energy levels are much higher, and the outcome is greater fire effects over a wider geographical area. Fire effects may include: 1) total tree mortality, 2) elimination of the duff and litter layers, 3) reduction of the downed woody component, especially logs in later stages of decay, 4) increased erosion and sedimentation of water courses, and 5) formation of snags.

Many fire history studies have been done on the H.J. Andrews Experimental Forest on the Blue River Ranger District, Willamette National Forest (Teensma 1987, Swanson and Morrison 1980). The H.J. Andrews is approximately 65 air miles SSE of the Molalla watershed. The results from the H.J. Andrews studies correlate with the Little North Santiam. Tables 4-6 (Teensma 1987) give a picture of fire frequency based on elevation, fire frequency based on aspect, and overall fire frequency

Table 4 Comparison of Mean Fire Rotation Intervals by Elevation

Mean Fire Return Interval, Stand-replacing (or partial stand-replacing) Fires
(bars connect elevations with MFRI that are not significantly different)

	Elevation Range, in Meters (feet)					
	< 762 (< 2,500)	762-914 (2,500-2,999)	914-1,066 (3,000-3,499)	1,067-1,219 (3,500-3,999)	1,220-1,371 (4,000-4,499)	> 1,371 (> 4,500)
MFRI (yrs)	209	170	186	171	126	82

Mean Fire Return Interval, All Fires
(bars connect elevations with MFRI that are not significantly different)

	Elevation Range, in Meters (feet)					
	< 762 (< 2,500)	762-914 (2,500-2,999)	914-1,066 (3,000-3,499)	1,067-1,219 (3,500-3,999)	1,220-1,371 (4,000-4,499)	> 1,371 (> 4,500)
MFRI (yrs)	153	121	123	109	82	73

Table 5 Comparison of Mean Fire Return Intervals by Aspect

Mean Fire Return Interval, Stand-replacing (or partial-stand-replacing) Fires
(bars connect aspects with MFRI that are not significantly different)

Aspect	Ridge	South	West	S	East	NE	SE	North	N	Valley
MFRI	116	124	178	W	154	159	151	198	W	227
(years)				162					207	

Mean Fire Return Interval, All Fires
(bars connect aspects with MFRI that are not significantly different)

Aspect	Ridg	Sout	Wes	S	East	NE	SE	North	N	Valle
MFRI	e	h	t	W	110	121	122	132	W	y
(years)	74	94	105	107					148	150

Table 6 Natural Fire Rotation by Period

Cultural Period	Interval (range of dates)	Estimated by Ratio Planimeter		Average
Pre-Anglo	1435-1830	102	89	96
Transition	1831-1850	36	30	33
Pre-fire Suppression	1851-1909	102	71	87
Suppression	1910-1986	768	587	587
"Natural Fires"	1435-1909	95	80	88
Immediate Pre-Anglo	1772-1830	86	69	78
Total for Length of Record	1435-1986	108	91	100

Fire history research shows that fire has occurred more often than earlier believed. Additionally, fire has not been as severe on the landscape (Cascades), and old-growth stands have multiple age classes that are not easily discernable. Research also helps collaborate aerial photo interpretation (1956) and written historical records about the Molalla watershed (survey notes, 1871, 1893, 1943, etc.).

Historically, this watershed was mostly timbered with some prairie. In all likelihood, part of the agricultural land today was a prairie at the time of settlement. The prairie ecosystem (lower elevations) in the northwest corner of the watershed was influenced by Native American burning. This influenced the ecology of the foothill forests and valley floors. Native Americans burned the prairie/forest ecotones to maintain traditional food sources, provide safety from warring tribes, provide better game forage, and ease of travel. The oak savannah (prairie) was burned primarily to maintain foodstuffs and game management of white-tailed deer.

What aspects of the watershed condition were not influenced by Native Americans? 1956 photos show a correlation to the results of Teensmas' fire history study in the H.J. Andrews Experimental Forest. Some correlations are: 1) High ridge tops and south slopes burned more often. This corresponds to young age classes at these locations where tree species are dense and more uniform in age. 2) East-west aspects at high/mid-elevation are next in fire frequency. Forest age, composition, and structure are more diverse and complex than on ridge tops and south slopes. 3) North slopes, valley bottoms, riparian areas, and lower elevations have the longest fire frequency. These parts of the forest are older with the greatest age class distribution, highest species composition, and greatest structural diversity. This forest is stable in that it can absorb a great deal of disturbance before its basic character changes.

On a watershed basis, the Matrix forest cover type at the turn of the century was a mix of young and older forest. There is a sense that there was a large block of younger aged forest on the east half of the watershed. This information was gleaned from cadastral survey notes of the middle and late 1800s and 1956 photos. In addition, there was a rash of large fires in the Cascades from the 1840s to 1910. This is a reflection of the early settlement period and a lack of concern toward wildfire and a loss of forested land.

Age distribution ranged from the silver fir zone at 200-300 years old to early seral stages of brush and young conifers with every conceivable variation between. Cadastral surveys (beginning in 1852 by J. Hunt to the early 1900s) of the townships in this watershed describe many different forest conditions. For T.7 S., R.3 E., General Description of the township by Jesse Moreland in December of 1868 writes "This Township is for the most part over rugged mountainous land; the Southern part being too much cut up with deep rocky canyons to be surveyed. A great part of the timber had been destroyed by fire." In 1857, Ives describes T. 6 S., R. 2 E., as follows, "The last six miles is rolling hilly and broken and mostly descending north. Trap rock are at and near the surface over most of it. The soil is first and second rate clay loam and gravelly stoney. In some places the surface is covered with stone. The timber is fir with a little white oak, cedar, maple, alder. It has all been burnt over and partly thinned out by fire which makes some small openings." William Bushey in 1882 surveying T. 7 S., R. 3 E., Sec 12 and 13, writes "Land mountainous and hilly-Soil 3rd rate. Dense forest of fir, pine, and cedar. Timber all dead. Scattering of hazel and maple brush. These are but a few examples of fire effects on the landscape with many more examples of fire effects throughout the cadastral notes."

From a historical perspective, the watershed was more complex and resilient than it is now. Disturbance did not have an adverse effect but added or maintained complexity and diversity.

Timber harvest has changed the forest to a less complex system. Fire has been virtually eliminated from the ecosystem. Since 1910, the fire return interval has increased from 95-114 to more than 585 years because of the current fire suppression policy. Species diversity has been simplified from many tree species to monocultures of Douglas-fir. Age class distribution has gone from 2.3 age classes per site (Teensma 1987) to one. Older forests are now young to early mid-age (50-100 years). Structural complexity is minimal. Areas that maintained the oldest, most complex ecosystems (primarily riparian areas) were logged first and support our transportation network.

What implications does disturbance have on the present watershed forest? Species composition is more uniform in age and species. Disease could cause greater widespread problems. Fire has large expanses of uniform fuel types in which to burn. If burning conditions are met and an ignition source is available, larger than normal fires could occur. Fire would also have a larger burning window because of dryer conditions created by precommercial thinning or manual release. The federal policy of dispersed smaller clearcuts has created dryer conditions in the remaining older forests. This makes them more susceptible to fire than under natural conditions. The opening of the canopy has also accelerated the blow down of timber.

Fire left a legacy of structural diversity with multiple age classes, snags, and downed wood. This caused multilayered canopies, nesting sites (nags), travel corridors (downed logs), foraging sites (snags, downed logs), germination sites (downed logs), nutrient/water storage (downed logs), mycorrizal activity (downed logs), and an establishment phase that lasted 20-100 years. It has been hypothesized that long establishment periods (brush>hardwoods>conifers) helped control root rots. Earlier timber harvest eliminated most the structural diversity components. Where fire gave diversity and complexity, yielding stability, timber harvest gave the forest simplicity and instability.

The ecosystem selected tree species that could survive disturbance. From the fire aspect, Douglas-fir develops thick bark, attains great height, and a deep-rooting habit. These characteristics allow tree survival of light to moderate intensity fires. The Douglas-fir forests of today do not have the characteristics to sustain a moderate intensity fire from thin bark alone.

There is very little documentation on the historical presence, abundance, and distribution of today’s rare plant and fungal species in western Oregon. For this analysis, a widely accepted assumption that species’ presence and distribution are directly related to the presence, and distribution of suitable habitat has been made.

Before fire suppression and European settlement, there was more available habitat for the species we describe as rare today. Species such as Bradshaw’s lomatium, howellia, Nelson’s sidalcea, golden paintbrush, peacock lockspur, and Willamette daisy inhabited the Willamette Valley prairies and wetlands before European settlement and modern land management practices began. As the Willamette Valley turned into an urban and agricultural center, the amount of habitat for these species decreased dramatically.

Today, oak savannahs and undisturbed low elevation’s wetlands are among the rarest habitats in this watershed. It follows that species that require those habitats have also become rare.

Oregon’s native vegetation evolved with fire. Some rare species are more dependent on fire as a natural disturbance than others. Those species that require fire to create and maintain optimal habitat conditions have lost habitat from fire suppression. It is believed that tall bugbane and Bradshaw’s lomatium and several other rare Willamette Valley and Cascade foothill species have lost habitat because of fire suppression.

The rare species which occupy higher elevation forested habitats include (but are not limited to) cold-water corydalis, noble polypore fungus, and fir clubmoss. It is reasonable to believe that these species were more abundant when there was more high quality suitable habitat available. A high quality habitat for these species could be described as mature forested habitats with a high degree of connectivity, minimal fragmentation and soil disturbance, and a natural fire frequency.

Aster gormanii is another high elevation species, but it inhabits open rocky ridges and meadows.

The habitat for the native vegetation began to degrade with fire suppression. The logging boom in the 1940s and timber activity up to the present progressively degraded the habitat. This was done by fragmenting the forest, allowing trees to encroach on dry meadow habitats, altering hydrological processes through road construction, creating seed beds for exotic species by disturbing soil, and by providing travel corridors and seed vectors for exotic plant species. Human activity along the roads and in the clearcuts has provided excellent opportunities for invasive plant species to infest the ecosystem that, in turn, reduced the quality and amount of available habitat for native vegetation.

Fisheries and Aquatic Habitat

Historically, winter steelhead trout and spring chinook salmon were the only anadromous salmonids that could migrate over Willamette Falls into the Molalla River. Both species used the Molalla River for spawning and rearing. Pacific lamprey also were capable of ascending the falls and entering the Molalla River, but little is known about their historic distribution or abundance.

Little information is available regarding historic abundance of winter steelhead in the Molalla. However, they are believed to have been plentiful and are known to have inhabited many third order and most fourth order and larger Molalla River tributaries not blocked by barrier waterfalls. Historically (and currently) the upstream limit of steelhead distribution in the mainstem Molalla River was Henry Creek Falls, approximately 43.5 miles upstream from the mouth of the Molalla River.

Spring chinook salmon used only the mainstem (up to Henry Creek Falls) and the North Fork Molalla River. Historically their abundance was probably limited by the amount of summer holding habitat (deep mainstem pools) available. A survey by USFWS personnel in 1941 revealed a minimum spawning population of 993 chinook (Willis et al. 1960). Since then, numbers have declined severely. Loss of fish to poachers in summer holding areas is suspected as a probable cause of the decline, coinciding with increased road access to the upper watershed.

Anadromous and resident fish existed in streams that would have had an abundance of large, persistent wood in the channels, particularly in the tributary streams. Log jams were common, particularly in the lower gradient (<2%) sections. Wood, in single pieces and jams, trapped spawning gravel, created pools, and decreased water velocity. Woody debris provided instream cover and helped to dissipate flood flows. Channels would have had a diversity of substrate types, for spawning and invertebrate production, as floods routed landslide debris throughout the system. Stream channels would have been complex, with water flowing around boulders and large pieces of wood. Side channels and off-channel habitats were probably common.

Stream temperatures were likely to be cool in summer. Periodic fires, often followed by landslides, would have affected salmonids due to increased sedimentation and increases in water temperature. However, due to the diversity of fire in the landscape, there were likely to be refugia where fish could escape the impacts of catastrophic events.

The mainstem Molalla River and many of its tributaries were surveyed in 1940-41 by USFWS personnel and in 1958-59 by the Oregon Fish Commission (Willis et al. 1960; McIntosh et al. 1994). Most of the information contained in the survey reports is in narrative form. It appears to be focused on investigation of the potential for increasing the range of anadromous fish distribution.

Riparian Reserves

The historic (pre-1850) Riparian Reserve vegetation of this watershed probably was divided into two distinct community types; those along the higher order streams with distinct flood plains near the valley margins, and those of the uplands along streams characterized by higher gradients and hill slope constrained reaches.

Based on early settlers' reports (Johannessen 1970), the present agricultural and residential lands in the lowlands of the Russell Creek, Dickey Creek, and lower Molalla sub-watershed basins were most likely fire-induced prairies, fire-induced open woodlands, or riparian gallery forests. These gallery forests consisted of a wooded strip of varying width and continuity bordering the gentler, higher order streams which link the valley margins to the mountainous uplands. Where this riparian woodland still exists, its species' composition has changed little. Douglas-fir, Oregon ash, cottonwood, willow, red alder, western red cedar, and bigleaf maple are the dominant species present. The width of the wooded area corresponded to the width of the flood plain (Towle 1982).

As one moves upstream into the watershed, the lowlands quickly give way to an area characterized by higher gradient, hillslope constrained tributaries. Here, flood plains are narrow or nonexistent, and slopes are steep, resulting in vegetation along the stream banks often resembling the up slope vegetation. These areas were dominated mainly by older age classes of conifer vegetation. Douglas-fir, western hemlock, western red cedar, grand fir, Pacific silver fir, and noble fir were the principal conifers present depending on elevation. Hardwoods such as red alder and bigleaf maple could be found scattered or clumped along the narrow flood plains.

One estimate of pre-settlement forest conditions of the west-central Cascades shows that old-growth conifer was the most extensive and most connected of the forest types (Rasmussen 1996). The multi-layered forest stand structure provided by this stand type used to be a dominant part of the landscape. As much as 51 percent of the landscape may have been in this condition, and an additional 20 percent may have been classed as single story late-seral forest. In contrast, the same study estimated early seral stage conditions in pre-settlement times to exist on approximately 6 percent of the landscape in the west-central Cascades.

These figures coincide with results from a regional ecological analysis (REAP) done to determine the range of natural variation (RNV) of the historic amounts of different forest seral stages that could be expected to be found on the pre-1850 landscape (USDA 1993). The results for the adjacent Clackamas River Basin showed that late-seral riparian forest ranged from 35 to 77 percent of stream length. Early seral riparian forest characteristics were found to range from 5 to 15 percent of stream length.

In assessing the spatial distribution of these seral stages, another study cites a source which found that the riparian areas along first and second order streams experienced more disturbance from fire (Ripple 1994). Riparian areas along first and second order streams on steeper southerly aspects would have been the most susceptible to burn and the most likely to maintain a component of early seral vegetation. Riparian forests on north facing slopes and along third order and larger streams harbored most of the older forest types found in pre-settlement times.

Chapter 5 Current Conditions

This chapter describes the current condition of the resources of the watershed according to terrestrial, aquatic, social, and other issues.

Terrestrial

Soils

Where are the major sources of sediment from erosion, landsliding, road runoff, or other management activity found? Where do they occur and where are they likely to occur? What are the processes that affect sediment from erosion, landsliding, road runoff, or other management activity? Where have they occurred, and where are they likely to occur?

Soil development is influenced by the geology, climate, vegetation, organic matter, topography, time, and disturbance such as fire, floods, and landslides. These factors working together produced the soils present in the watershed and continue to alter soil characteristics. Past glaciation in the watershed has influenced soil development, forming steep slopes and poorly sorted shallow soils prone to downslope movement in the upper elevations. Historic fires and volcanic events covering most of the watershed have also affected soil development. Loss of organic matter, vegetative cover, and soil nutrients have periodically affected productivity and soil erosion. Forest management practices and the exclusion of fire have altered soil erosion rates and soil productivity in the past 100 years. Fragile soil conditions on federal land have been identified through the Timber Productivity Capability Class (TPCC) inventory on BLM lands. Map C shows the locations of fragile soil conditions.

Soils in the western lower elevation portion of the watershed are young and poorly developed. They consist of mostly well drained clay loams over clay soils that formed in glacial till or colluvium underlain by tuffaceous igneous rock. Some soils developed in volcanic ash or have low base saturations that affect productivity. The winters are wet and mild, summers moist, and soils generally have some moisture throughout the year depending on cover. Mid-elevation soils consist of young well drained and moderately well drained loams and cobbly loams over cobbly clay loams or cobbly loams. These soils formed in glacial till, colluvium, or volcanic ash over basic tuffaceous igneous rock. Soils in the eastern upper elevation areas are also young, have poor horizon development, have low base saturation, or have formed in ash. The winters are cold and wet, while summers are moist and cool. The cooler climate resulted in slower soil formation and less soil development. Soils consist of well drained and moderately well drained shallow to moderately deep cobbly or stony loams.

General soil stability in the watershed was assessed by grouping soils into classes depending on slope and age of forest cover. Three categories were used: stable, potentially unstable, and unstable. Stable soils occur on less than 60 percent slope, or on 61 to 75 percent slopes with a forest cover greater than 10 years in age. Potentially unstable soils have slopes of 60 to 75 percent and forest cover 10 years old or less, or slopes of 76 to 90 percent and a forest cover greater than 20 years old. Unstable soils have slopes greater than 90 percent, or slopes of 76 to 90 percent and forest cover less than 20 years old. Acres of soils in each stability class are listed in Table 7 by sub-watershed basin (SWB). Map D shows slope hazard for the watershed.

Table 7 General Soil Stability by SWB

Sub-Watershed	Unstable (Acres)	Potentially Unstable (Acres)	Stable (Acres)
Lukens Creek	181	235	7287
Emerald	124	217	5470
Ogle	118	270	4848
Table Rock Fork	88	404	8279
Nasty Rock	85	186	4154
Bear Creek	70	103	7001
Camp Creek	49	128	6267
Cougar Creek	39	139	3785
Dead Horse Creek	36	96	4717
Lost Creek	31	118	4307
North Fork Molalla	26	126	7254
Copper Creek	21	69	4267
Upper Molalla	18	116	8266
Horse Creek	18	34	3333
Joyce Lake	16	50	3462
Gawley Creek	14	59	5759
Lower Molalla	4	6	6902
Goat Creek	2	16	3144
Lower Dead Horse	2	25	960
Russell Creek	0	2	4514
Glenn Avon	0	0	2413
Dickey Creek	0	0	3782
Pine Creek	0	0	6456
Trout Creek	0	0	9342
Total	942	2399	125969

Vegetation

Vegetation Patterns/Seral Stage

What is the present vegetation pattern and seral stage distribution within the watershed? How does this relate to adjacent and larger ecosystems? How do current seral stages, amounts and distribution, special habitats, and vegetation patterns influence the landscape structure, functions, and processes? What are the predominate matrices, patches, and fragments?

Vegetation Composition

Age class distribution is an important component in describing the overall structure of the watershed as an ecosystem. Age classes in the Molalla watershed have been categorized into age class bands corresponding to vegetative seral stage development:

SERAL STAGE	AGE RANGE
Non-forest	Roads, rock, farms, water, etc.
Grass/forb.	<10
Open sapling/brush	11 to 40
Closed sapling	41 to 80
Mature	81 to 199
Old Growth	200 year +
Young Hardwood	<40
Mature Hardwood	>40

Information on vegetative conditions was derived from BLM Forest Operations Inventory (FOI) records updated in 1997 for BLM lands. Vegetative condition on private, state of Oregon, and USFS lands was determined using 1993 aerial photographs and/or Oregon Department of Revenue forest cover maps. All estimates of vegetative cover and stand conditions were made in the winter of 1997/98. Timber harvest and other land uses occurring since then may not be reflected in maps and tables. See Seral Stage Map E and the table, Seral Stage Amounts by Ownership.

Most of the Molalla watershed is in the western hemlock zone. This is characterized by forests with western hemlock in the overstory during the climax seral stage and Douglas-fir as the sub-climax overstory species. Upper elevations are in the Pacific silver fir zone characterized by forests with Pacific silver fir dominating during the climax seral stage. Three major upland plant groupings are in the watershed. At low elevations in the foothills is the Douglas-fir/ocean spray/herbs and grasses (D/OS/H) plant grouping. At mid elevations, forests of the Douglas-fir mixed brush/salal (D/B/SA) plant grouping is dominant. Above 3500 feet, there is a true fir/rhododendron-ceanothus/beargrass (TF/RH/H) component. In addition, minor components of mixed hardwood stands consisting of big leaf maple and red alder exist at low elevations and in riparian zones of larger streams. Minor amounts of Oregon white oak and Oregon ash also occur within the watershed.

Approximately 94 percent of the Molalla watershed is in conifer types - mostly Douglas-fir and western hemlock; approximately 2 percent are hardwood types; and about 4 percent consists of non forest types such as roads, rock quarries, rural residential and agricultural lands, meadows, rock cliff/talus, and other natural openings.

Landscape Structure

The structure and pattern of vegetation or habitats within an ecosystem, such as a watershed, can be characterized as patches, background matrix, and corridors. The pattern of these features strongly influences the ecological characteristics, processes, and energy flows (Forman and Gordon 1986). The underlying cause of current landscape structure is historic disturbance processes. The primary disturbances being fire, wind and insect/disease. The historic disturbance patterns resulting in patch size, location, and tree species distribution influenced past and present timber harvest patterns and harvest progression within the watershed. In addition, disturbance (mainly fire) set the stage for the plant and animal composition and overall vertical and horizontal vegetative structure within the watershed. It is from the context of disturbance that the natural range of watershed ecosystems developed.

The matrix (background) is the most connected portion of the landscape as to vegetative cover and plays a dominant role in landscape function. The predominant matrix across all ownerships in the Molalla watershed consists of open sapling/brush (10 to 40 years old) and closed sapling (40 to 80 years old) stands. The age class distribution between sub-basins is highly variable and generally follows ownership patterns.

Patches varying in size and shape are definable vegetative types that differ in their habitat characteristics from their surroundings (matrix) and are generally isolated from like patches. The most common patch element within the watershed varies from mature conifer (less than one percent) on private and state lands to the early grass/forb stage on federal lands (11%).

Patches of old-growth forest comprise approximately four percent of the watershed and are concentrated on federal land at higher elevations (above 3500 feet).

The drainages and their associated riparian/streamside vegetation provide dispersal/migration corridors for plant and wildlife movement. These corridors can be especially important for reintroduction/recolonization of species extirpated from parts of this watershed or adjacent watersheds. They flow east/west through the Molalla watershed from the Willamette Valley to the Cascade Range or vice versa. The higher elevation ridge top areas to the east and south also serve as corridors. The natural dispersal corridors of plants and animals have also been the main travel corridors of humans. Human incursion has resulted in habitat degradation over time that will be hard to correct in many areas.

FEDERAL LANDS

Seral Stage	Age Class	LUA					
		MATRIX				LSR	
		GFMA		Connectivity			
		Acres	%	Acres	%	Acres	%
Non-forest	*	252	2	44	4	703	2
Early-Grass/Forb.	<10	2066	14	169	14	2379	8
Open Sapling/ Brush	11 ÷ 40	4920	32	465	39	4769	16
Closed Sapling	41 ÷ 80	1466	10	222	19	1788	6
Mature	81÷ 199	5076	33	0	0	15453	54
Old Growth	200+	964	6	282	24	3482	12
Young Hardwood	<40	37	1	0	0	0	0
Mature Hardwood	>40	386	3	0	0	645	2
TOTALS		15167	100	1182	100	29219	100

C Non-forest includes roads, rock quarries, rural residential and agriculture lands, meadows, rock cliffs/talus and other natural openings

SERAL STAGE	OWNERSHIP									
	BLM		USFS		STATE		PRIVATE		TOTALS	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Non Forest*	959	2	40	2	5	0	4306	5	5310	4
Early-Grass Forb.	4803	11	70	3	312	9	8617	11	13802	11
Open Sapling /Brush	9900	23	283	11	652	18	29255	38	40090	31
Closed Sapling	3191	7	23	1	2635	70	34746	43	40595	31
Mature	19766	46	765	30	25	1	1163	1	21719	17
Old Growth	3397	8	1330	53	0	0	2	0	4729	4
Young Hardwood	37	1	0	0	15	1	165	0	217	0
Mature Hardwood	1031	2	0	0	25	1	1781	2	2837	2
TOTALS	43084	100	2511	100	3669	100	80035	100	129299	100

Riparian Reserves

Vegetation Composition, Distribution and Structure

The federal Riparian Reserve system comprises 43 percent of the federal land in this watershed. Being less comprehensive by definition, the Oregon Forest Practices Act (OFPA 1997 revised) designated riparian buffers on private, and state land comprises about four percent of the total land base on these ownerships.

Seral stages were analyzed on both the federal Riparian Reserves and the OFPA riparian management buffers in this watershed. Total acres are shown in Table 8.

Table 8 Seral Stage Acres in Federal Riparian Reserves and OFPA Riparian Buffers, Molalla WAA

Seral Stage	Federal Riparian Reserve Acres	Percent of Total Federal Riparian Reserves	OFPA Riparian Buffer Acres	Percent of Total OFPA Riparian Buffers
Non-Forest	458	2	291	8
Early Grass/Forbs (less than 10 years)	2129	11	193	6
Open Sapling/Brush (11 to 40 years)	4937	25	1016	29
Closed Sapling (41 to 80 years)	1381	7	1404	40
Mature (81 to 199 years)	8021	41	73	2
Old Growth (greater than 200 years)	1908	10	0	0
Young Hardwood (less than 40 years)	36	less than 1	61	2
Mature Hardwood (greater than 40 years)	876	5	467	13

The riparian vegetation within the Molalla watershed is characterized by varied age classes caused by many years of intensive forest management across the watershed. Ownership patterns of the watershed are in large blocks, with private industry having the largest percentage. Much of the north ½ and the south ¼ of the watershed is privately controlled, and most of it was progressively harvested in the past 20 to 50 years. The result is a vegetation pattern of open sapling and closed sapling conifer timber types on these timberlands. At the time of harvest, restrictions governing removal of riparian vegetation were minimal. Uncut riparian buffers were rare, so most land in the OFPA riparian management buffers is dominated by relatively young conifer stands. Approximately 62 percent of the OFPA riparian management areas are dominated by conifer timber types less than 50 years old; only two percent are greater than 80 years old. Hardwood-dominated riparian stands are also present and form 15 percent of private/state riparian ownership.

Most of these riparian areas exhibit a forest stand structure simplified from its original character. Structural attributes that develop as stands mature and become decadent are characterized by large trees, vertical canopy layering, and canopy gaps. A large dead wood component is predominantly absent from this portion of the landscape. Habitat availability for late-successional dependant species and certain riparian functions such as LWD recruitment is low.

In addition, some non-forested agricultural lands are found in the privately owned lowlands of the Lower Mainstem Molalla analysis area; however, they make up a relatively small percentage of the acres. These lands are interspersed with forested acres, so none of the streams, except Dickey Creek, are without riparian zone vegetation for very long reaches.

The blocks of federal ownership in the watershed have sustained dispersed timber harvesting for more than 30 years. Therefore, many areas of young conifer stands are now interspersed among older conifer stands. Many of these units were cut before the *Northwest Forest Plan*, so Riparian Reserve vegetation in these units range from early seral to open sapling conifer. Present stand structural conditions on these managed acres would be similar to those found on private/state managed riparian buffers. Simplified structural attributes on these acres also result in reduced availability of late-successional habitat and diminished riparian function. The 6,028-acre TRW Area is an exception to the present general riparian condition in this watershed. This area has remained unmanaged, and the Riparian Reserve vegetation here is predominantly classed as mature conifer seral type.

Approximately 51 percent of the federal Riparian Reserve network in the watershed is in mature to old-growth seral stages. About 11 percent is early seral. Only five percent of the federal Riparian Reserves is hardwood dominated, and most of these acres are classified as hardwood non-convertible. These numbers seem to show that the seral stage distribution of the Riparian Reserves of the watershed is close to pre-1850 RNV values determined by REAP and other studies previously mentioned. However, the spatial distribution patterns are probably different from historical conditions. There is now less of a late-successional core because of the fragmentation effect of the dispersed past cutting units. Probably most of the younger seral stages in the natural system were concentrated on upper steeper slopes and south aspects rather than being mixed among the older types as they are today.

The amount of good multi-layered structure that exists is probably below the RNV values. Some stands that make up this seral stage have not fully developed all of the structural attributes of older forests, and some older forested stands have had some treatments associated with them. All analysis areas except the Lower Mainstem Molalla have had some commercial thinning/mortality salvage operations within part of the mature and old-growth seral vegetation of the Riparian Reserves. The Upper Mainstem Molalla has the highest percentage of acres treated in this manner.

Both activities would be responsible for altering stand structure. Dead and dying trees were targeted for removal. Many snags were felled for safety and fire hazard reduction purposes. However, some thinning activities would have accelerated residual tree growth rates and would have initiated some understory conifer development. Although these managed stands lost some dead wood components, large tree development and some canopy layering diversity may have been accelerated.

All of the analysis areas have had a large portion of their Riparian Reserve plantations older than 18 years precommercially thinned. The Upper Mainstem Molalla has seen the highest percentage of acres treated, while the Lower Mainstem Molalla has the least.

For all of the analysis areas within the watershed, the age classes below 80 years old exhibit a predominantly simplified stand structure. Older forest structure can generally be found developing in the conifer-dominated stands over age 80 and to be generally present in conifer-dominated stands starting at 120 years. Tables 9 to 13 depict Riparian Reserve age classes by analysis area.

1. Lower Mainstem Molalla Analysis Area (24,552 acres)
   - Land ownership status: 11 percent federal, 89 percent private

Table 9 Vegetation Age Class Distribution, Lower Mainstem Molalla Analysis Area--All Ownerships

	Federal Riparian Reserve		**OFPA Riparian Buffer**	
	Acres	**Percent**	**Acres**	**Percent**
Early-Grass/ Open Sapling (0 to 40 years)	822	55	151	18
Closed Sapling (41 to 80 years)	289	19	282	33
Mature Conifer (81 to 199 years)	276	18	8	1
Old Growth (greater than 200 years)	4	less than 1	0	0
Young Hardwood (less than 40 years)	22	2	39	5
Mature Hardwood (greater than 40 years)	33	2	195	23
Non-Forest	53	4	187	22

OFPA Riparian Buffers: Because of the land ownership patterns, the riparian condition of the OFPA riparian buffers dominates this analysis area's riparian system. Intensive forestry, agriculture, and rural homes have shaped their present character by heavily affecting the original riparian stand structure. Late-successional forest attributes that contribute to habitat and proper riparian functions are absent from this area.

OFPA riparian buffers in this analysis area appear to be outside the RNV with very low amounts of mature/late-seral riparian vegetation.

Riparian Reserves: These acres have also been affected by past intensive forestry practices. Most of the federal Riparian Reserves are on BLM land beside the Molalla River corridor. A large portion of them were acquired by BLM in a land exchange with private industry to block up federal land along the river. These lands were all harvested before the exchange, so they are mostly made up of younger age classes.

The Riparian Reserves of this analysis area appear to be outside the RNV with very low amounts of mature/late-seral riparian vegetation.

2. Middle Fork Molalla Analysis Area (23,199 acres)
   - Land ownership status: 62 percent federal, 38 percent private

Table 10 Vegetation Age Class Distribution, Middle Fork Molalla Analysis Area--All Ownerships

	Federal Riparian Reserve		OFPA Riparian Buffer	
	Acres	**Percent**	**Acres**	**Percent**
Early-Grass/ Open Sapling (0 to 40 years)	1530	25	276	57
Closed Sapling (41 to 80 years)	271	4	165	34
Mature Conifer (81 to 199 years)	2812	46	10	2
Old Growth (greater than 200 years)	1095	18	0	0
Young Hardwood (less than 40 years)	0	0	11	2
Mature Hardwood (greater than 40 years)	270	4	27	5
Non-Forest	148	3	0	0

<u>OFPA Riparian Buffers:</u> Private/state land of this analysis area has been extensively harvested. The structure has been simplified, and late-successional forest attributes that contribute to habitat and proper riparian functions are absent from this analysis area.

OFPA riparian buffers in this analysis area appear to be outside the RNV with very low amounts of mature/late-seral riparian vegetation.

<u>Riparian Reserves:</u> Overall, federal Riparian Reserves in this analysis area have not been heavily affected by past intensive forestry practices. This is because the western block of the area holds a large part of the TRW. However, outside this relatively large core area of unmanaged older forest, the mature/late-seral stages have been largely fragmented by past cutting practices.

With 54 percent of the vegetation more than 120 years old, it appears that the Riparian Reserves may be on the low end of RNV for amounts of mature/late-seral vegetation. However, the amount of these acres that support multi-layered canopy conditions with an adequate dead wood component is likely below the RNV that historic conditions may have shown. In addition, historically there were likely more canopy gaps with brush or younger trees seeding in. There has not been adequate time since the fires of the late 1800s for stand structure to develop fully.

3. North Fork Molalla Analysis Area (36,293 acres)

< Land ownership status: 22 percent federal, 78 percent private

Table 11 Vegetation Age Class Distribution, North Fork Molalla Analysis Area--All Ownerships

	Federal Riparian Reserve		**OFPA Riparian Buffer**	
	Acres	**Percent**	**Acres**	**Percent**
Early-Grass/ Open Sapling (0 to 40 years)	886	27	318	27
Closed Sapling (41 to 80 years)	3	0	577	48
Mature Conifer (81 to 199 years)	1,918	58	24	2
Old Growth (greater than 200 years)	278	8	0	0
Young Hardwood (less than 40 years)	0	0	4	less than 1
Mature Hardwood (greater than 40 years)	215	7	188	16
Non-Forest	11	less than 1	88	7

OFPA Riparian Buffers: Because of the land ownership patterns, the riparian condition of the OFPA riparian buffers dominates this analysis area's riparian system. Intensive forestry and some rural homes have shaped their present character by heavily affecting the original riparian stand structure. Late-successional forest attributes that contribute to habitat and proper riparian functions are absent from this area.

OFPA riparian buffers in this analysis area appear to be outside the RNV with very low amounts of mature/late-seral riparian vegetation.

Riparian Reserves: Overall, federal Riparian Reserves in this analysis area have not been heavily affected by past intensive forestry practices. This history of reduced past management has left this analysis area with older forest on a large percentage of its riparian acres. Approximately half of this older forest is more than 120 years old; however, fragmentation is evident throughout most of the acres.

The Riparian Reserves of this analysis area may be close to the low end of RNV for amounts of mature/late-seral riparian vegetation. This analysis area likely had similar age distributions but differed in other respects. The younger, more uniform age classes were probably more oriented to the steeper slopes of the southeast to southwest aspects. The older, more diverse stands were likely found on the lower areas along the higher order streams and on the more northerly aspects. Today there are probably less of the true old-growth multi-layered stands. The spatial distribution of the earlier seral stages is skewed because of the uniform pattern of cutting units dispersed among the older forest, making today's Riparian Reserves much more fragmented with less interior forest habitat than they had historically.

4. South Fork Molalla Analysis Area (22,417 acres)
   - Land ownership status: 51 percent federal, 49 percent private/state

Table 12 Vegetation Age Class Distribution, South Fork Molalla Analysis Area--All Ownerships

	Federal Riparian Reserve		OFPA Riparian Buffer	
	Acres	**Percent**	**Acres**	**Percent**
Early-Grass/ Open Sapling (0 to 40 years)	1,584	32	319	56
Closed Sapling (41 to 80 years)	579	12	210	37
Mature Conifer (81 to 199 years)	1,991	40	3	less than 1
Old Growth (greater than 200 years)	525	11	0	0
Young Hardwood (less than 40 years)	0	0	2	less than 1
Mature Hardwood (greater than 40 years)	149	3	29	5
Non-Forest	120	2	9	2

OFPA Riparian Buffers: Private and state land has been extensively harvested, and the result is that the structure has been simplified and late-successional forest attributes that contribute to habitat and proper riparian functions are absent from this analysis area.

OFPA riparian buffers in this analysis area appear to be outside the RNV with very low amounts of mature/late-seral riparian vegetation.

Riparian Reserves: Overall, the federal Riparian Reserves in this analysis area have been moderately affected by past intensive forestry practices. This is partly because the western block of the area holds part of the TRW Area. The relatively limited past management practices have resulted in older forest found over about half this area's Riparian Reserves. Approximately half this older forest is more than 120 years old. The older forest habitat outside the wilderness area has been fragmented from past cutting practices.

The Riparian Reserves of this analysis area are likely below the historic RNV for amounts of mature/late-seral riparian vegetation. By today's standards, this analysis area has a relatively large amount of vegetation in the mature/late seral stage but probably less than historic conditions. It also differs in other respects. The younger, more uniform age classes were probably more oriented to the steeper slopes of the southeast to southwest aspects. The older, more diverse stands were likely found on the lower areas along the higher order streams and on the more northerly aspects. Today there are less of these true old-growth multi-layered stands, and the spatial distribution of the earlier seral stages is skewed because of the uniform pattern of cutting units dispersed among the older forest. This makes today's Riparian Reserves much more fragmented with less interior forest habitat than they had historically.

5. Upper Mainstem Molalla Analysis Area (22,836 acres)
   < Land ownership status: 40 percent federal, 60 percent private/state

Table 13 Vegetation Age Class Distribution, Upper Mainstem Molalla Analysis Area--All Ownerships

	Federal Riparian Reserve		**OFPA Riparian Buffer**	
	Acres	**Percent**	**Acres**	**Percen t**
Early-Grass/ Open Sapling (0 to 40 years)	2,244	58	146	38
Closed Sapling (41 to 80 years)	239	6	169	44
Mature Conifer (81 to 199 years)	1,025	28	29	7
Old Growth (greater than 200 years)	5	less than 1	0	0
Young Hardwood (less than 40 years)	14	less than 1	5	1
Mature Hardwood (greater than 40 years)	209	5	29	8
Non-Forest	125	3	7	2

<u>OFPA Riparian Buffers:</u> Private and state land has been extensively harvested, and the result is that stand structure has been simplified and late-successional forest attributes that contribute to habitat and proper riparian functions are absent from this analysis area.

OFPA riparian buffers in this analysis area appear to be outside the RNV with very low amounts of mature/late-seral riparian vegetation.

<u>Riparian Reserves:</u> These acres have been highly affected by past intensive forestry practices. Most of the federal Riparian Reserves are on BLM land beside the Molalla River corridor. Some of them were acquired by BLM in a land exchange with private industry to block up federal land along the river. These lands were all harvested before the exchange so they mostly consist of younger age classes.

The Riparian Reserves of this analysis area appear to be outside the RNV with low amounts of mature/late-seral riparian vegetation.

Connectivity

No late-seral riparian connectivity exists within this watershed on private or state-managed lands. Under the OFPA harvesting guidelines, some late-seral riparian structural attributes will develop over time within the OFPA riparian buffers. However, connectivity of high quality late-seral habitat is not anticipated to develop. See Map F.

On federal land, this watershed exhibits good Riparian Reserve and aquatic system connectivity. This is due to the large blocks of federal ownership instead of the usual checkerboard pattern of BLM ownership found in many other watersheds. Excellent connectivity is maintained up the mainstem of the Molalla River from the northwest corner of the watershed. This pattern continues up the Copper Creek Fork and the Table Rock Fork as there are no breaks in ownership. The South Fork Analysis Area and the Middle Fork Analysis Areas combine to create the largest block of federal ownership in the watershed. Here, riparian connectivity is excellent between sub-basins as the main river corridors maintain connections to the uplands via all of the small tributaries and their associated Riparian Reserves.

Other smaller blocks of federal land maintain good connectivity in selected areas of the watershed, to the watersheds to the east, and to a lesser degree with the watersheds to the south. The blocks of contiguous sections will help to provide for good uninterrupted dispersal corridors up and down some main riparian corridors of the watershed.

While most analysis areas exhibit good physical connectivity of the Riparian Reserves, the connectivity of mature/late-seral vegetation varies from almost nonexistent in some, fragmented in others, to relatively good in part of the Middle Fork. A consideration that might affect the quality of the present and developing mature/late-seral habitat connectivity would be the effect of roads, many of which closely follow the main river corridors.

1. Lower Mainstem Molalla Analysis Area

    - Contiguous federal ownership within the main Molalla River corridor helps maintain good Riparian Reserve connectivity from the lowlands in the northwest corner of the watershed to the Upper Mainstem analysis area.

    - Some upland connectivity from tributaries to the east and west sides of the Molalla River, but the federal ownership is limited as you get away from the main river in this analysis area.

    - Scattered mature/late-seral vegetation exists (18%), resulting in very poor mature/late-seral connectivity.

2. Upper Mainstem Molalla Analysis Area

   - Continued federal ownership maintains contiguous riparian connectivity from the Lower Mainstem analysis area to the South Fork and Middle Fork analysis areas.

   - With Riparian Reserves branching out along connected tributaries, better upland connectivity to the main river exists due to more extensive federal ownership.

   - Scattered mature/late seral vegetation exists (28%), resulting in poor mature/late-seral connectivity.

3. South Fork Molalla Analysis Area

   - Contiguous Riparian Reserve connectivity along the main river from the Upper Mainstem analysis area for about 50 percent of the way into this analysis area. The blocked federal ownership here allows for uninterrupted upland Riparian Reserve connectivity with the Middle Fork analysis area to the north. Amounts of mature/late seral vegetation are moderately high (51%), but past dispersed cutting practices have fragmented the older forest connectivity.

   - A privately owned block of approximately twelve square miles breaks the Riparian Reserve connectivity along the main river corridor.

   - Good connectivity with the watershed to the east is provided by a small block of federal ownership (Nasty Rock SWB) on the eastern part of the analysis area. However, there is limited mature/late-seral connectivity. This block was identified in the Mid-Willamette LSRA as a general connectivity area of concern due to lack of late-successional and dispersal habitat.

   - Scattered federal sections on the south part of the analysis area provide some limited connectivity with the watershed to the south. These scattered Riparian Reserves offer limited mature/late-seral connectivity.

4. Middle Fork Molalla Analysis Area

   - There is contiguous Riparian Reserve connectivity along the main river from the Upper Mainstem analysis area for about 60 percent of the way into this analysis area. The blocked federal ownership allows for uninterrupted upland Riparian Reserve connectivity with the South Fork analysis area to the south. This block, which contains a large portion of the TRW Area, also supports the watershed's largest area of uninterrupted mature/late-seral Riparian Reserve vegetation. A few scattered clearcuts are found only on the perimeter of this analysis area, leaving a large unmanaged core area of older forest with good riparian/aquatic connectivity.

< A privately owned block of approximately nine square miles breaks the Riparian Reserve connectivity along the main river corridor.

< Good connectivity with the watershed to the east is provided by a large block of federal ownership (Lost Creek and Joyce Lake SWB) on the eastern part of the analysis area; however, there is limited mature/late-seral vegetation connectivity.

5. North Fork Molalla Analysis Area

< The only federal land is a contiguous block of about 12 square miles. This block shows no connectivity to other federal blocks within the watershed.

< The two main river corridors on federal land, Deadhorse Creek and Lukens Creek, provide good east/west connectivity with the watershed to the east. Their upland Riparian Reserve system further solidifies the aquatic connectivity of the whole block.

< Amounts of mature/late seral vegetation are relatively high (66 %), but past dispersed cutting practices have fragmented the older forest connectivity.

Stream Channel LWD Potential

Recruitment of LWD into a particular stream reach occurs when wood is floated downstream from an upstream reach or when trees next to the stream fall into the channel. The source of trees are the adjacent Riparian Reserves and the OFPA riparian buffers. LWD is recruited from these areas within approximately 30 meters of the stream channel (FEMAT 1993). The best quality LWD is considered to originate from mature seral conifer stands with tree diameters greater than 24 inches. Younger conifer stands may not have trees of sufficient size to provide full benefits to the ecosystem. Recruitment may be poor because little mortality of the larger tree sizes available tends to occur. Conifers are preferred to hardwoods because they last longer in the aquatic environment. Lands dedicated to rural homes and intensive agriculture are considered to have low LWD potential.

The vegetation of the Riparian Reserves and the OFPA riparian buffers within 30 meters of stream channels was analyzed by species and age. Acres classified as conifer dominated and greater than 120 years old were flagged as having “high” LWD recruitment potential. Acres dominated by a mixed conifer/hardwood type greater than 80 years old and those dominated by conifer stands between 80 and 120 years old were flagged as “moderate” LWD recruitment potential. Acres dominated by hardwoods, non-forest, or conifer stands below 80 years old were flagged as having “low” LWD potential at this time.

In the Molalla watershed, 55 percent of the Riparian Reserves exhibit a low potential to provide LWD to stream channels, 14 percent are providing a moderate potential, and 31 percent exhibit a high potential (Table 14).

Table 14 Current Potential for LWD Recruitment Within 30 Meters of Stream Channels, Molalla Watershed - all Ownerships (Percent of Riparian Reserves or OFPA Riparian Buffers)

Analysis Area	Federal Riparian Reserves			OFPA Riparian Buffers		
	High	**Moderate**	**Low**	**High**	**Moderate**	**Low**
Molalla WAA	31	14	55	1	2	97
Lower Mainstem Molalla Analysis Area	7	16	77	0	1	99
Upper Mainstem Molalla Analysis Area	9	18	73	1	7	92
South Fork Molalla Analysis Area	40	10	50	0	1	99
Middle Fork Molalla Analysis Area	44	13	43	0	5	95
North Fork Molalla Analysis Area	37	20	43	1	2	97

On private/state lands, LWD recruitment potential has been heavily affected through past management on all analysis areas. Most of these acres support a low recruitment potential due to young age classes of vegetation.

On federal lands, the Lower Mainstem and the Upper Mainstem Analysis Areas have been affected the most with decreased LWD recruitment potential. Here, approximately 75 percent of the acres are classed as low potential due to the younger age classes present and less than 10 percent are classed as having high potential. The remaining three analysis areas exhibit much more high LWD recruitment potential; however, approximately 50 percent of these acres are classed as low potential.

Species and Habitats

Special Habitats

A special habitat is a habitat that has a function not provided for by plant communities and successional stages (Brown et al.1985). Special habitats are usually non-forest types such as meadows (wet and dry), wetlands, rock outcrops, cliffs, and talus slopes.

Special habitats can be found throughout the Molalla watershed. Most of the wetlands occur within the lower **a** of the watershed, whereas most of the dry meadows, rock outcrops, cliffs, and talus slopes can be found in the upper **a** - beside the higher ridges and peaks. Some more significant special habitat complexes occur within the TRW and near Nasty Rock. Wetlands usually increase or decrease with cyclic beaver populations/activity. (See Table 15 for details.)

Table 15 Special Habitats (all ownerships)

Non Forest Rock	Permanent Wetland	Seasonal Wetland	Shallow Soils/ Rocky	Surface Water	Talus Slopes	Total
178	1535	608	5324	191	227	8063

Habitat Quality (Influences on Older Forest Interior)

Natural disturbance, timber harvest patterns, and road building have created the mosaic of older forest patches (includes the mature and old-growth seral stages) found within the watershed. Where an older forest patch is surrounded by younger age classes, the edge effect on the older patch exhibits conditions that are different from the interior of the patch. (Climatic influence may affect habitat quality up to 600 feet into a forest patch). As older forest patches decrease in size and amount, edge and open areas increase. As a result, species associated with older forest habitats (habitat specialists) will be adversely affected. Species associated with edge and open areas (habitat generalists) will be favored.

The amount of interior older forest habitat in relation to total older forest habitat shows the quality of the remaining habitat and the influence of edges. Edge effect on the remaining older forest was modeled to determine the amount of interior older forest and the influence of the edge effect. This analysis revealed that 43 percent of the remaining 23,163 acres of older forest is in the high quality interior forest condition. Most of the interior older forest (80 years and older) habitat is found in four of the sub-basins - Camp Creek (11%), Lukens Creek(19%), Table Rock (27%), and Upper Molalla (19%), all of which are within designated LSRs.

Big Game Habitat

Inputs from the age class analysis were used to calculate the habitat effectiveness for cover using the Wisdom Model (Wisdom et al.). The Wisdom Model is used to determine effectiveness of habitat primarily for deer and elk. As Table 16 below reflects, federal lands in the Molalla watershed are considered highly viable, whereas the watershed as a whole would be considered marginal.

Table 16 Habitat Effectiveness

Owner	Optimal			Thermal			Hiding			Other			HE
	Acres	%		Acres	%		Acres	%		Acres	%		
		of total	by owner		of total	by owner		of total	by owner		of total	by owner	
Federal	25258	95	55	3214	8	7	10183	25	22	6940	31	<1	1
Other	1230	5	1	37381	92	45	29907	75	36	15186	69	<1	0
All	26488		20	40595		31	40090		31	22126	18	<1	0

HE: <.1 Non-viable
.2 to .3 Marginal
.4 to .5 Viable
.6 to .9 Highly Viable
1.0 Optimal

Open road densities relate to harassment and disturbance associated with roads being usable by vehicles. The habitat effectiveness index derived from open road densities is at or near .6 which is a threshold value between highly viable and viable. Approximately 60 percent of the lands and 64 percent of the roads within the watershed are closed to public vehicle traffic and an additional +-20 percent are seasonally closed (generally November through May due to snow). All this results in a very low exposure of wildlife to harassment.

Standing Dead (snags) and Down Logs (course woody material)

Data from inventory plots, stand exams, and anecdotal information were used to estimate the amount of standing dead (snags) and down logs (course woody material) in the watershed. Estimates of the amount and condition of standing dead snags across the watershed were correlated with Neitro et al. 1985 to estimate existing percent of potential cavity nesting bird populations. Estimates show that the Molalla watershed is between the 20-30 percent level (cavity nesting birds). The standing dead component was found to consist mostly of material in more advanced stages of decay within older stands and small diameter snags within younger stands.

Estimates of the amount and condition of coarse woody material (CWM) was compared to the Salem District RMP standard of 240 lineal feet per acre of hard material more than 20 inches on the small end. It is estimated that the watershed’s condition is at less than 25 percent of this standard. Often, down log material exceeds 200 lineal feet per acre across all age classes. However, most of the large material is in more advanced stages of decay.

Large standing dead and down logs in the early stages of decay generally occurred as impulses of material after a wildfire. Fire exclusion over the last eighty years has essentially eliminated this source. Large, hard snags provide habitat over the long term and are important for future habitat and nutrient capital both within the forest and in the streams. The most functional down log is an old snag that has fallen.

Animals

Special Status Species, Special Attention Species, and Species of Concern

A list of wildlife species known or suspected to occur was compiled using BLM Wildlife Observations (WOBS) and Oregon Natural Heritage Program (ONHP) databases, various wildlife field guides and texts, knowledge of the habitats present, GIS information, and field reconnaissance. The resulting list is included in Appendix B. This list includes one Federal Endangered, one Federal Threatened, ten Federal Species of Concern, 26 Bureau Sensitive species, 3 Bureau assessment species and 12 Bureau tracking species. Species documented to occur in the watershed are denoted with a “D” in Appendix C.

Northwest Forest Plan Survey and Manage

The only known survey and manage sites are for two mollusk Component 1 and 2 animal species are listed in table C-3 of the ROD. However, the Molalla watershed is considered within the historic range of seven additional species.

The red tree vole, a Survey and Manage strategy one species, is suspected to occur in the watershed. The red tree vole is considered a late successional associate, and there is suitable habitat present, primarily below 3500 feet elevation. The Molalla watershed was screened according to the *Interim Guidance for Red Tree Voles*. It was viable with 38 percent of the watershed in federal ownership, of which 62 percent is suitable habitat for the red tree vole. The great gray owl, a protection buffer species, is not known to occur in the watershed. Sightings of this species have occurred in adjacent watersheds to the east and south. A nesting pair has been identified to the west of the watershed. The silver-haired bat and Pacific western big-eared bat, which are identified as in need of additional protection in the NFP, are suspected to occur in the watershed. Also, the long-eared myotis and long-legged myotis, which were also identified as in need of additional protection, are suspected to occur in the watershed. Five NFP survey and manage mollusk species (one snail and four slugs) are suspected to occur in the watershed and are listed in Appendix C. Two of these are known to occur - the blue/gray tail-dropper and the papiloose tail-dropper. All of the species are terrestrial and are thought to be associated with big leaf maple trees and sword ferns. (Initial surveys for mollusks within the watershed show the target species are present in a much wider range of habitats.) Surveys in adjacent watersheds (Abiqua/Butte) have revealed that up to 48 percent of suitable habitat surveyed contains one or more of these mollusk species. Therefore, it can be assumed that similar habitat within the Molalla watershed would have similar results.

For the purposes of this analysis, all special status, survey and manage, or species associated with older forests or standing dead and/or down logs were considered species of concern in the Molalla watershed. In addition, the golden eagle is also listed as a species of concern in the watershed. The golden eagle, a species more typical of open areas east of the Cascades, is known to occur and breed in the watershed.

Habitat for the lynx (proposed for listing) may exist within the watershed and is thought to be limited to areas greater than 4500 feet in elevation. The Molalla watershed contains approximately 698 acres of potential habitat. However, there are no known sites within the watershed.

Threatened and Endangered Species

The peregrine falcon, a federally endangered species, is likely to occur as a rare migrant and could possibly occur in the watershed during the breeding season. It has been documented in watersheds to the north and east. Many cliffs qualify as suitable habitat in the watershed.

Bald eagles (listed threatened) are suspected as rare migrants in the watershed and have been observed in the lower portions of the watershed. There are no known nest sites within the watershed.

Northern Spotted Owls

The overall habitat condition for northern spotted owls was analyzed across the watershed. Age classes and forest types were classified as suitable for nesting, foraging and roosting, dispersal, or non-suitable habitat.

Approximately 20 percent of the watershed is considered suitable habitat for nesting, foraging and roosting, 34 percent is dispersal, and 45 percent is non-suitable habitat. Of the non-suitable habitat present in the watershed, 40 percent could grow into habitat suitable for spotted owls (this is known as capable habitat). Results are shown in Table 17.

Table 17 Spotted Owl habitat by Ownership.

	BLM/FS		Private/State		Total	
	Acres	%	Acres	%	Acres	%
Nesting	18,946	42	103	0	19,049	15
Foraging	6,311	14	1,038	1	7,349	6
Dispersal	4,243	9	39,225	47	43,468	34
Capable	14,697	32	38,638	46	53,335	40
Non-capable	1,403	3	4,820	6	6,223	5
Totals	45,600	100	83,824	100	129,424	100

Table 18 Spotted Owl Habitat on Federal Lands by Land Use Allocation.

	Matrix				LSR		Total	
	GFMA		CONN					
	Ac.	%	Ac.	%	Ac.	%	Ac.	%
Nesting	2798	18	184	17	15966	55	18946	42
Foraging	3808	24	0	0	2502	9	6311	14
Dispersal	1851	12	222	20	2170	8	4243	9
Capable	6983	44	614	57	7100	25	14697	32
Non-capable	351	2	63	6	989	3	1403	3
Total	15791	100	1083	100	28727	100	45600	100

Approximately 56 percent of the federal land in the watershed is considered suitable habitat for nesting, foraging and roosting, 9 percent is dispersal and 35 percent is non-suitable habitat. Of the non-suitable habitat present on federal land, 91 percent could grow into habitat suitable for spotted owls over varying lengths of time (capable).

The Molalla watershed provides some dispersal to/from the known owl sites (KOS) to the south and east. Dispersal of spotted owls is severely limited by the Willamette Valley to the west. Most of dispersal between known spotted owl sites in the Cascade physiographic province takes place between the large LSRs east of the watershed.

Some federal lands in the watershed are designated as critical habitat for the northern spotted owl (CHU-12). They total 23,720 acres, of which 21,810 acres are included in LSRs. Critical habitat outside of LSRs (1,910 acres) are considered as Matrix (see Land Use Allocation Map G) according to the *Northwest Forest Plan*.

There are 15 KOS in the watershed, 10 of which are considered active, one is inactive, and the status of four is unknown. All but one of the 15 sites are on BLM land; the other is on USFS land. Of the 15 sites, 12 are within the LSR land use allocation. The other three are in the Matrix. The KOSs were established by buffering the site center with the provincial home range radius for the northern spotted owl. The provincial home range radius for the Cascade Province is 1.2 miles. The results were compared with USFWS guidelines for determining incidental take and for estimating current site viability. A KOS that has an intact 70- to 100-acre core area and the equivalent of 40 percent suitable habitat within its provincial home range radius is considered viable.

Of the 15 active KOS centers in the watershed, 10 were found viable. Current acres of capable habitat, suitable habitat, and number/condition of KOSs in the Molalla watershed were calculated, and the results are shown in Table 19.

Table 19 Current Status of the Spotted Owl and Its Habitat Within the Molalla Watershed

	Total	Total Protected	Total Unprotected
Acres within Boundary	**129,299**	**28,727 (22%)**	**100,571**
Acres of Federal	**45,600**	**28727 (63%)**	**16,873 (37%)**
Federal Spotted Owl Habitat Capable Acres	**44,197**	**27,737 (63%)**	**16,460 (37%)**
Total Suitable Spotted Owl Habitat Acres	**26,398**	**25,257 (96%)**	**1,141 (4%)**
Federal Suitable Spotted Owl Habitat Acres	**25,257**	**18,467 (73%)**	**6,790 (27%)**
Total Spotted Owl Sites	**15**	**12(80%)**	**3(20%)**
Spotted owl sites (>40%)	**10**	**9**	**1**
Spotted owl sites (30-40%)	**4**	**3**	**1**
Spotted owl sites (20-30%)	**0**	**0**	**0**
Spotted owl sites (<20%)	**1**	**0**	**1**

Four known introduced wildlife species are of concern. The bullfrog is found at lower elevations in the watershed and is known to prey on and displace native species such as the red-legged frog and western pond turtle. The European starling and house sparrow are known to displace cavity nesting birds such as violet-green swallows, purple martins, and bluebirds. They are also found at lower elevations in the watershed, usually near human settlements. The starling has also been observed at mid to high elevations. The eastern cottontail is thought to have displaced the native brush rabbit at lower elevations in the watershed.

Invertebrates

Little is known about the occurrence of the various invertebrate species in the Molalla watershed. A list of invertebrate species that could occur in the watershed was developed based on very limited information. (Also see section on Survey and Manage).

Special Status Species (SSS)-Plants

> *What Special Status Species (SSS), SEIS Special Attention Species (SSAS), and Species of Concern (SOC) are known or suspected to occur in the watershed? How will land use objectives and management guidelines in the SEIS, the Salem District ROD, and on privately managed lands influence future habitat for SSS, SSSA, and SOC?*

Special Status Species, Special Attention Species, and Species of Concern

There are ten known populations of BLM special status plant species populations and numerous known survey and manage species sites in the Molalla watershed. Based on a literature review of the habitat requirements of the SSS known to occur in the province, a list of potential species has been identified for the Molalla watershed and its special habitats (Appendix D). This list includes Federal Endangered, Federal Threatened, Federal Proposed Threatened, and Bureau Sensitive species. Included in Appendix D is a list of Survey and Manage Species known or suspected to occur in the Cascades Resource Area. It is based on Table C-3 of the *Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl.*

Allotropa virgata, candystick is an SEIS Special Attention Species. *Allotropa virgata* occurs in closed canopy, pole, mature, and old-growth seral stages in coniferous forests throughout the Pacific Northwest. Most of the plant grows underground in close association with conifer roots and mycorrhizal fungi; only the inflorescences become visible when the plants flower. There are two known *Allotropa* sites in the Molalla watershed; one in the GFMA and another in the LSR.

Aster gormanii, Gorman's aster is a Species of Concern endemic to the north-central Oregon Cascade Mountains. *Aster gormanii* is restricted to scattered open areas on ridge crests, mountain summits, and slopes between 3900 and 5500 feet in elevation. The known range of *A. gormanii* is characterized by very steep and rugged topography. There are at least three populations and many *Aster gormanii* sites in the Molalla watershed All of the *Aster gormanii* populations in the Molalla watershed are in stable condition; one is in the TRW and the rest are in the LSR.

Cimicifuga elata, tall bugbane, is a Species of Concern found in forested areas in western Oregon, Washington, and British Columbia. More than one hundred populations are documented in Oregon. *Cimicifuga elata* is a temperate forest herb found in forest gaps in moist sites with well-drained soils. *C. elata* occurs in small populations at moderate to low elevations. Although populations are found within coniferous forests, deciduous tree species are nearly always present in the local overstory. One population of *Cimicifuga elata* is known to occur in the Molalla watershed. Two sites are on roadsides within the river corridor.

Corydalis aquae-gelidae, cold-water corydalis, also has a dual status as a Bureau Species of Concern and an SEIS Special Attention Species. *C. aquae-gleidae* is a species restricted to cold, flowing springs, seeps, and streams ranging from the west slopes of the southern Washington

Cascades down to the west slopes of the central Oregon Cascades. Sightings of *Corydalis aquae-gelidae* have not been documented in the Molalla watershed analysis area since the mid-1970s.

Delphinium pavonaceum, peacock larkspur, is a Species of Concern. This species grows in low, wet flood plain areas in the Willamette Valley. There are two documented occurrences in the Molalla watershed. Both sites are on roadsides and private land.

Douglasia laevigata, smooth-leaved douglasia, is a tracking species. This species grows on talus slopes, rocky alpine areas, and on river and coastal bluffs. It ranges west of the crest of the Cascade Range from Olympic Mountains and Cascades in Washington south to the central part of the Cascades in Oregon. There are two known sites of *Douglasia laevigata* in the Molalla watershed; one in the TRW and the other in the LSR.

Huperzia occidentalis, fir clubmoss, is an assessment species. Fir clubmoss grows on a variety of substrates from rocks to rotten logs in humid areas on the west slopes of the northern Cascades in Oregon, northern Idaho, and northwestern Montana. There are several documented sites of *Huperzia occidentalis* in the Molalla watershed, all of which are in the LSR.

Poa laxiflora, loose-flowered bluegrass, is a tracking species which is most commonly found in the Coast Range. Loose-flowered bluegrass grows in moist woods and rocky open slopes from low to mid-elevations in Alaska south to Benton County in Oregon. One occurrence of *Poa laxiflora* is documented in GFMA in the Molalla watershed.

Sullivantia oregana, Oregon sullivantia, is a Species of Concern. *Sullivantia oregana* inhabits moist cliffs in the Columbia River Gorge and the lower Willamette Valley. One disjunct population has been documented in the TRW.

Exotic and Introduced Species of Concern

Noxious weeds and exotic species may threaten native plant communities and wetlands, replace forage for wildlife, create fire hazards, reduce recreational enjoyment, compete with crops, and poison livestock. Noxious weeds usually do not become established in native plant communities in western Oregon until there is disturbance. Some weed species become established after a disturbance and may become tenacious.

Noxious weeds spread primarily along roads, through the spreading of infested gravel, and through other ground-disturbing actives such as the yarding of timber.

There are no known sites of Priority 1 (potential new invaders) noxious weed species in the Molalla watershed. In the Molalla watershed, there are a few known meadow knapweed, spotted knapweed, and diffuse knapweed sites. Both species are Priority II noxious weed (eradication of new invaders) species. Priority species definitions are discussed in the *Salem District 1992-1997 Noxious Weed Control Program Environmental Assessment*.

There are several known occurrences of the Priority III noxious weeds (established infestations) such as Canadian thistle, St. Johnswort, tansy ragwort, and Scotch broom in the Molalla watershed. Established infestations are widespread throughout the landscape. Additional Priority III species populations are expected to be found in the analysis area.

Biological control agents have been released to contain infestations throughout the state for Priority III species and to prevent further spread. Biological control agents will reduce, but not eradicate, noxious weed populations. Increased miles of roads and disturbed ground will increase the suitable habitats for noxious weeds.

Besides noxious weeds, several exotic species exist in the watershed. Although these species are not classified as noxious, they compete with the native vegetation and often have negative ecological impacts. In areas where the soil has been disturbed, such as road cuts, gravel pits, and clearcuts, exotic species such as Oxeye daisy and Himalayan blackberry are common. Nonnative species are found in almost every type of habitat throughout western Oregon.

Aquatic

Hydrology and Water Quality

Introduction

The Molalla River watershed drains approximately 222,720 acres or 348 square miles of the west slope of the Oregon Cascade Mountains; this watershed also is contained within the 878 square mile Pudding/Molalla sub-basin. The Pudding/Molalla sub-basin is located in the Willamette River Basin, which is the largest river basin in Oregon, draining 11,100 square miles. A large percentage of the state’s population and major cities are located in the Willamette River Basin including Portland, Salem, and Eugene. The USGS has divided the Willamette River Basin into hydrologic units and assigned each a hydrologic unit code. The Molalla River analysis watershed contains the Upper Molalla 5th field hydrologic unit (1709000906) and a portion of the Lower Molalla 5th field hydrologic unit (1709000902). The portion of the Molalla River covered in this analysis extends from river mile (rm) 22 upstream to the headwaters, encompassing 129,301 acres or 202 square miles. River miles begin at the mouth of the river and are measured in an upstream direction.

The Molalla River watershed analysis has been divided into five assessment areas based on major drainage patterns and geomorphology. The five assessment areas are further divided into 24 sub-watersheds. (Map B). Assessment areas and sub-watershed acreages are listed in Table 20.

Table 20 Molalla Assessment Areas and Sub-Watershed Acreages

Analysis Area	Sub-Watershed	Acreag e
South Fork Molalla	Nasty Rock	4,426
	Ogle Creek	5,235
	Copper Creek	4,367
	Upper Molalla	8,400
	Assessment Area Total	22,428
Middle Fork Molalla	Lost Creek	4,446
	Joyce Lake	3,532
	Camp Creek	6,461
	Table Rock Fork	8,753
	Assessment Area Total	23,192
North Fork Molalla	Goat Creek	3,115
	Dead Horse Creek	4,899
	Lukens Creek	7,700
	Cougar Creek 1	3,963
	Emerald Creek	5,810
	Lower Dead Horse Creek	1,148
	North Fork Molalla	7,112
	Glenn Avon	2,318
	Assessment Area Total	36,065
Upper Mainstem Molalla	Gawley Creek	5,774
	Horse Creek	3,382
	Pine Creek	6,454
	Bear Creek	7,238
	Assessment Area Total	22,848
Lower Mainstem Molalla	Lower Molalla	6,972
	Trout Creek	9,335
	Russell Creek	4,630
	Dickey Creek	3,831
	Assessment Area Total	24,768
Watershed Total		**129,301**

There are approximately 1,170 miles of stream in the watershed analysis area. Stream densities by analysis area and sub-watershed are shown in Table 21. The sub-watershed stream densities vary from 3.9 miles per square mile in Dickey Creek to 7.1 miles per square mile in Ogle Creek. Analysis areas further upstream in the watershed have higher stream densities than analysis areas nearest the mouth. Figure 3 displays the differences between analysis areas. It identifies the higher elevation South Fork and Middle Fork Molalla analysis areas as the highest in stream density, North Fork and Upper Mainstem Molalla analysis areas as about average, and the lower elevation Lower Mainstem Molalla analysis area as below average.

Table 21 Molalla Stream Densities by Assessment Areas and Sub-Watershed

Analysis Area	Sub-Watershed	Stream Densities (mi./sq.mi.)
South Fork Molalla	Nasty Rock	7.0
	Ogle Creek	7.0
	Copper Creek	6.7
	Upper Molalla	6.0
	Assessment Area Average	6.7
Middle Fork Molalla	Lost Creek	5.2
	Joyce Lake	6.4
	Camp Creek	6.4
	Table Rock Fork	5.9
	Assessment Area Average	6.0
North Fork Molalla	Goat Creek	4.7
	Dead Horse Creek	5.0
	Lukens Creek	5.9
	Cougar Creek 1	5.6
	Emerald Creek	5.7
	Lower Dead Horse Creek	6.4
	North Fork Molalla	5.4
	Glenn Avon	5.2
	Assessment Area Average	5.5
Upper Mainstem Molalla	Gawley Creek	5.5
	Horse Creek	5.6

	Pine Creek	5.0
	Bear Creek	5.7
	Assessment Area Average	5.5
Lower Mainstem Molalla	Lower Molalla	6.0
	Trout Creek	4.8
	Russell Creek	5.8
	Dickey Creek	3.9
	Assessment Area Average	5.1
Watershed Average		**5.7**

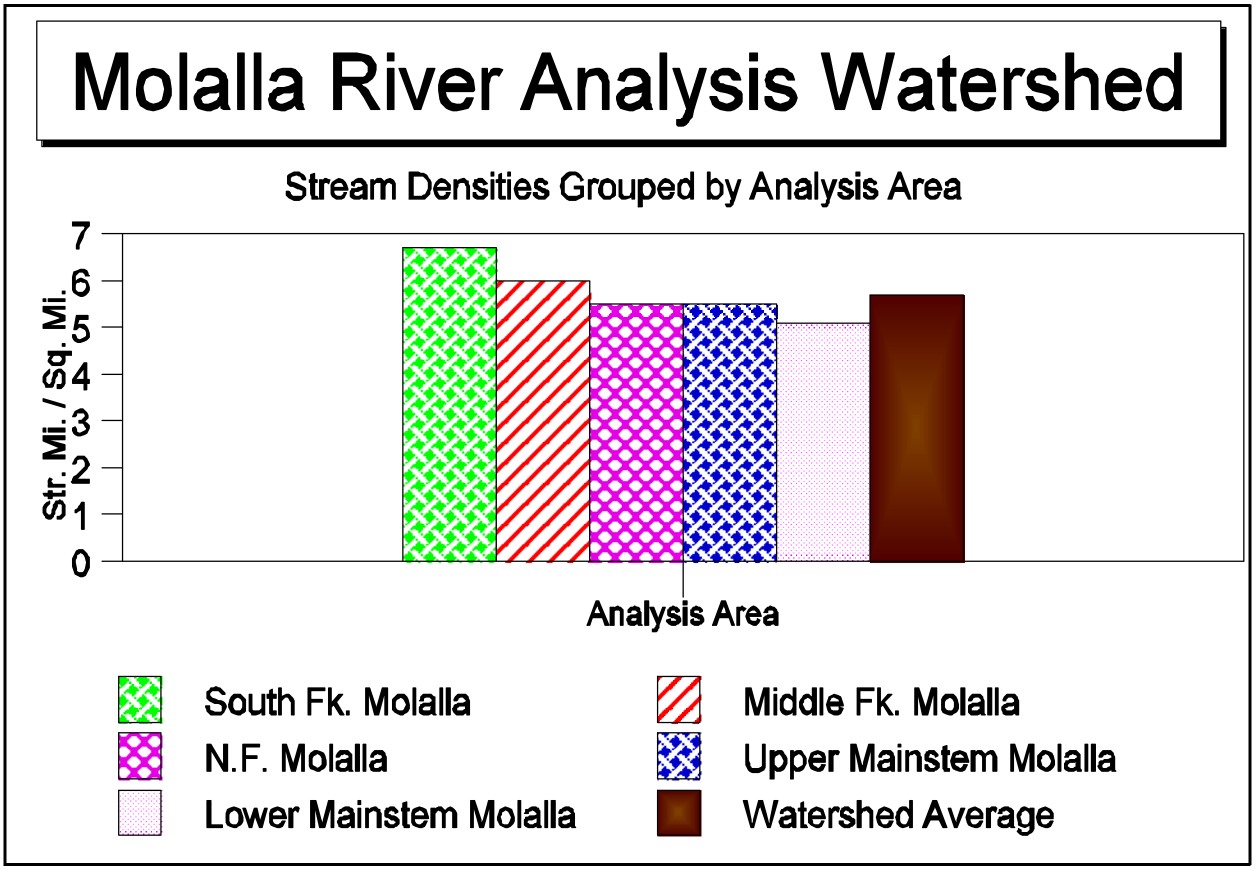


Figure 3 **Stream Density by Analysis Area**

Streamflows

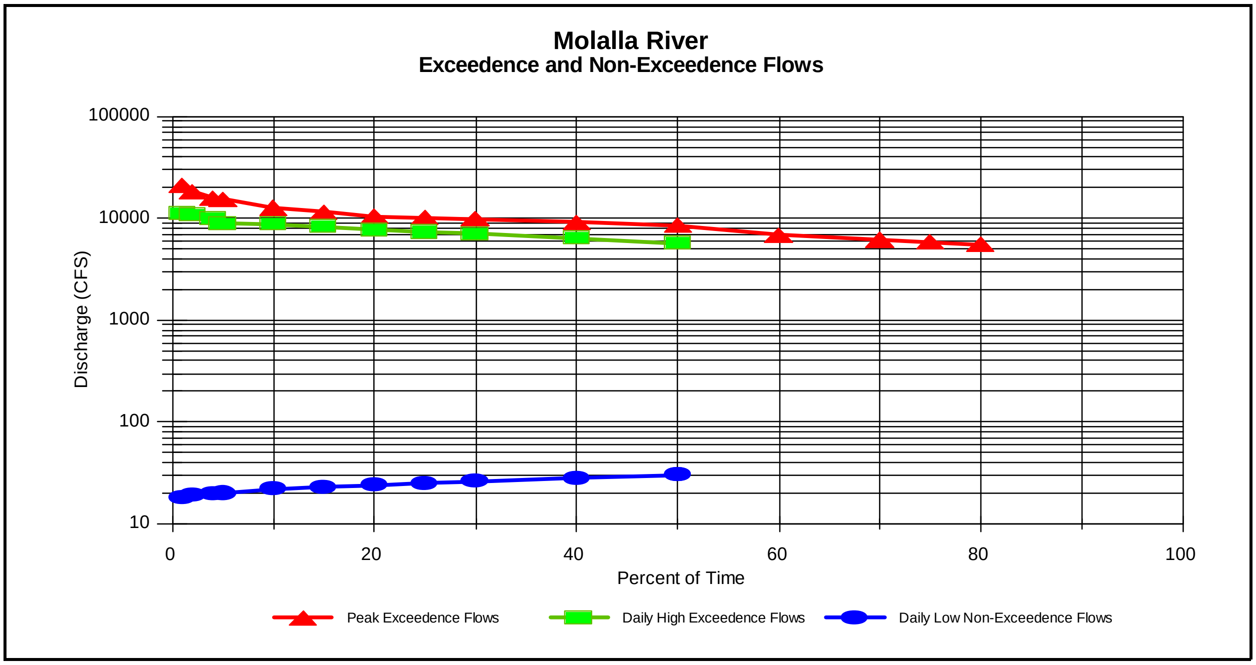
The watershed analysis area exhibits high winter flows and low summer flows typical of the Cascade Range drainages, with 80 percent of the flow occurring November through April. Approximately 73 percent of annual precipitation is also received during this period.

No major dams or reservoirs exist in the watershed analysis area, and most of the summer flow is derived from groundwater.

A graph of peak and daily high exceedence flows is displayed in Figure 4 along with non-exceedence values for daily low flows. The graph was developed from discharges for the 58 years of record. The two exceedence graphs for peak and daily high flows show the percentage of time flows are greater than a given value. Peak exceedence flow values were based on the highest instantaneous discharge observed during storm events, while daily high exceedence flow values were based on the highest annual one day discharges for the period of record. The graph is read by choosing a percent value on the x-axis and moving up to either the peak or daily high flow lines then across to the discharge level. For example, using the peak exceedence flow line, 80 percent of the time (x-axis) instantaneous peak flows are greater than 5,520 cubic feet per second (y-axis), and instantaneous peak flows are greater than 10,500 cubic feet per second (y-axis) only 5 percent of the time (x-axis). On the daily high exceedence flow line, 50 percent of the time (x-axis) the highest daily flow on an annual basis is above 5,730 cubic feet per second (y-axis), while 10 percent of the time the highest annual daily flow is above 8,760 cubic feet per second.

The daily low non-exceedence line is based on the lowest annual one day discharges and is read in a different way than the peak and daily high exceedence flow lines. The low non-exceedence graph line indicates the percentage of time the lowest annual daily flows are less than the indicated amount. For example, 50 percent of the time (x-axis) the lowest annual one day flows are less than 30 cubic feet per second, while they are less than 22 cubic feet per second 10 percent of the time. The average exceedence values have implications for water right allocations on the Molalla River and are discussed below in the water rights section.

A residual mass curve was developed for the sub-watershed using precipitation and stream discharge to look at climatic trends and variation over time. This type of analysis can be useful for separating climatic trends and for looking at the response of discharge to yearly fluctuations in precipitation. The graph is produced by calculating the average value for a set of data then summing the cumulative annual differences from the mean. A downward sloping line indicates periods of lower than average values, while an upward sloping line indicates years with above average values. Figure 5 shows the residual mass curve for precipitation and discharge for the period of stream flow record, 1936 through 1993. Precipitation and discharge were included together on the same graph to allow comparison.



. Figure 4 Molalla River Exceedence and Non-Exceedence Flows.

A climatic trend can be seen in the graph, with three distinct periods of precipitation and discharge in the watershed. A below average discharge and precipitation period occurred from 1936 to1944 indicated by the downward sloping lines. A higher than average precipitation and discharge period from 1945 to 1975 is shown by upward trending lines and another below average period from 1976 to 1993. The precipitation and discharge lines track each other fairly well. Higher than average precipitation years result in higher than average discharge during the same year. However, upon closer examination of the graph, a lag of one year can be seen between an above average precipitation year and the resulting rise in discharge when it occurs following several years of below average precipitation. For example, the precipitation in 1980 was above average (upward sloped line between 1979 and 1980) after several years of mostly below average precipitation, yet the resulting discharge in 1980 was not above average. This phenomenon indicates that after several years of below average precipitation, groundwater reserves are reduced, and greater than average precipitation recharges groundwater rather than contributing to runoff. Conversely, a lag can also be seen when several years of above average precipitation are followed by a year of below average precipitation, but discharge remains above average. An example can be seen in 1956 where below average precipitation did not result in below average discharge. It is not uncommon to have a one or more year delay between precipitation and groundwater response (Fetter 1980).

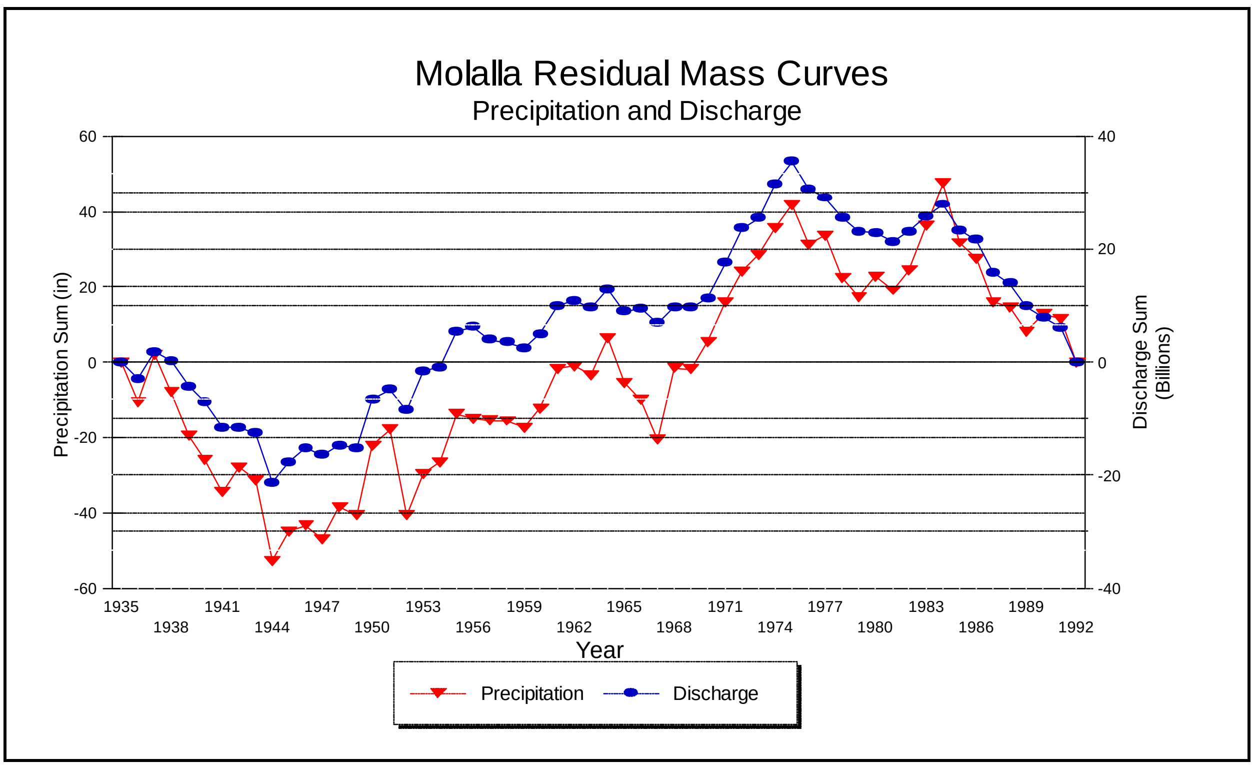


Figure 5 Molalla River Residual Mass Curves.

Annual stream hydrographs were used to analyze low flows and groundwater storage in the watershed. Using annual hydrographs from the USGS stream gaging station number 14198500, MOLALLA RIVER ABOVE PINE CREEK, NEAR WILHOIT OR for the period of record, a groundwater recession curve was developed. A groundwater recession curve is a generalized line which describes the contribution of groundwater to streamflow and can be used to determine groundwater storage and release in a watershed. Since groundwater discharge characteristics in a watershed are constant, the slope of the recession curve remains the same and does not change from year to year. Discharge above the recession curve is from precipitation, snowmelt, and other temporary storage, while discharge displayed below the recession curve is from groundwater. The total area below the recession curve indicates the watershed groundwater storage which varies from year to year depending on precipitation and groundwater recharge.

A manual method described by Barns (1939) was used to separate the hydrograph into periods of groundwater recharge, and discharge, and to develop the groundwater recession curve. The hydrograph for 1969, which was the second of two consecutive average precipitation years, is displayed in Figure 6. Groundwater recharge and discharge periods are identified on the graphs along with the groundwater recession curve. In a year of average precipitation, the groundwater recharge due to storms occurs until approximately April 1st, then groundwater discharge occurs until approximately September 15th when fall storms begin to again recharge groundwater. In an average year, the total groundwater available for runoff from the beginning of the groundwater discharge period (April 1st) is estimated to be $2.9x10^9$ cubic feet. By the end of the low flow period (September 15th), there are 52 days of baseflow from groundwater remaining in storage before the stream would become dry. In 1992, an extremely dry year, total groundwater available for runoff from the beginning of the groundwater discharge period was estimated to be $6.3x10^8$ cubic feet. This is approximately 20 percent of the groundwater available for flow in an average year. At the end of the low flow season in 1992 there were estimated to be 27 days of baseflow remaining before the stream became dry.

Water Rights and Minimum Instream Flows

All waters within Oregon are publicly owned and controlled by the state in accordance with state laws. With few exceptions, a permit from Oregon Water Resources Department (WRD) must be obtained to claim rights to surface waters. This includes the instream uses and diversions of water. State laws recognize prior appropriation as the basis for water right allocation and, during periods of water shortage, the permittee with the oldest water right has priority over junior claims. In addition, a water right can be attached to the land where the permit was established and transferred to subsequent owners. Table 22 contains a summary of permitted water withdrawals or diversions from the Molalla analysis watershed from the Oregon State Water Rights Information System (WRIS).

Domestic		Agriculture	Recreatio n	Industrial	Municipal	Fish/Wil dl.	Misc.
CFS	0.20	0.02	5.1	1.11	4.0	2.1	0.01
AFT	0	0	5.0	0		23.2	0

CFS: Cubic Fee per Second
AFT: Acre Feet

Totals are for permitted withdrawals or current maximum allowed usage and do not necessarily reflect actual use. ODFW instream water rights are not included in this summary.
From; Oregon Water Resources Department, Water Rights information System (1992).

Table 22 Water Rights Summary for the Molalla River Analysis Watershed.

Minimum streamflows were converted to instream water rights on several sections of the Molalla River in 1964, 1988, and 1990 for protection of fisheries through Oregon Senate Bill 140 (ORS 537.346 and OAR 690-77-050) and appropriated by the Oregon Department of Fish and Wildlife (Wevers et al. 1991). Instream water rights and date of appropriations are listed in Table 23. The mouth of the Molalla analysis watershed discussed in this document is located at river mile 22 and the stream gauge used to assess flows at river mile 32.5.

River Mile	Nov.-May	June	July	Aug.	Sept.	Oct.	Acq. Date
0-8	500	500	200	100	150	450	12-22-88
6	60	60	60	60	60	60	6-22-64
8-21.5	300	200/150(	100/80(	80	80/300(	300	10-11-90
32.5	35	35	35	35	35	35	6-22-64

Flows are in Cubic Feet Per Second (CFS).

(The first value is required flow for the first 15 days of the month, and the second is the required flow for the remainder of the month.

Table 23 Existing Instream Water Rights for the Molalla River.

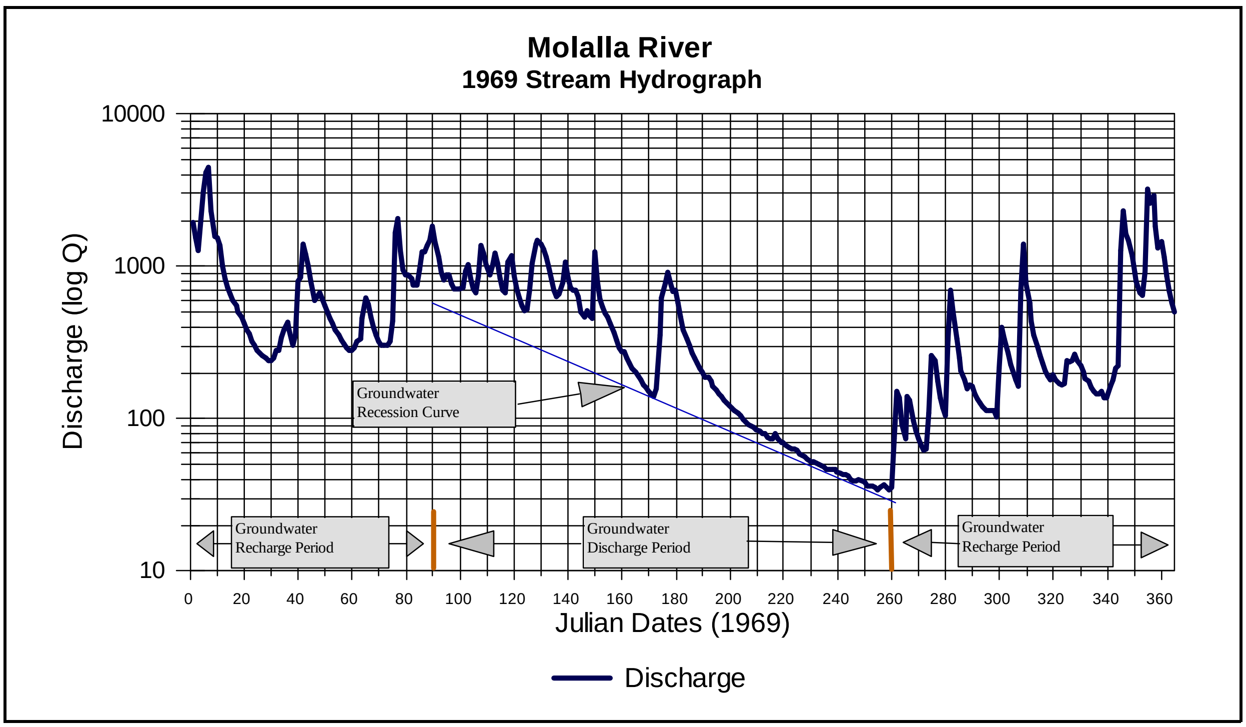


Figure 6 1969 Molalla River Stream Hydrograph.

I

In addition to the water rights listed above, the ODFW has compiled a list of streams within the Molalla River watershed considered high priority for instream water rights to protect fisheries values including: North Fork Molalla River, Cedar Creek, Dickey Creek, Pine Creek, Gawley Creek, Table Rock Fork Molalla River, and Ogle Creek.

The purpose of instream water rights on the Molalla River is to provide flow for the protection of fisheries habitat and production. However, the rights themselves are not a guarantee that sufficient flows will be available within the protected sections. Consumptive water rights pre-dating the instream rights and extreme low flow periods may prevent the desired flows from being achieved during some periods. Table 24 provides an example of the potential for insufficient flows during the summer and fall low flows at river mile 32.5. It uses data from the existing USGS streamflow gauge located at the site.

Table 24 Average and Minimum Flows, Consumptive and Instream Water Rights, and Potential Flow Deficits at River Mile 32.5.

Month	Average Flow [1]	Minimum Flow [1]	Water Rights [2]	Instream Rights [3]	Potential Flow Deficit
July	103	37	12.5	35	-10.5
Aug.	53	22	12.5	35	-25.5
Sept.	75	24	12.5	35	-23.5
Oct.	239	28	12.5	35	-19.5
Nov.	756	24	12.5	35	-23.5

[1] Flows and water rights in CFS from USGS streamflow records (USGS 1990 and 1991.)

[2] Consumptive water rights summarized from table 1.

Wellman et al. 1993 indicated low flows in the Molalla River drop to 33 cfs for a duration of approximately 14 days, 1 out of every 2 years, and to 35 cfs for 60 days an average of 1 in 5 years. During an average flow year (Moffatt et al. 1990), there is sufficient discharge to allocate between consumptive and instream water rights. However, as Table 24 illustrates, during certain low flow conditions the Molalla River is over allocated, which may result in potential conflicts between users.

A number of small hydropower dams exists on tributaries to the Molalla River; however, the main stem of the river has no impoundments and is free-flowing. Stream reaches on the Molalla river and certain tributaries are protected from future hydroelectric power development by the Northwest Power Planning Council. A summary of the Molalla stream reaches and several tributaries protected from hydroelectric power development are provided in Table 25.

Table 25 Stream Reaches Protected from Future Hydroelectric Development.

Stream	Protected River Miles
Molalla R.	0-49
Trout C.	0-8
Pine C.	0-7
Gawley C.	0-5
Copper C.	0-1
N.F. Molalla R.	0-15
Dead Horse Canyon C.	0-7
Lukens C.	0-8
Cougar C.	0-5
Table Rock Fork Molalla	0-11
Camp C.	0-4
Lost C.	0-4

General Water Quality

Protection and enhancement of water quality in the Willamette River Basin was identified by ODEQ as one of the most critical long range environmental issues facing the state (Tetra Tech 1993). Pollutants are generally divided into two sources. Point sources which come from an identifiable source, such as a factory or sewage treatment plant, and non-point source pollutants such as soil erosion or pollutants in precipitation runoff, which are not as easily trackable. Point sources of water pollution are closely monitored by the ODEQ and contribute significantly less pollution to Oregon rivers than in the past. Non-point sources, such as road and agricultural runoff, are harder to regulate because of the difficulty in determining accurately the amounts as sources of pollutants entering the stream. Most of the non-point pollution in the Willamette River Basin occurs in the winter and spring when heavy rains wash pollutants into rivers (Tetra Tech 1995). Due to the lack of industry within the Molalla River watershed, non-point sources are the main sources of pollution.

The ODEQ has divided Oregon into 19 river basins and developed water quality criteria for each. Streams that do not meet these criteria may be listed as water quality limited. The criteria encompass physical and chemical characteristics including: pH, water temperature, dissolved oxygen, fecal coliforms, turbidity, and other parameters (Table 26).

Table 26 Selected State Water Quality Criteria for the Willamette River Basin.

pH	6.5 to 8.5
Water temperature	No increase above background if temp. 58 deg. F. or greater
Dissolved oxygen	> 90% saturation
Fecal coliform	< 200 per 100ml.
Turbidity	< 10 % increase

In the ODEQ publication, *1988 Oregon Assessment of Non-point Sources of Water Pollution* (ODEQ 1988), also known as the 319 Report, the Molalla River is divided into three sections. From the mouth of the Molalla River to near the city of Molalla (SW ¼ Sec. 2, T. 5 S., R. 2 E.), water quality is listed as being severely impacted (by observation only). Problems identified include: turbidity, erosion, sediment, low dissolved oxygen, and low flows. The probable causes were listed as landslides, traffic and road locations, physical alterations, and dredging. Impacted values were identified as fisheries, irrigation, and aesthetics. The section of the Molalla River from near the city of Molalla upstream to NE¼ Sec. 7, T. 7 S., R. 3 E. (near Bear Creek) is listed as moderately impacted (by observation only) for sediment. The probable causes were landslides, road locations, and road runoff. Fisheries are impacted values. The section of the Molalla River upstream of the two sections discussed above is listed as having no problem and/or no data. The 319 report was an initial assessment of water quality in Oregon and was used as a bench mark for future studies.

Oregon Department of Environmental Quality's 303(d) List Of Water Quality Limited Waterbodies, also known as the 303(d) report, is a compilation of water bodies where existing required pollution controls are not stringent enough to achieve the state's water quality standards. States were required to develop this list under the 1972 Federal Clean Water Act. The mainstem of the Molalla River and a tributary are listed as water quality limited in the report, as displayed in Table 27.

Several water quality studies, or reports including water quality information, have focused on the Molalla/Pudding sub-basin. The *1991 Molalla and Pudding Sub-Basin Fish Management Plan*, prepared by the ODFW found in a review of the literature that most of the water quality problems in the sub-basin occur primarily in the Pudding River watershed. They are associated with non-point source runoff and treated sewage discharge. The publication also stated that low summer flows and high water temperatures are the most important limiting factors for winter steelhead and fall chinook in the watershed. Other studies have analyzed pollutants in the Molalla watershed. A 1996 publication by Anderson et. al identified four pesticides near the mouth of the river, but stated agricultural areas were the likely source.

Table 27 303(d) Listed Stream Segments in the Molalla River Analysis Watershed.

Listed River Segments	Listed Parameter	Affected Uses
Mouth of Molalla to North Fork Molalla	Fecal Bacteria	Water Contact Recreation
Mouth of Molalla to Table Rock Fork Molalla	Summer Temperatures	Fish Rearing
Mouth of Table Rock Fork Molalla to the Headwaters	Summer Temperatures	Fish Rearing
South Fork Molalla River to Headwaters	Summer Temperatures	Fish Rearing
Mouth of Pine Creek to Headwaters	Summer Temperatures	Fish Rearing

Stream Temperatures

Summer and fall water temperatures are collected at two sites on the mainstem Molalla River and on the Table Rock Fork Molalla, South Fork Molalla, and Pine Creek using temperature data loggers set to record hourly. Oregon Administrative Rules (OAR340-41) give numeric temperature criteria where measurable increases in stream temperatures due to human activities are not allowed. The temperature threshold for salmonid fish rearing in the Molalla River is 17.8 degrees C.

In the Molalla River watershed, the main channel and several tributaries have been listed as water quality limited due to temperature as illustrated above in Table 27. The two temperature sites on the mainstem Molalla River maintained by BLM are located at river miles 38, and 27. River mile 38 is near the Horse Creek Bridge, and mile 27 is near the lower end of the BLM Molalla River Corridor. The Table Rock temperature site is located at river mile 1 and monitors stream temperatures in the Middle Fork analysis area. The South Fork Molalla recorder at Molalla river mile 40 measures temperatures on the South Fork analysis area, and the Pine Creek recorder at river mile 0 measures temperatures from the Pine Creek sub-watershed. Data from 1997 were summarized by calculating seven day maximum averages. The seven-day maximum average takes the maximum recorded temperature for each date and averages it with the maximum recorded readings from the three days prior and the three days after the date. Each average was then plotted on a graph (Figures 7 and 8). The seven-day maximum average was used rather than straight daily maximums. This is because aquatic organisms are more susceptible to disease and other environmental stress when water temperatures are elevated over a period of time. Seven-day maximum averages also remove some of the fluctuation that can appear in graphs of daily maximums.

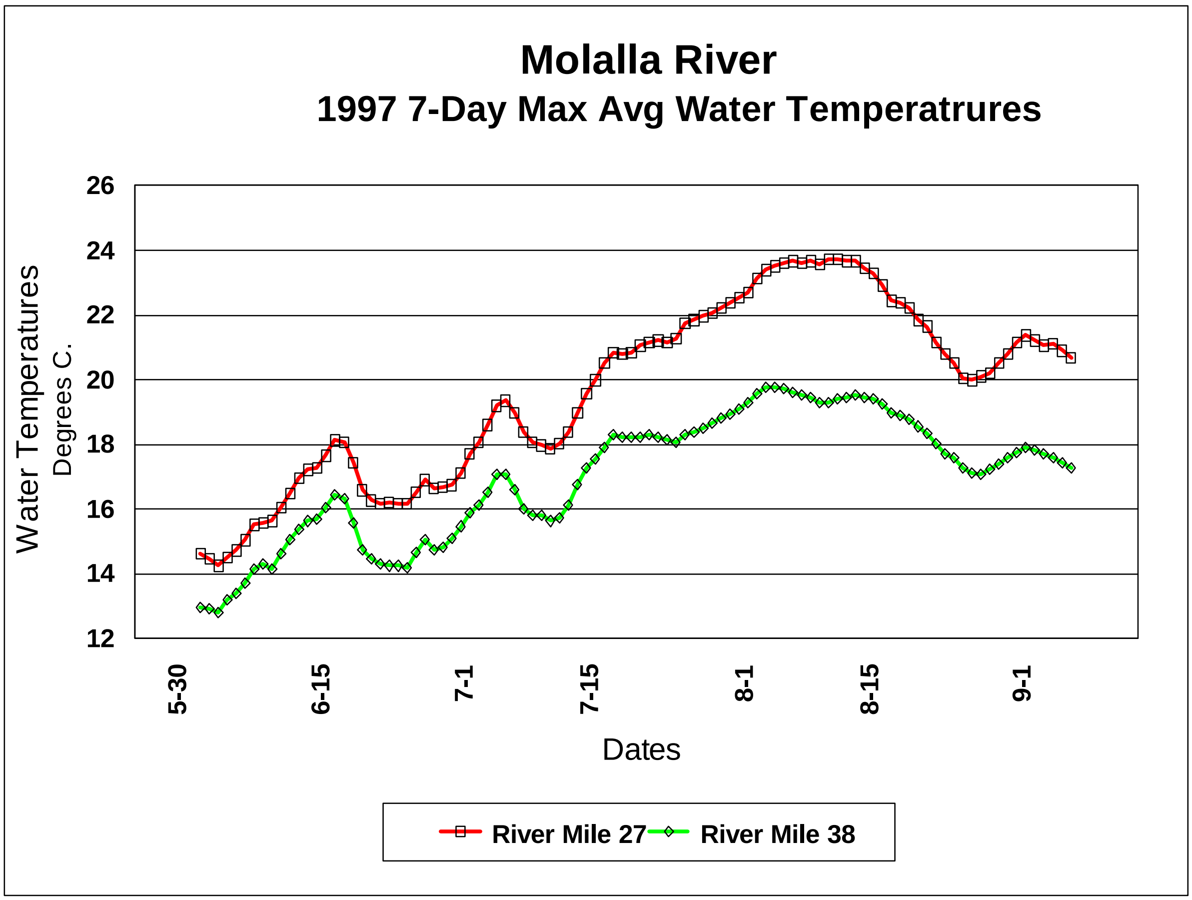


Figure 7 Molalla River 7-Day Maximum Average Stream Temperatures for 1997.

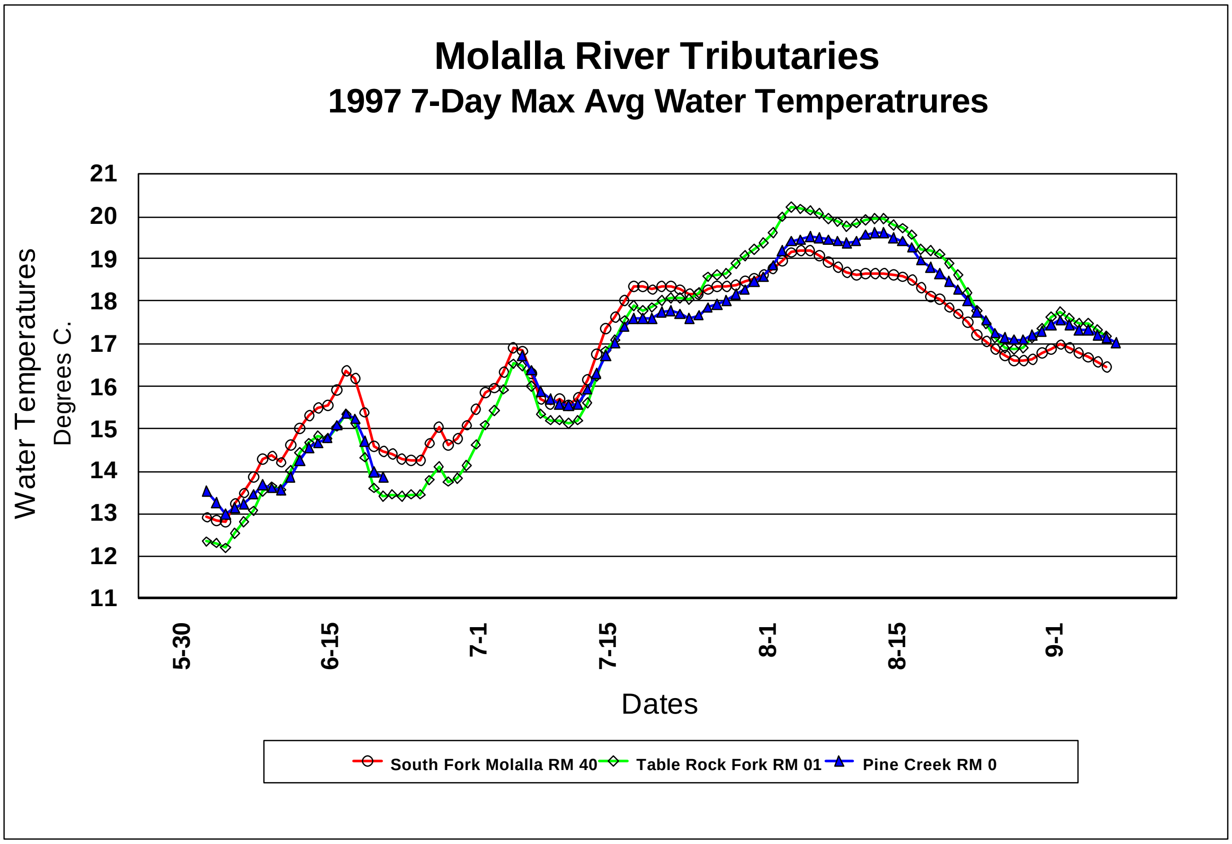


Figure 8. **Molalla River Tributaries 7-Day Average Maximum Stream Temperatures.**

The water temperature graphs show all sites were above the 17.8 degree Centigrade salmonid rearing threshold for extended periods during the summer, and temperatures recorded at Molalla river mile 27 approached 24 degrees Centigrade. Because the data represent a seven day running average, it is apparent that water temperatures are high for extended periods of time in the summer. At temperatures near or above the 20 degrees Celsius threshold, salmon are forced to seek refuge in cooler water in places such as deep pools or cooler tributaries.

Streambank Shading

Canopy cover is an important factor for controlling stream temperatures. Temperatures can increase or decrease along a stream course depending on the amount of shade provided by the riparian canopy. Timber harvest, stream sluicing, or rocky streambanks can cause openings in the canopy affecting stream temperatures. Stream shade in each sub-watershed was estimated from 1996 aerial photographs using the methods described in the manual *Standard Methodology for Conducting Watershed Analysis* (Washington Forest Practices Board 1993) and is summarized in Figures 9 through 14 grouped by analysis area. The graphs include first through fifth order streams. Larger streams were not included because their size prevents canopy closure, and the analysis presented here is intended to show areas for potential restoration.

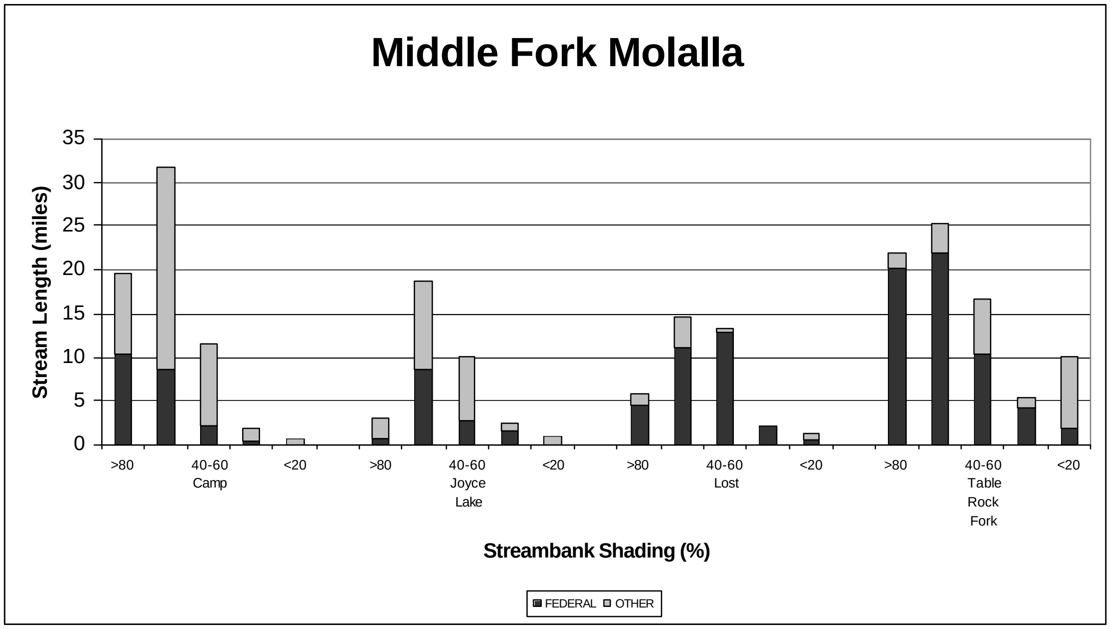


Figure 9. **Middle Fork Molalla Analysis Area Streambank Shading.**

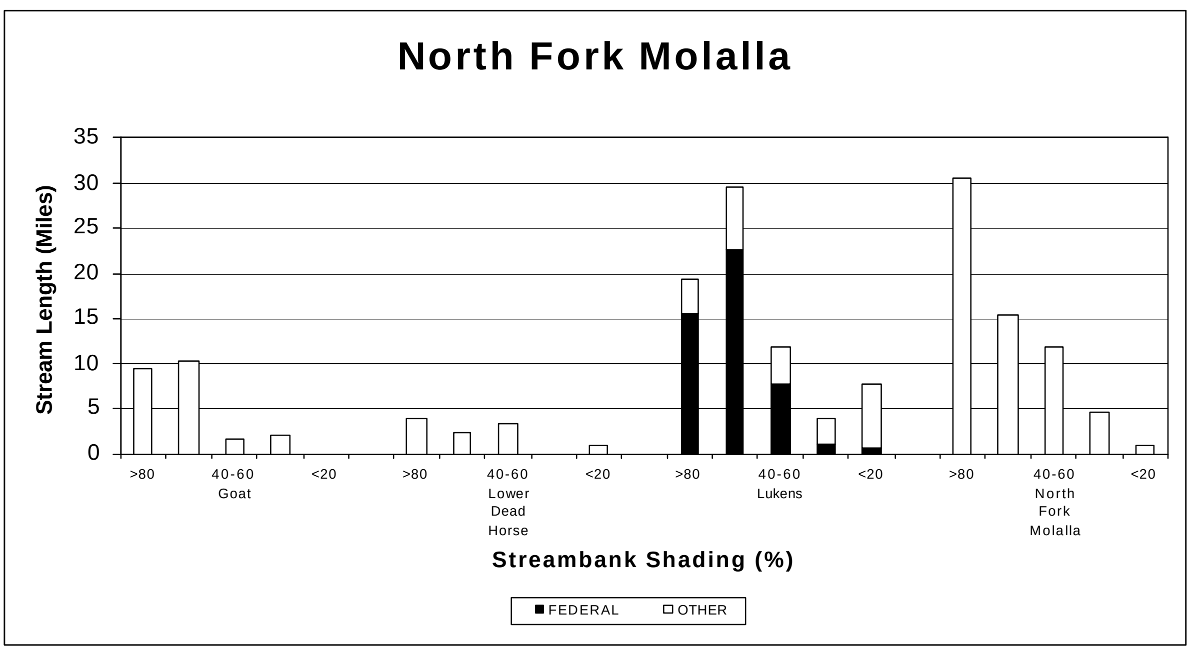


Figure 10. **North Fork Molalla Analysis Area Streambank Shading.**

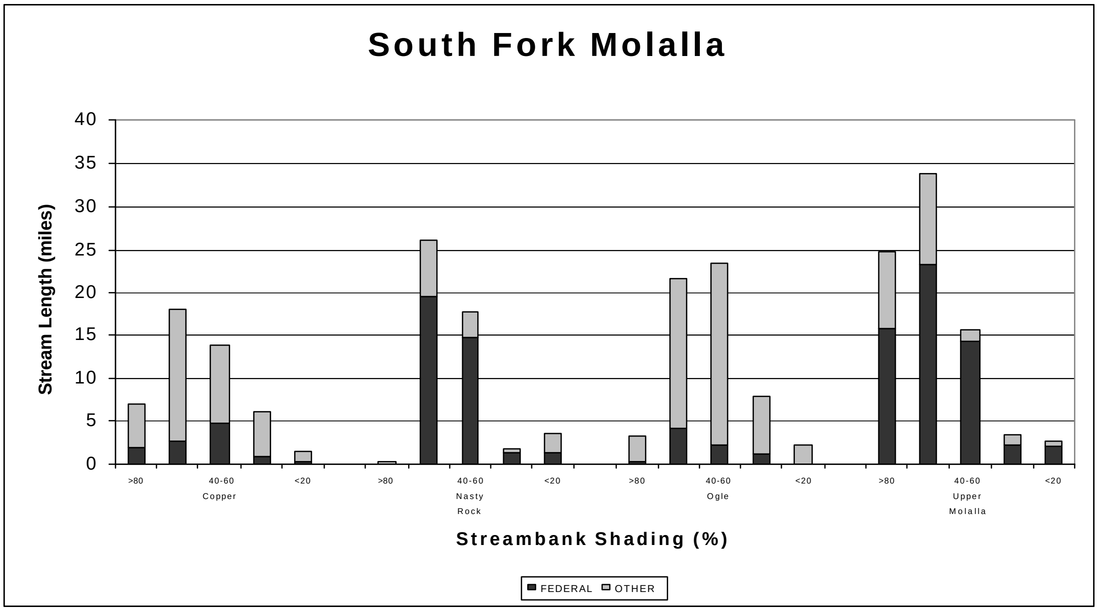


Figure 11. South Fork Molalla Analysis Area Streambank Shading.

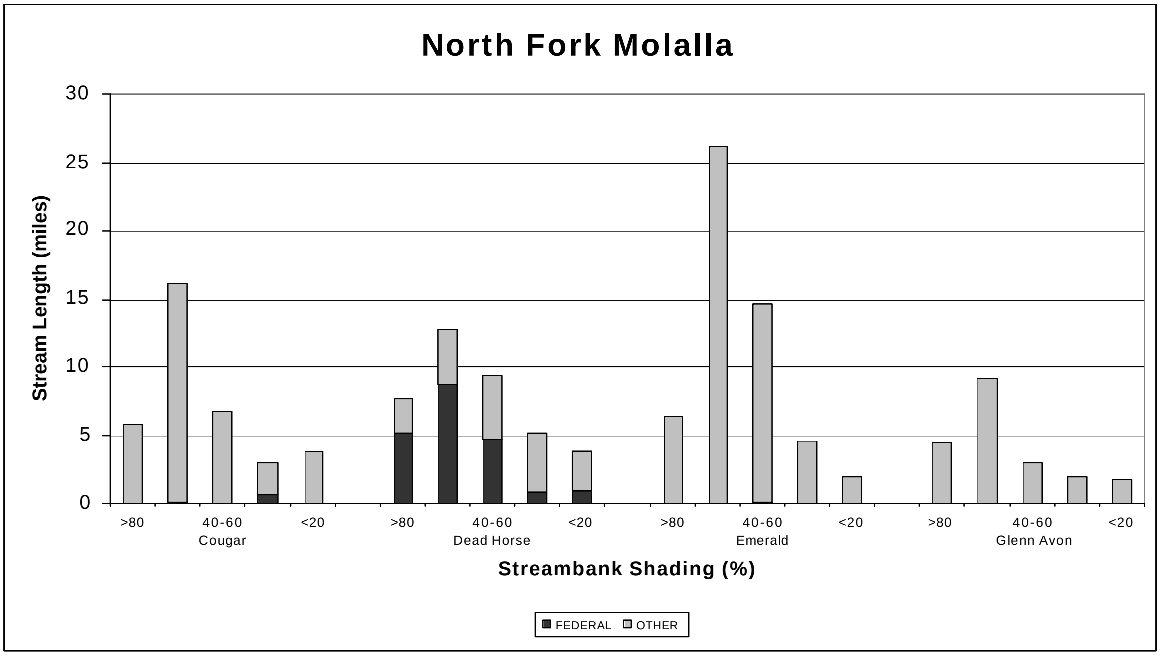


Figure 12 North Fork Molalla Analysis Area Streambank Shading

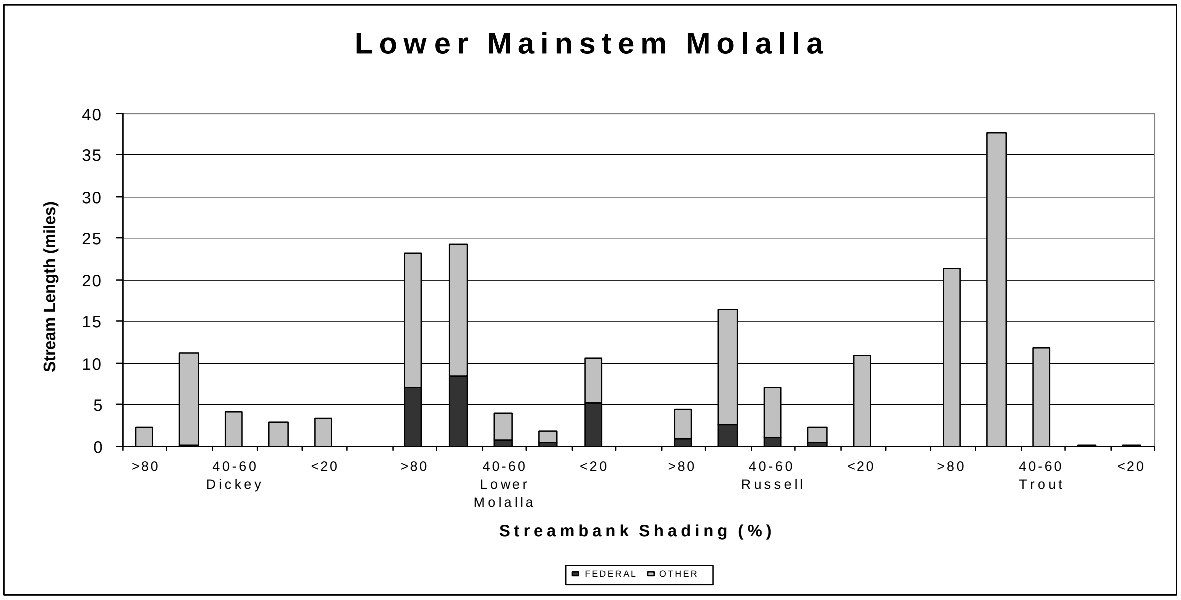


Figure 13 Lower Mainstem Molalla Analysis Area Streambank Shading.

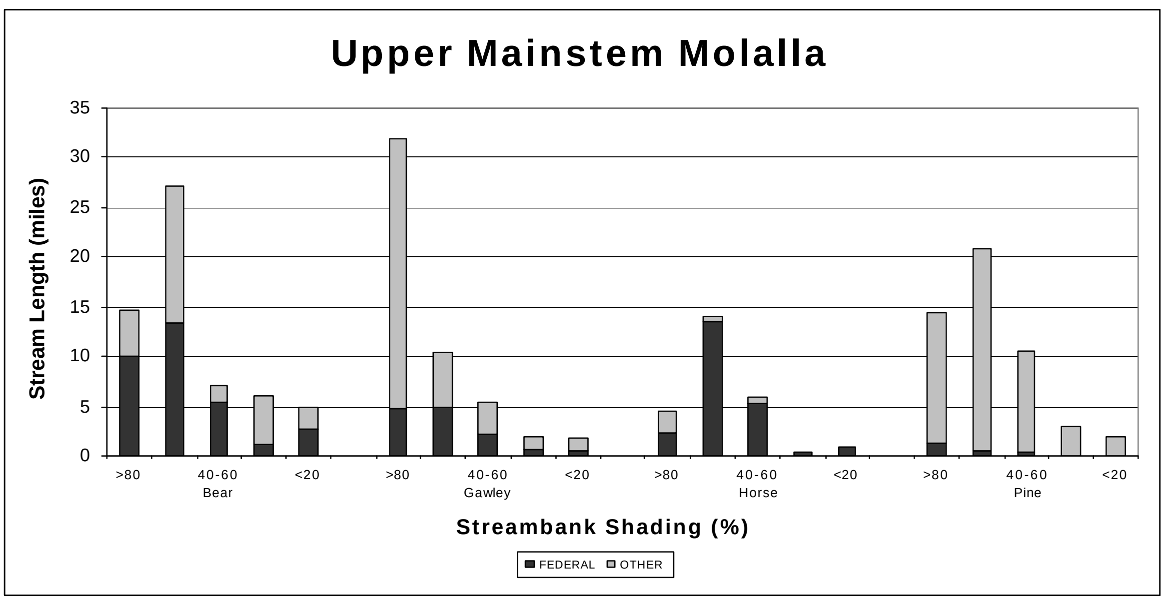


Figure 14. Upper Mainstem Molalla Analysis Area Streambank Shading.

Miles of stream with shade of less than 40 percent are summarized in Table 28. The sub-watershed total and BLM miles of less than 40 percent stream shade are presented from highest to lowest, grouped by analysis area. The table is a general indicator of where the majority of stream openings are located. Other related factors not included in this analysis that can affect stream temperatures are stream aspect, discharge, and groundwater contribution to summer stream flows.

Table 28 Molalla Assessment Areas and Sub-Watershed - Less than 40 Percent Cover.

Analysis Area	Sub-Watershed	Total Miles of Less Than 40 Percent Stream Cover	BLM Miles of Less Than 40 Percent Stream Cover
South Fork Molalla	Ogle Creek	10	1
	Copper Creek	8	2
	Upper Molalla	7	5
	Nasty Rock	6	4
	Assessment Area Total	31	12
Middle Fork Molalla	Table Rock Fork	16	7
	Joyce Lake	4	2
	Lost Creek	4	3
	Camp Creek	3	1
	Assessment Area Total	27	13
North Fork Molalla	Lukens Creek	13	3
	Dead Horse Creek	9	2
	Cougar Creek 1	7	1
	Emerald Creek	7	0
	North Fork Molalla	6	0
	Glenn Avon	4	0
	Goat Creek	2	0
	Lower Dead Horse Creek	1	0
	Assessment Area Total	49	6
Upper Mainstem Molalla	Bear Creek	11	4
	Pine Creek	5	0
	Gawley Creek	4	1

	Horse Creek	2	1
	Assessment Area Total	22	6
Lower Mainstem Molalla	Russell Creek	13	1
	Lower Molalla	13	6
	Dickey Creek	6	0
	Trout Creek	1	1
	Assessment Area Total	33	8
Watershed Total		**162**	**45**

The sub-watersheds with the greatest number of miles of open canopy over streams are: Table Rock Fork, Lukens Creek, Lower Molalla, Russell Creek, Bear Creek, and Ogle Creek. Sub-watersheds containing the greatest number of miles of BLM stream with open canopies are: Table Rock Fork, Lower Molalla, Upper Molalla, Bear Creek, Nasty Rock, Lukens Creek, and Lost Creek.

Water Quality Monitoring

BLM collected water quality data on the Molalla River at river miles 27, 31, and 39. River mile 27 is near the lower end of the BLM Molalla River Corridor, river mile 31 upstream near the Pine Creek Bridge, and river mile 38 near the Horse Creek Bridge. The physical and biologic water quality data were collected in 1993 through 1996. Table 29 lists the water quality parameters and general results by station.

Table 29 Molalla Water Quality Data Summary.

River Mile 27			
Parameter	**Mean**	**Minimum**	**Maximum**
Total Coliforms	85	2	266
Enterococci Bacteria	17	0	139
Fecal Coliforms	8	0	33
Sediment (ppm)	1.5	0.2	5.6
Turbidity (JTUs)	1.7	0.4	7.3
pH	7.5	6.0	8.7
Specific Conductivity (mmohs)	40.8	25.0	55.0
River Mile 31			
Parameter	**Mean**	**Minimum**	**Maximum**
Total Coliforms	72	6	180
Enterococci Bacteria	13	0	90
Fecal Coliforms	6	0	29
Sediment (ppm)	2.0	0.2	16.8
Turbidity (JTUs)	1.3	0.4	3.6
pH	7.6	6.7	8.5
Specific Conductivity (mmohs)	43.6	26.3	58.2
River Mile 39			
Parameter	**Mean**	**Minimum**	**Maximum**
Total Coliforms	38	6	92
Enterococci Bacteria	16	0	129
Fecal Coliforms	9	0	47
Sediment (ppm)	1.3	0.2	16.8
Turbidity (JTUs)	1.1	0.2	3.2
pH	7.3	6.7	8.1
Specific Conductivity (mmohs)	39.6	25.8	59.6

The stations were compared using all of the available data with no seasonal breakout and by dividing the data into seasons then comparing to look for differences that might only appear seasonally. Following an initial examination, the data were divided into 3 four-month "seasons." Three divisions were chosen rather than four to group low flow months into one season and to keep the number of observations in each group high enough to ensure that any statistical differences that might appear would be reliable. The breakdown of the three seasons were: Fall-Winter (November through February), Spring-Summer (March-June), and Summer-Fall (July-October). The lack of sufficient data for the fall-winter period prevented analysis for that season.

The method used to compare data between sites was the *Wilcoxon Matched pairs Signed Ranks Test*, which is a non-parametric statistical test of differences. Non-parametric tests are less powerful than parametric tests when looking for differences between data; however, when the data were graphed they did not fit a bell-shaped curve and required non-parametric analysis. The statistical program *SPSS for Windows* tm version 6.1 was used to analyze the data. Stations were compared with each other in turn by calling data collected at each sampling event a matched pair of data between two stations. There are limitations and assumptions that need to be made when using this approach. Water quality at a given cross section in a natural river is highly variable and can fluctuate not only over a short period of time but also within a cross section at any given point. Pollutants and other constituents that affect water quality can move through a system in pulses or waves and, depending on several physical factors, can take many miles of mixing before they are mixed across the whole cross section. Another factor that can affect data collected on rivers is the order and time of day samples are taken. Sampling from the upstream stations first and working in a downstream order can have the advantage of sampling the same relative section of water as it flows downstream. This depends on flow velocities and distance between stations. While this assumption depends on many variables, it can provide a basis for drawing conclusions when analyzing data. The time of day a station is sampled can also have an effect on the parameter measured. For example, water temperature will be higher in the afternoon than in the morning, and a station consistently measured in the morning will probably show a significantly lower temperature than a station always measured in the afternoon. This holds true for many of the physical parameters which are interrelated including temperature, oxygen, pH, and carbon dioxide to name a few. Unfortunately it is difficult to be in two places at the same time. The only other way to avoid this problem is to have automatic recorders installed at sites or buy equipment and hire enough field people to collect data at all stations simultaneously. This is unrealistic given budget restraints. While there are drawbacks to any system of data collection, the assumption was made that the physical and biological water quality data covered enough sampling events that variations due to individual pulses or waves of water constituents would be overshadowed by actual trends in the data over time.

There are several statistically significant differences among the three sites resulting from the data analysis.

Total coliforms belong to the enteric bacteria group, *Enterobacteriaceae*, and consist of various species found in the environment and in the intestinal tracts of warm blooded animals. The combined data on the Molalla showed a statistically significant increase in total coliforms in a downstream direction. The difference was also significant in the summer/fall grouped data but not in the spring/summer data.

Fecal coliforms are the enteric bacteria that represent those members of the total coliform group found in the intestines and feces of warm-blooded animals. All samples from the Molalla River were within ODEQ's standard for contact recreation of less than 200 fecal coliform per 100 milliliter (OAR 340-41-445 (2)(e)). The summer/fall data at river mile 39 were statistically higher than at river mile 31 but signify a small difference.

Enterococci bacteria are fecal bacteria which are short lived outside warm-blooded animals so are indicators of recent fecal contamination. The combined data showed higher enterococci levels at river mile 39 than river mile 31. The difference is also present in the summer/fall data implying an input upstream from river mile 39 that is diluted by the time it reaches river mile 31. During the spring/summer period, enterococci increases in a downstream direction.

Turbidity is a measure of opaqueness or cloudiness produced in water by suspended particulate matter. Turbidity levels on the Molalla River are comparable at all stations, although statistically the levels increase in a downstream direction.

Total solids are a measure of mineral and organic materials suspended and dissolved in water. Results for total solids showed a similar pattern to turbidity with an increase in the levels as you travel downstream, although the difference is small.

The availability of free hydrogen ions in water is measured by the pH. Pure water has a pH of 7.0 which represents neutrality, and most natural waters have pH values between 6.0 and 9.0. Many aquatic organisms are highly sensitive to changes in pH. The pH increases statistically in a downstream direction, although the increase is small. All readings were within the normal range.

To summarize, the levels of total coliforms, turbidity, solids, and pH increase as water moves downstream in the Molalla River. The level of fecal coliforms and enterococci were statistically higher at river mile 39 than river mile 31 and, although the difference was relatively small, may indicate a greater input of fecal material above river mile 39 than below. Fecal and enteric bacteria levels appeared to be within the state standards as no samples were above 200 coliforms per milliliter.

Storm Turbidities

Turbidities were measured on the Molalla River and major tributaries during or after five storms in 1996 to look for potential sources of turbidity. Grab samples were collected, and turbidities measured in the office. Samples were compared with turbidities in other tributaries and the mainstem of the Molalla downstream of the watershed analysis boundary to attempt to identify the streams providing the greatest input. Due to time and logistic constraints, many but not all major Molalla tributaries were sampled. The tributaries that exhibited the greatest number of high turbidity readings during storms compared with the mainstem Molalla River were Pine Creek, Mining Creek, Trout Creek, and Table Rock Fork Molalla. Table 30 summarizes results of the storm turbidity sampling.

Table 30 Storm Turbidity Monitoring Results.

Stream	Sub-Watersheds	Number of High Storm Turbidities Out of 5.	Highest Turbidity Recorded (NTU's)
Pine Creek	Pine Creek	4	19.5
Mining Creek	Upper Molalla	2*	18.0
Table Rock Fork Molalla	Table Rock Fork, Camp Creek, Lost Creek, Joyce Lake	2	26.5
Trout Creek	Trout Creek	2	23.5

* Only two samples were collected at this site.

The streams listed in the table above warrant further investigation to narrow down potential sources of turbidity.

Road Summary

Road surfaces and cut banks are basically impermeable to rainfall and snowmelt runoff. Roads can also intercept subsurface flow in cutbanks and concentrate surface runoff. During storms and snowmelt periods, roads act as intermittent stream channel extensions. They increase drainage density by concentrating runoff and routing it to streams more quickly than by natural processes. Increases in road densities in the vicinity of streams result in more water being delivered to natural channels in a short period of time. This can cause peak discharges to occur sooner than expected and increase their size (Jones and Grant 1996). The potential channel network expansion due to roads was calculated by totaling the length of road within 100 feet of a stream channel and adding the value to the total stream miles in the sub-watershed. Table 31 lists miles of stream, miles of roads within 100 feet of an existing stream, and the estimated channel network expansion due to roads. Several sub-watersheds show greater than 20 percent channel expansion which is considered high.

Table 31 Estimated Channel Network Expansion.

Analysis Area	Sub-Watershed	Stream Miles	Road Miles Within 100 Feet of Streams	Estimated Channel Network Expansion (Percent)
South Fork Molalla	Copper Creek	46.7	6.3	13
	Ogle Creek	58.8	7.1	12
	Nasty Rock	49.5	5.8	11
	Upper Molalla	80.3	8.8	11
Middle Fork Molalla	Joyce Lake	35.5	5.9	17
	Lost Creek	36.9	4.0	11
	Camp Creek	65.6	6.9	11
	Table Rock Fork	79.0	7.6	10
North Fork Molalla	Cougar Creek 1	35.4	9.1	26
	Goat Creek	23.2	4.4	19
	Emerald Creek	53.4	9.4	18
	Glenn Avon	19.5	2.7	14
	Lukens Creek	72.5	9.4	13
	Dead Horse Creek	39.3	4.6	12
	North Fork Molalla	61.0	9.7	16
	Lower Dead Horse Creek	11.8	1.3	11
Upper Mainstem Molalla	Pine Creek	50.8	11.6	23
	Bear Creek	60.8	10.2	17
	Horse Creek	27.8	3.4	12
	Gawley Creek	51.1	6.2	12
Lower Molalla	Trout Creek	71.2	17.0	24
	Lower Molalla	65.1	12.3	19
	Dickey Creek	23.9	4.7	20
	Russell Creek	42.7	6.7	16

While surface erosion on exposed hillslopes usually decreases within a few years of disturbance as the slope revegetates, road surfaces can continue to erode as long as the road is in use. Cutslopes and fillslopes revegetate after road construction; however, the running surfaces produce fine-grained sediments over the life of the road. Roads can disrupt sub-surface flow, re-route surface flow and, in effect, act like stream channel extensions during storms contributing runoff and sediment to streams. The amount of sediment and runoff reaching streams depends on the location, quantity and type of traffic, geology, and construction of the road. The manual *Conducting Watershed Analysis* produced by the Washington Forest Practices Board (1993) was used to assess sediment production from roads. For this analysis, roads within 200 feet of a stream were assumed to affect sediment additions to streams. The actual effect varies depending on whether a road section crosses a stream or just parallels it. Figures 15 through 19 are a summary of road sediment production normalized by sub-watershed acreage. The estimated road sediment in tons was divided by the sub-watershed acreage to produce a graph of sediment per acre and multiplied by 1000. The resulting values are in thousandths of a ton of road sediment per sub-watershed acre per year. Normalization of the data provides a method to compare sub-watersheds regardless of size because values are on a per acre basis.

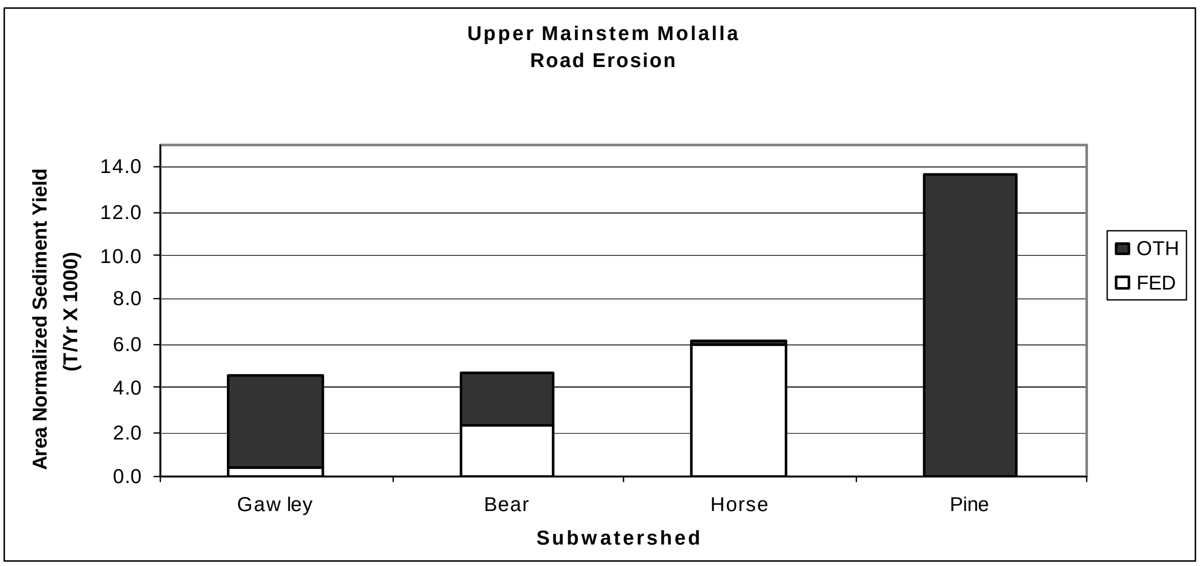


Figure 15. Upper Mainstem Analysis Area Road Erosion (Thousandths Ton per Acre per Year)

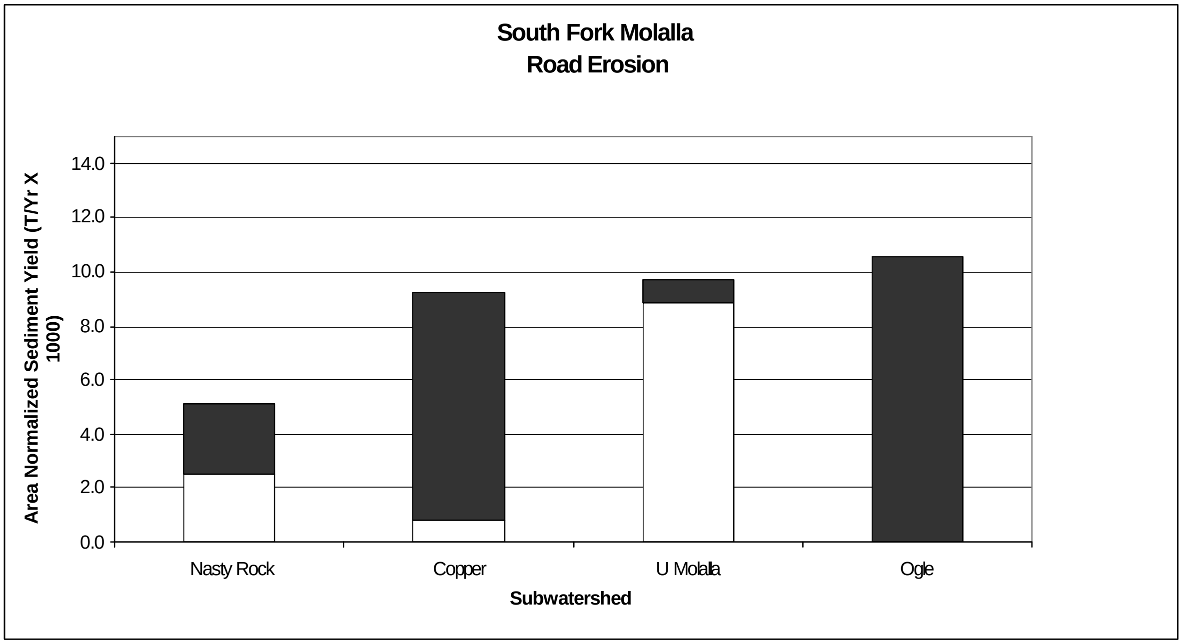


Figure 16. South Fork Molalla Analysis Area Road Erosion (Thousandths Ton per Acre per Year)

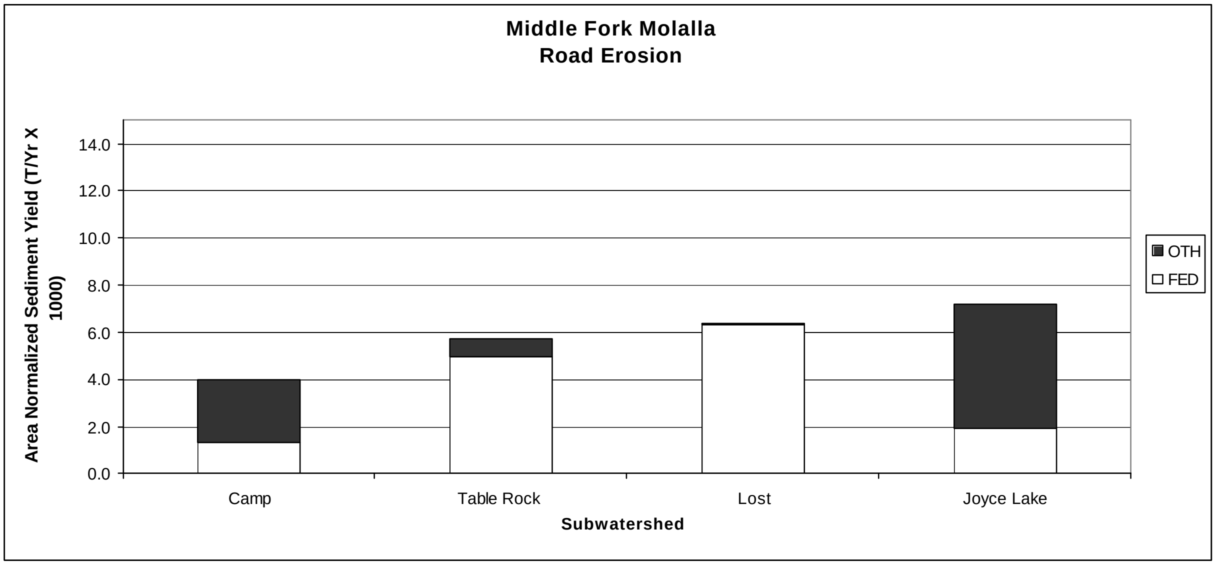


Figure 17. **Middle Fork Molalla Analysis Area Road Erosion (Thousandths Ton Per Acre Per Year)**

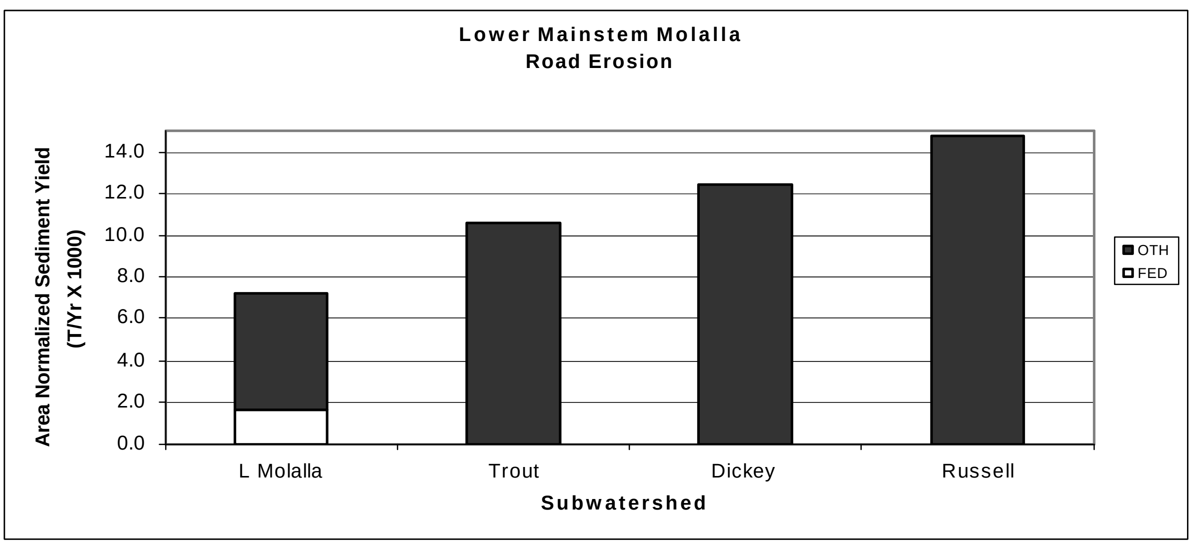


Figure 18. Lower Mainstem Molalla Analysis Area Road Erosion (Thousandths Ton per Acre per Year)

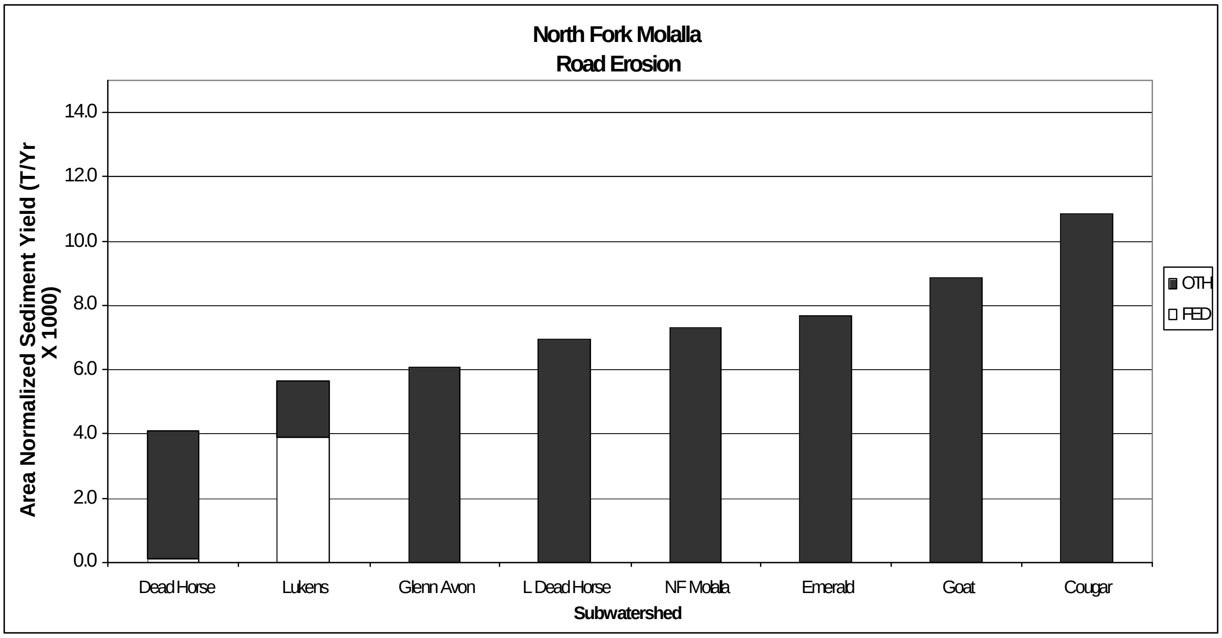


Figure 19 North Fork Molalla Analysis Area Road Erosion (Thousandths Ton per Acre per Year)

The sub-watersheds with the highest estimated road erosion rates affecting streams per sub-watershed acre (in descending order) are: Russell Creek, Pine Creek, Dickey Creek, Cougar Creek, Trout Creek, Ogle Creek, Upper Molalla, Copper Creek, and Goat Creek. Sub-watersheds with the highest road erosion rates on BLM lands in descending order are: Upper Molalla, Lost Creek, Horse Creek, Table Rock Fork, and Lukens Creek. These sub-watersheds would benefit most from road removal and should be considered when prioritizing road restoration or removal projects.

Benthic Macroinvertebrate Sampling

Benthic macroinvertebrate samples were collected in the Molalla River catchment in 1981, 1982, 1993, 1996, and 1997. Samples were analyzed for community and population structure as indicators of habitat and water quality change. Benthic macroinvertebrates are thought to be good bio-indicators of habitat disturbance. This is because they live in close proximity to streambed materials, possess relatively long life cycles, and tend not to migrate very much during their aquatic phases. Vinson (1997) stated that the combination of these characteristics allows investigators to use macroinvertebrates in assessing site-specific water quality because they integrate effects over time and are spatially representative of a small area. Natural and human-caused impacts result in a unique set of circumstances that dictate which types of benthic macroinvertebrates will occupy available habitat.

Along with identification to the lowest possible taxon level, the analyses included the use of one or two indices developed to characterize community structure. Community Tolerant Quotient (CTQ) and Biotic Condition Index (BCI) were developed by the USFS for use primarily in western states. See Winget and Mangum (1979) for a complete explanation of methods for assigning tolerant quotients for each taxon and for calculation of CTQ and BCI. In short, the CTQ is the arithmetic mean of tolerant quotients for all sampled taxa, while BCI is calculated by dividing potential CTQ by the actual field determined CTQ. BCI is expressed as a percentage of potential. Table 32 shows a summary of rankings for BCI and CTQ, habitat quality, and a suggested management strategy supplied by Winget and Mangum (1979). Table 33 provides a list of sampling locations and actual CTQ and BCI for each site.

Table 32 Habitat Management Strategies Using Macroinvertebrate Indices.

CTQ	Habitat Quality	Management Strategy
<65	High	Maintain high quality
65-80	Moderate	Habitat and/or water quality improvement
>80	Low	Habitat and water quality improvement
BCI	Habitat Condition	
>90	Excellent	Maintain high quality
80-90	Good	Maintain high quality
72-79	Fair	Habitat and/or water quality improvement
<72	Poor	Habitat and water quality improvement

Table 33 Macroinvertebrate Sampling Results.

Stream Name	Year	CTQa	BCI
Dead Horse Canyon Creek - 1	1981	43	116
- 2		47	100
- 3		48	102
- 4		45	100
- 5		49	94
- 1	1982	62	81
- 2		56	85
- 3		53	88
Table Rock Wilderness: Avalanche Creek	1993	62	89*
Bull Creek		57	96*
Dungeon Creek		61	90*
EF Hayburn Creek		63	87*
WF Hayburn Creek		60	92*
Image Creek (upper)		58	95*
Image Creek (lower)		57	96*
Lake Creek		62	89*
Scorpion Creek		67	82*

Molalla River RM 27	1996	74	74*
RM 31		70	79*
RM 39		63	87*
RM 27	1997	64	86*
RM 31		64	86*
RM 39		65	85*

*= denotes that BCI was computed using an office estimated potential CTQ (CTQp).

For 1981, Mangum (1981) reported no evidence of observed impacts or apparent dominant taxa in the macroinvertebrate analysis for Dead Horse Canyon Creek. Overall, resident populations were found in low numbers which likely was attributable to low stream productivity. The benthic macroinvertebrates were balanced between clean water species but contained a few moderately tolerant species. Mangum suggested the low population numbers as indicative of a fragile ecosystem which could be adversely affected by outside impacts. However, he found no evidence of excessive sedimentation and rated the system condition as good.

For 1982, Mangum (1982) noted an increase in CTQ resulting from an increase in tolerant and moderately tolerant species which suggested a downward trend in water quality for Dead Horse Canyon Creek. He stated that there was no evidence of increased sedimentation, but that it remains the greatest threat to water quality. The water quality and system condition ratings remained good.

Table 34 provides a summary of habitat condition derived from CTQ and BCI for all sampling locations.

Table 34 Habitat Condition Estimates from Macroinvertebrate Indices.

Stream Name	Year	CTQ Habitat Condition	BCI Habitat Condition
Dead Horse Canyon Creek 1	1981 1982	High High	Excellent Good
2	1981 1982	High High	Excellent Good
3	1981 1982	High High	Excellent Good
4	1981	High	Excellent
5	1981	High	Excellent
TRW: Avalanche Creek	1993	High	Excellent
Bull Creek	1993	High	Excellent
Dungeon Creek	1993	High	Good
EF Hayburn Creek	1993	High	Good
WF Hayburn Creek	1993	High	Excellent

Image Creek (upper)	1993	High	Excellent
Image Creek (lower)	1993	High	Excellent
Lake Creek	1993	High	Good
Scorpion Creek	1993	High-Moderate	Good
Molalla River RM 27	1996 1997	High-Moderate High	Fair Good
RM 31	1996 1997	High-Moderate High	Fair Good
RM 39	1996 1997	High High-Moderate	Good Good

It is evident that the sampling frequency and design does not lend itself to trend analysis to assess environmental change. An insufficient sampling regime does not allow for a determination of spatial or temporal natural variability. Additional samples spanning several more years would be necessary to assess possible change due to management activities exclusive of natural effects. However, sufficient data exist to make a general appraisal of overall habitat and water quality condition. The presence and increase in tolerant and moderately tolerant species at Molalla River miles 27 and 31 suggest that portions of the Molalla watershed are subjected to additional impacts, whether natural or anthropogenic. Vinson (1997) noted that the Molalla River water quality was influenced by moderate organic enrichment. Furthermore, it was noted that the management strategy for the watershed should stress maintenance of high habitat and water quality and where a downward trend may exist the improvement of both.

Mass Wasting

Recent slope and stream related failures were inventoried using 1996 aerial photographs of the watershed and tallied by sub-watershed. The 1996 aerial photos were taken after the large flood in February 1996. Only the recent failures visible on the photos were included in the assessment. The size and geomorphic position on the landscape were determined and are presented in Table 35.

Table 35 Mass Wasting Inventory.

Analysis Area	Sub-Watershed	Geomorphic Landform	Number of Failures	WFPB Class[1]	Stand Age at Head
South Fork Molalla	Copper Creek	Road	1	Medium	1982
		Road	3	Very Large	1972 - 1982
	Ogle Creek	Road	2	Large	1970
		Road	1	Very Large	1979
	Nasty Rock	Road	2	Large	1970
		Stream	1	Large	1970

	Upper Molalla	Road	2	Large	1976 - 1980
		Road	3	Very Large	1955 - 1976
		Stream	3	Very Large	1970 - 1987
		Upland/Convex	1	Small	1989
		Upland/Convex	1	Very Large	Non-Forest
Middle Fork Molalla	Joyce Lake	Road/Stream	1	Very Large	1975
		Stream	2	Large	1970 - 1975
	Lost Creek	Road	1	Large	1968
	Camp Creek	Road	1	Very Large	1970
		Road/Stream	2	Very Large	1975 - 1976
		Stream	1	Large	1970
		Stream	2	Very Large	1955 - 1962
	Table Rock Fork	Road	3	Very Large	1968 - 1990
		Road/Stream	1	Very Large	1880
		Stream	2	Very Large	1984 - 1995
North Fork Molalla	Cougar Creek 1	None			
	Goat Creek	None			
	Emerald Creek	Road /Stream	1	Very Large	1980
	Glenn Avon	None			
	Lukens Creek	Road	1	Very Large	1987
		Road/Stream	1	Large	1968
		Road/Stream	1	Very Large	1977
		Stream	1	Very Large	1971
	Dead Horse Creek	None			
	North Fork Molalla	Stream	1	Very Large	1950
	Lower Dead Horse Creek	Stream	1	Very Large	1974
Upper Mainstem Molalla	Pine Creek	Stream	1	Very Large	1985
	Bear Creek	Stream	1	Very Large	1988
		Upland/Convex	1	Very Large	1988
	Horse Creek	Road	1	Very Large	1986

	Gawley Creek	Road	1	Very Large	1989
		Stream	1	Medium	1989
		Stream	1	Large	1987
Lower Molalla	Trout Creek	None			
	Lower Molalla	None			
	Dickey Creek	None			
	Russell Creek	None			

[1] From Washington Forest Practices Board (1993). < 500 sq. yds = Small, 500-2000sq. yds. = Medium, 2000-5000sq. yds. = Large, >5000sq. yds. = Very Large

Failures listed in the geomorphic landform column as stream, or road/stream contributed sediment to streams. Those listed as road or upland/convex were contained to hillslopes and did not appear to reach surface waters. Roads played the biggest role in observed mass movement and were involved in 60 percent of the failures. Half of all failures affected streams, and most of the inventoried failures occurred in the high elevation sub-watersheds. The sub-watersheds in the South Fork Molalla analysis area contained 40 percent of the total failures, and the Middle Fork Molalla Sub-watersheds contained 33 percent. Overstory stand ages at the head of failures were essentially less than 30 years old with a few exceptions.

Cumulative Effects

Past management activities were analyzed to determine cumulative effects in the Molalla watershed. Cumulative effects analysis looks at management activities collectively regardless of ownership. Several indices are used to assess cumulative effects. These indices are tools which can be used with other watershed information to make professional judgments regarding the relative hydrologic health of a watershed. Given the complexity of watershed response to disturbance and the variable nature of weather, absolute thresholds do not work well in describing cumulative effects. However, the risk of negative long-term changes to a watershed can be grouped in high, moderate, or low categories using the values resulting from analysis. Two indices were used in this watershed analysis to assess relative watershed health: ECA and water available for runoff.

Equivalent Clearcut Acres (ECA)

ECA evaluates the total acreage in a clearcut-like condition within the sub-watersheds. It does this by multiplying the number of acres by a factor depending on the age of the harvest unit. ECA analysis recognizes that the most recent harvest activity causes the most impact, decreasing over time to a point called hydrologic recovery. Hydrologic recovery occurs when overstory canopy cover is 70 percent or greater and evapotranspiration and runoff characteristics have recovered to preharvest conditions. The calculation of ECA assumes a hydrologic recovery which varies depending on elevation and stand characteristics; however, an average recovery period of

30 years was used for this analysis. Alternative harvest treatments produce different hydrologic responses and, therefore, are analyzed differently in the calculation of ECAs. Roads, residential, and agricultural areas are considered as clearcut acres. Impacts to sub-watersheds with ECA values below 15 percent are considered low, 15 to 20 percent is considered moderate, and above 20 percent high. Figures 20 through 24 show existing ECAs by assessment area and sub-watershed. The contribution to the total ECA due to BLM forest management and all ownership roads were included in the figures. Sub-watersheds with existing ECA values greater than 20 are: Glenn Avon, Dead Horse Creek, Bear Creek, Pine Creek, and Horse Creek.

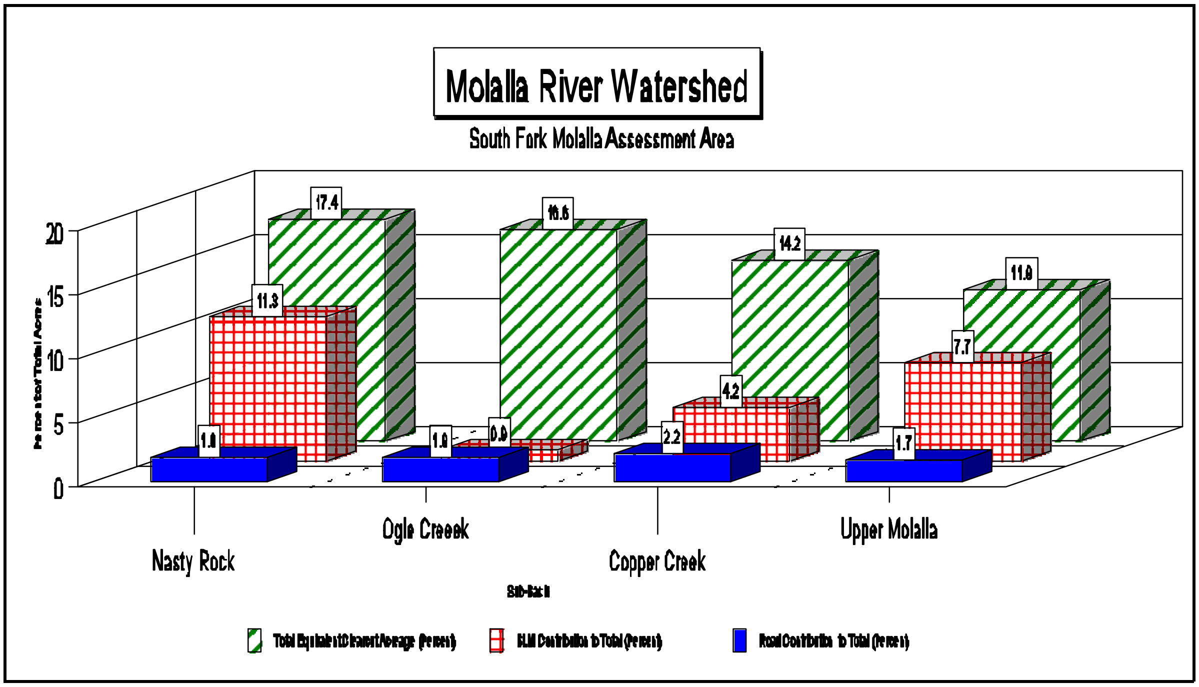


Figure 20. South Fork Molalla Assessment Area Equivalent Clearcut Acreage (in percent).

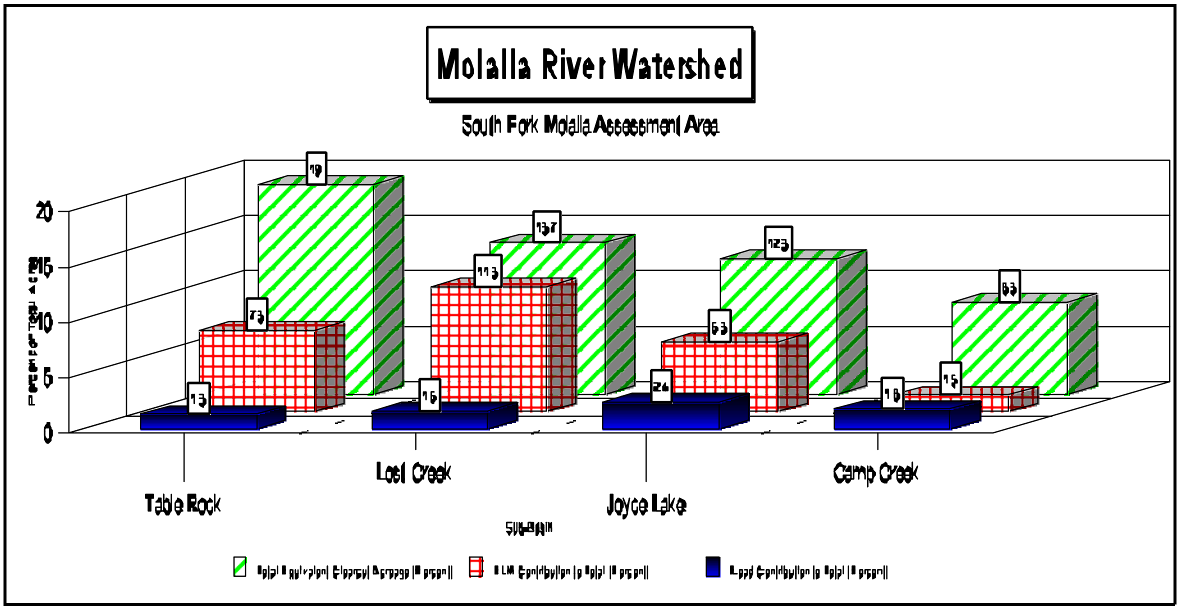


Figure 21. Middle Fork Molalla Assessment Area Equivalent Clearcut Acreage (in percent).

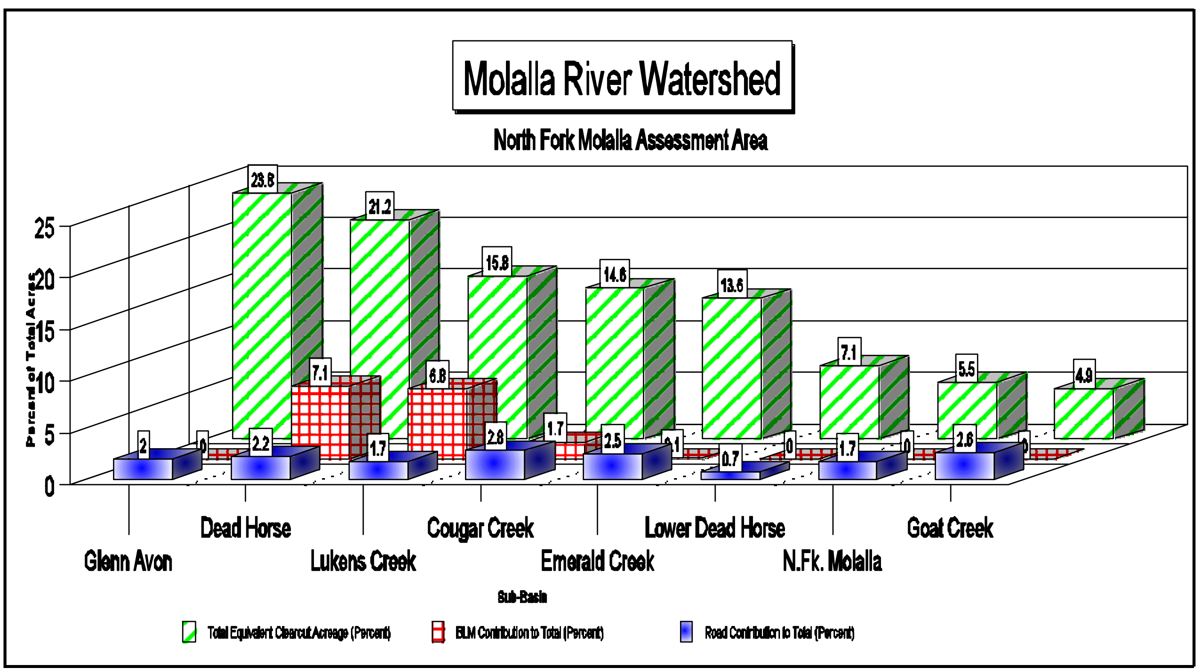


Figure 22 North Fork Molalla Assessment Area Equivalent Clearcut Acreage (in percent).

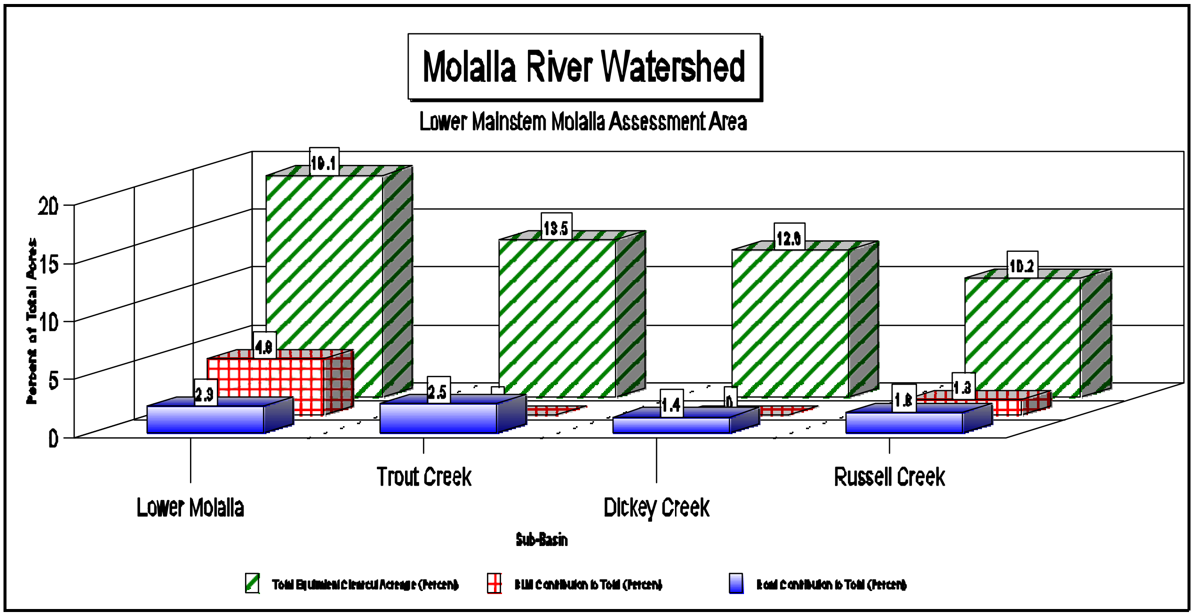


Figure 23 Lower Mainstem Molalla Assessment Area Equivalent Clearcut Acreage (in percent).

Water Available for Runoff (WAR)

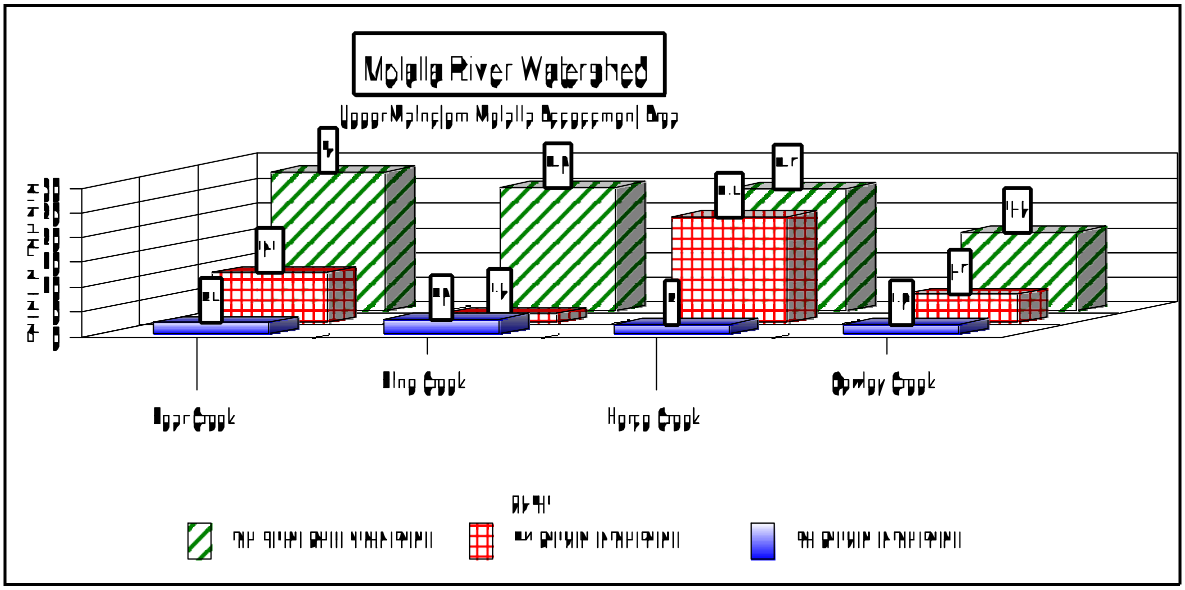


Figure 24 Upper Mainstem Molalla Assessment Area Equivalent Clearcut Acreage (in percent).

Transient snow zones (TSZ) are areas where snow normally accumulates and melts several times a winter, often melting rapidly. Openings in the forest canopy in these areas increase the amount of snow accumulating on the ground and provides more runoff when a rain on snow event occurs. The cumulative effect of increases in runoff can be large, causing flooding, stream channel, and bank damage.

Stream channel dimensions and characteristics adjust to accommodate the bankfull flows which correspond to the 2-year event in lower gradient steams and apparently to the 5-year event in steeper mountain streams (Wolman and Miller 1960, Lisle 1981, Washington Forest Practices Board 1993). Change in the magnitude of frequent flood flows can affect channel scour and may affect fish habitat.

The potential for rain on snow flow enhancement was estimated using the procedure outlined in *Standard Methodology for Conducting Watershed Analysis* (Washington Forest Practices Board 1992). The sub-watershed was analyzed using a weighting system based on the dominant precipitation type (rain, transient snow, snow) and the percent of the area with canopy cover in three different categories (open, sparse, small or large dense). The equations given in the Washington publication were modified using data from northern Oregon Cascade climate stations. Using this method, the change in water available for runoff (WAR) from a rain on snow event was calculated. The WAR values were then used to estimate increases in peak flows during storms using the USGS publication: *Magnitude and Frequency of Floods in Western Oregon* (Harris et al. 1979). Return periods are the peak flows resulting from 24- hour precipitation amounts expected at a given level of frequency; for example, once in 5 years for the 5-year return period or once in 50 years for the 50-year return period. The plus (+) sign denotes a given return period precipitation event with the addition of a heavier snow pack on the ground than average and a warmer storm than average. This situation is often responsible for the severe flood events experienced in the Pacific Northwest. The units are in percent change of cubic feet per second streamflow from a fully forested condition to the present condition. Due to the inherent error in the peakflow prediction method, changes up to 10 percent are usually below the detection limits of stream gages. Given this limitation, hydrologic change may not become visible until the percent change over fully forested condition approaches 10 percent. An increase in volume of 20 percent has been suggested as a general rule of thumb to move a 5-year flow event to a two-year flow event (Washington Forest Practices Board 1993). Figures 25 through 29 summarize predicted percent increase in peak flows under current conditions for standard storm conditions and major rain on snow events (+ storms) compared with the sub-watershed in a fully forested condition. Changes in the more frequent storm events (5 and 5+) were used as an indicator of effects on channel maintenance, dynamics, and fisheries habitat. Changes in the less frequent events (50 and 50+) may have profound effects on stream flood plains and flood-related damage.

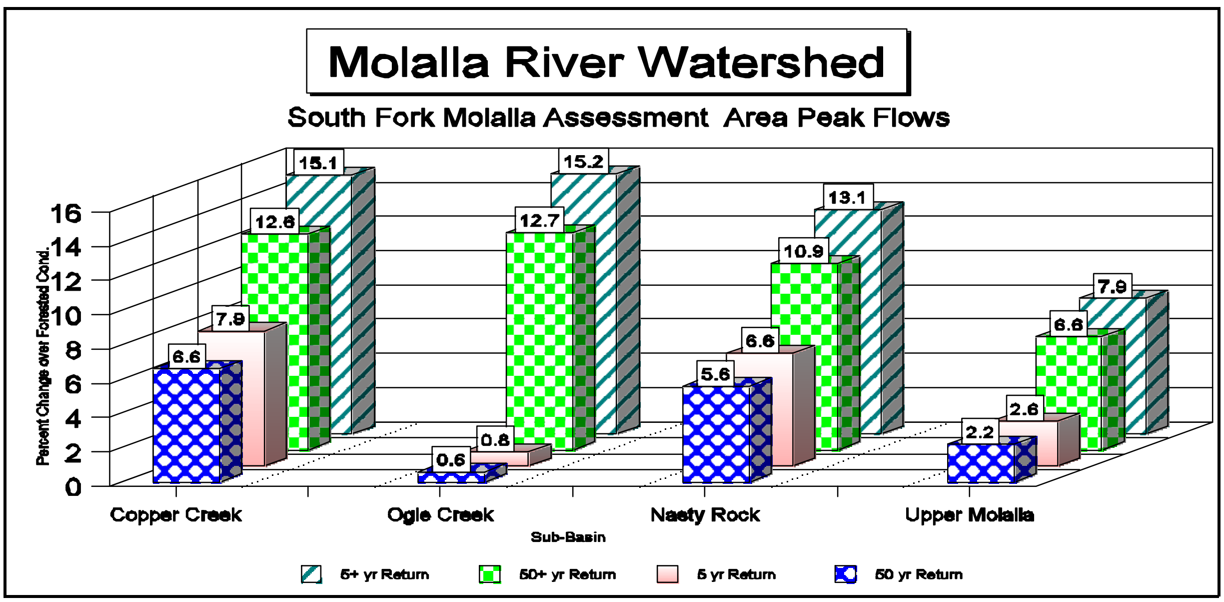


Figure 25. **South Fork Molalla Analysis Area Estimated Percent Increase in Peak Flows for Normal and Major Rain on Snow (+) Storms**.

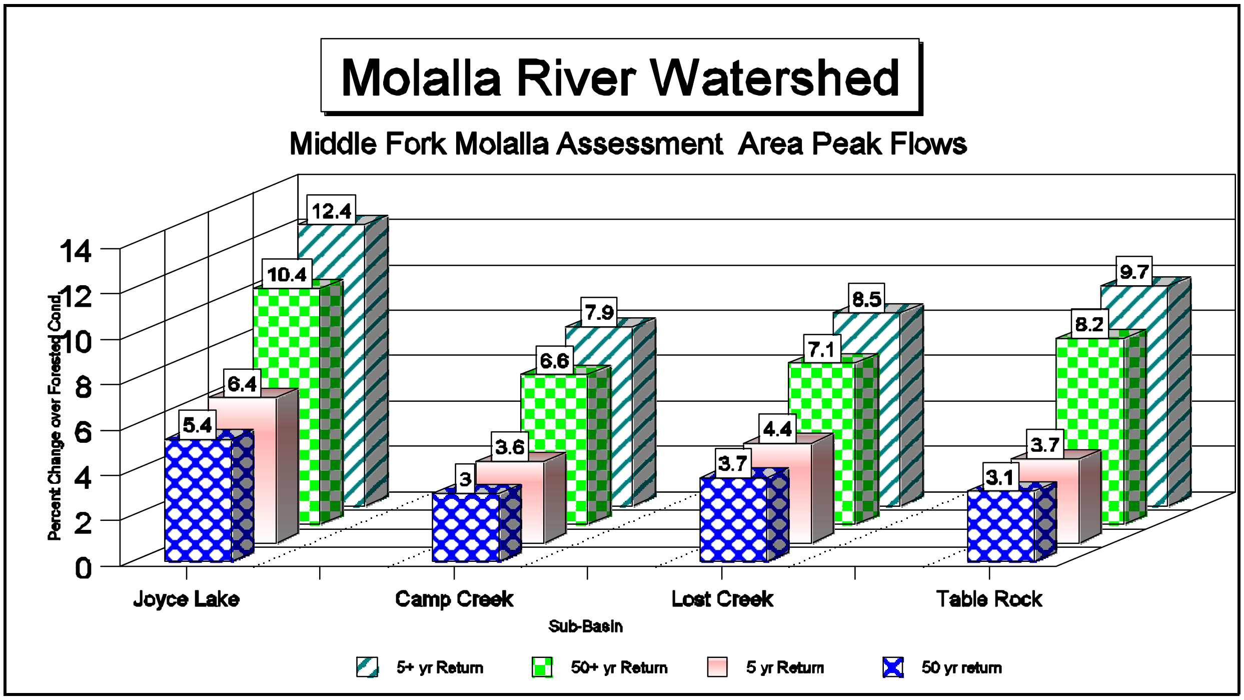


Figure 26. Middle Fork Molalla Analysis Area Estimated Percent Increase in Peak Flows for Normal and Major Rain on Snow (+) Storms.

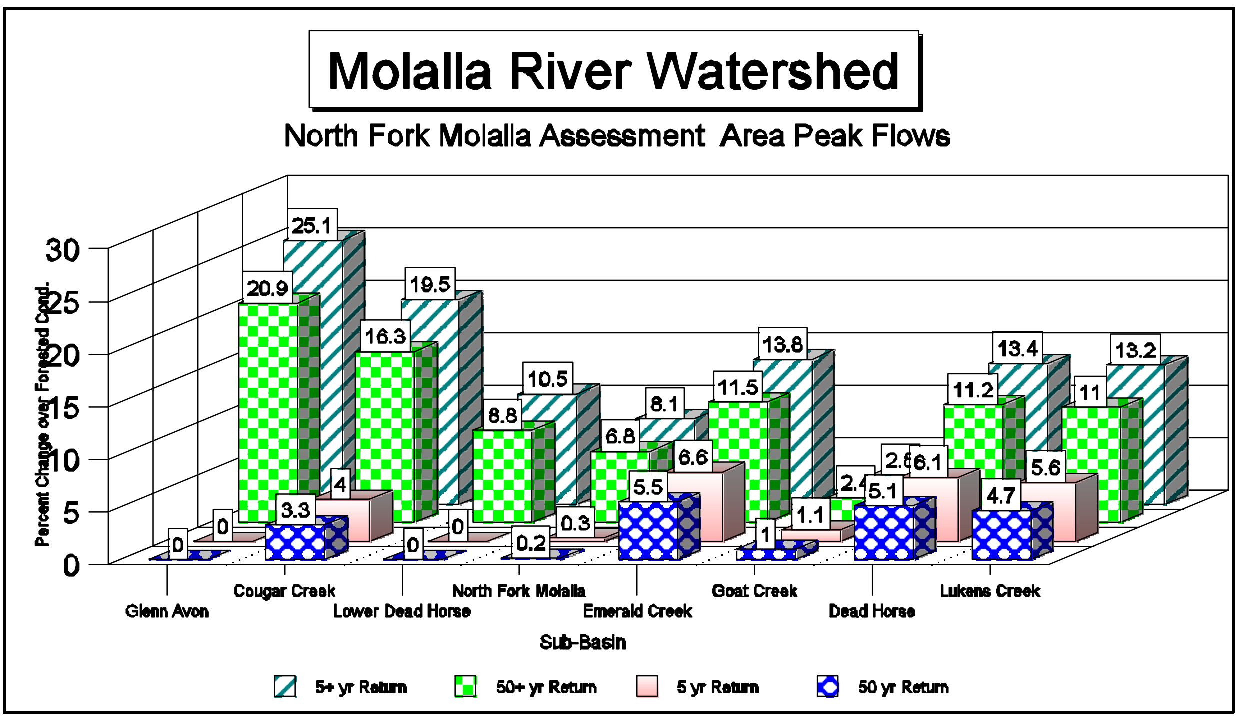


Figure 27. North Fork Molalla Analysis Area Estimated Percent Increase in Peak Flows for Normal and Major Rain on Snow (+) Storms.

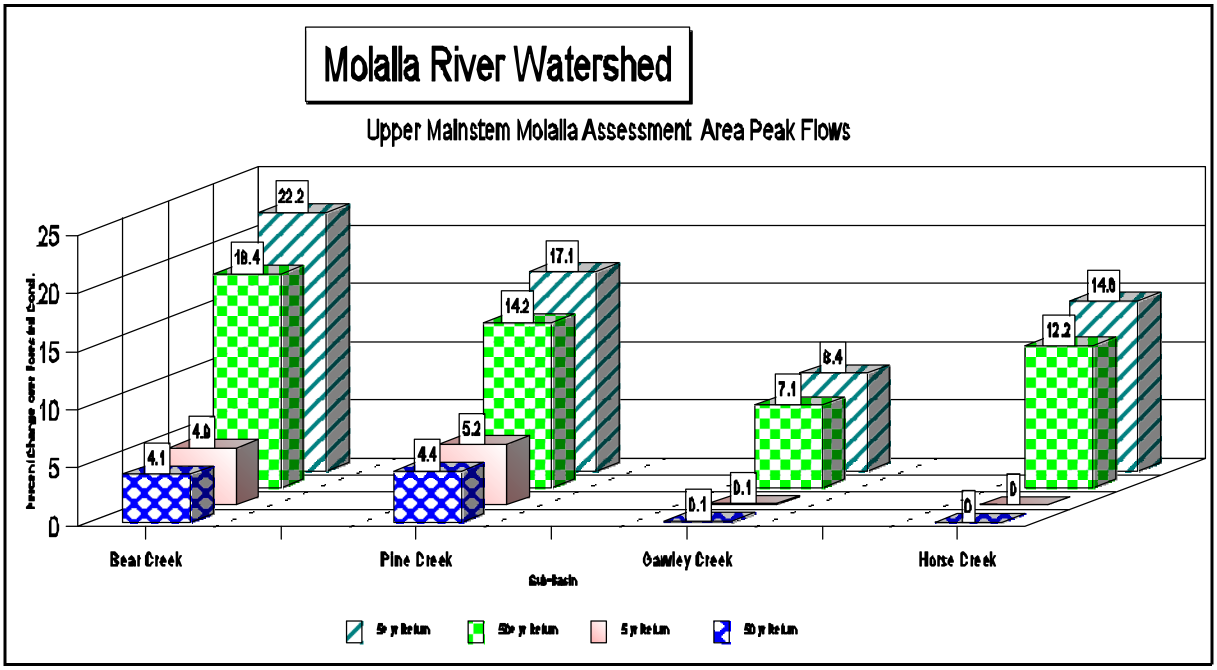


Figure 28. Upper Mainstem Molalla Analysis Area Estimated Percent Increase in Peak Flows for Normal and Major Rain on Snow (+) Storms.

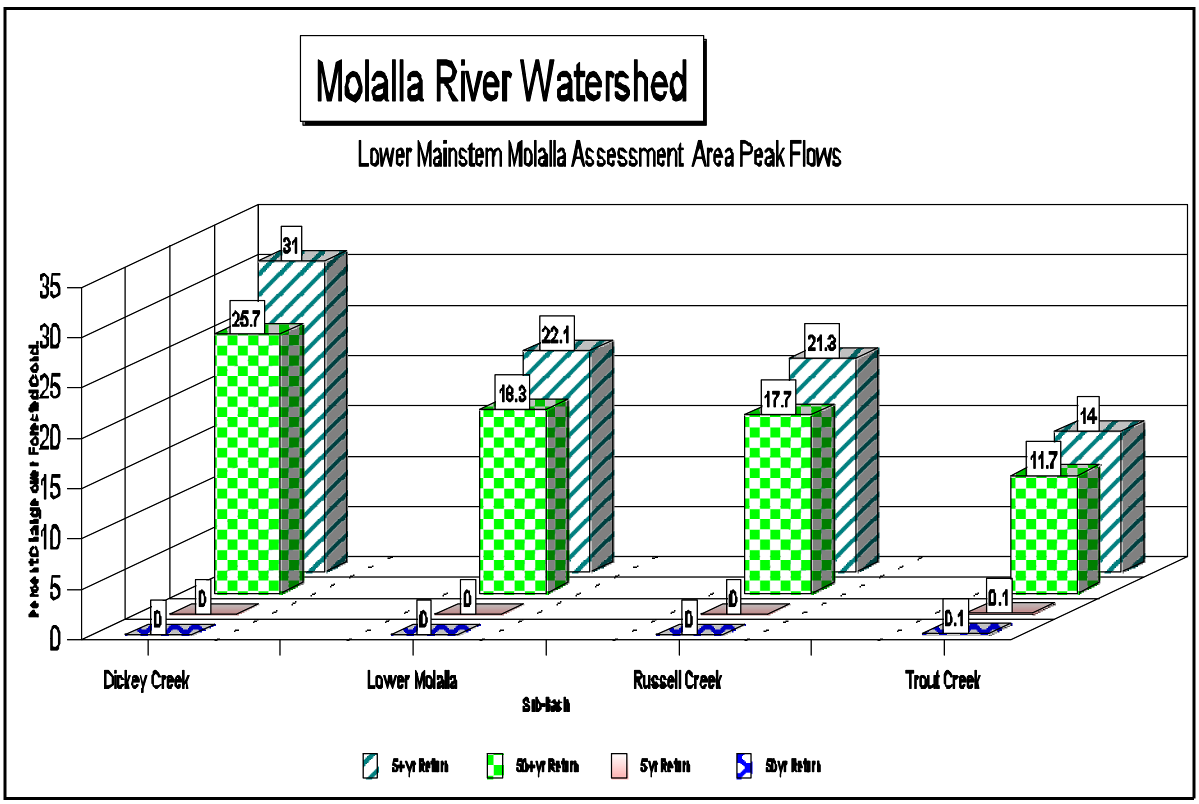


Figure 29. Lower Mainstem Molalla Analysis Area Estimated Percent Increase in Peak Flows for Normal and Major Rain on Snow (+) Storms.

The change in peak flow analysis conducted here assumed climatic conditions which are often responsible for the periodic large flood events experienced in the region. For the major storms (+) a larger than normal transient snowpack and a warm, wet storm were included in the analysis. None of the sub-watersheds indicate significant increases in Peakflow during normal snowmelt storms; however, the analysis identified several sub-watersheds with greater than 20 percent increases in the 5+ or 50+ return period rain-on-snow events. This suggests a high potential for impacts to stream channels, aquatic habitat, and flood plains during major rain-on-snow events. The sub-watersheds estimated to be in the high category for changes to peak flow are: Glenn Avon, Bear Creek, Dickey Creek, Lower Molalla, and Russell Creek.

Aquatic Species and Habitats

Fish

The Molalla River supports anadromous and resident species of fish. See Map I. Within these species are distinct stocks, some native to the basin and some introduced. The native stocks are unique in that they have evolved in conditions particular to the Molalla Basin. The native stocks of Molalla Basin salmonids are greatly reduced from historic levels due to habitat degradation, heavy fishing pressure (ocean and river), and ocean survival conditions. Native stocks may also have been weakened by hybridization and competition with introduced hatchery stocks.

The Molalla River supports native populations of winter steelhead and cutthroat trout, mountain whitefish, suckers, dace, redside shiner, and northern squaw fish. Introduced fish stocks found in the Molalla River are summer steelhead trout, resident rainbow trout, and spring chinook salmon. Spring chinook salmon are native to the Molalla Basin; however, the native run is believed to be extinct. The existing run is the result of hatchery outplanting by the ODFW.

Due to their sport and commercial value, much more information exists for salmonid fishes (salmon, trout, char, and whitefish) than for other groups. Salmonids also are highly sensitive to habitat and water quality changes, making them an excellent group to use for the monitoring of trends in the Molalla Basin. The salmonids of greatest importance in the basin are winter steelhead trout and spring chinook salmon. These species will be discussed in detail in the following section, Special Status Species.

Special Status Species

<u>Winter Steelhead Trout</u>
Status: Depressed

The proportion of Willamette Basin winter steelhead produced in the Molalla watershed is unknown. Runs of Willamette Basin early-run and late-run winter steelhead have been declining since the late 1980s and are at or near record low numbers. In 1996, a record low number of 1,322 late-run winter steelhead were counted at Willamette Falls. Early run fish are of hatchery origin, while native fish make up the late-run. In February 1994, the National Marine Fisheries Service (NMFS) received a petition to list Willamette River winter steelhead under the Endangered Species Act. In August 1996, the NMFS determined that Upper Willamette River steelhead did not warrant listing (Federal Register 1996). In February 1998 the NMFS proposed Upper Willamette River steelhead (upstream of Willamette Falls) for federal listing as threatened; the listing occurred in March 1999.

The Molalla River is considered by ODFW to be a key area for late-run, wild fish production. ODFW spawner surveys in the Molalla watershed show wild steelhead escapement has been declining since the late 1980s (Table 36). Sport catch data for the Molalla River (Table 37) also show a downward trend starting about 1990.

Table 36 Winter steelhead redds per mile, 1985-1997, based on an annual May survey of 7.05 miles of the Molalla River, the North and Table Rock forks (ODFW, 1992; unpublished data).

Year	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Redds per mile	25	20	22	22	16	15	11	15	5	19	7	3	5

Table 37 Sport Catch of Winter Steelhead by Run-Year in the Molalla River, 1982-1994 (ODFW data).

Run-year	**82-83**	**83-84**	**84-85**	**85-86**	**86-87**	**87-88**	**88-89**	**89-90**	**90-91**	**91-92**	**92-93**	**93-94**	**94-95**
Sport catch	531	1123	1028	1099	1313	1234	964	658	419	251	124	11	150

Steelhead are found in approximately 78 miles of streams in the watershed, primarily using accessible tributaries for spawning and rearing and the mainstem for rearing and migration.

Hatchery releases of winter steelhead have been conducted in the basin since 1969 using a variety of stocks; Big Creek, Eagle Creek, North Santiam River and Alsea River, reared at several hatcheries in northwestern Oregon. Hatchery releases of winter steelhead in the Molalla Basin were stopped in 1997. This was due to concerns over competition with the native stock and compliance with ODFW's Natural Production and Wild Fish Management Policy.

Spring chinook salmon
Status: native run may be extinct.

Spring-run chinook salmon are found in the mainstem Molalla River, the North Fork Molalla, and in the Table Rock Fork, using approximately 39 miles of stream within the watershed. The native run of Molalla River spring chinook is probably extinct with the present run of spring chinook believed to be of hatchery origin (J. Haxton, personal communication). As much as 85 to 95 percent of the spring chinook run in the Willamette River above Willamette Falls is hatchery produced. The hatchery fish are derived primarily from native Willamette stock. Spring Chinook releases of fry and smolts have been conducted in the Molalla River by ODFW since 1981 to reestablish runs and to provide a fishery. In February 1998, the NMFS proposed Upper Willamette River chinook for federal listing as threatened; the listing occurred in March 1999.

Instream Habitat

ODFW has conducted habitat inventories on several streams in the basin with BLM and the Oregon Forest Industries Council. Surveyed streams are shown in Table 38. Surveys began at the mouth of each stream, except for Reach 1 of the mainstem Molalla River which began at the bridge crossing at Feyrer Park. Reach changes were generally determined by changes in valley or channel form, major changes in vegetation type, changes in land use or ownership, or confluences of named tributaries. Surveys typically ended at the headwaters where the stream went dry; however, on some streams surveys were stopped at barrier falls such as Henry Creek Falls on the mainstem Molalla River. See Appendix F for a summary of habitat conditions in the surveyed reaches listed in Table 38. Changes resulting from the flood of February 1996 have not been evaluated.

Table 38 Streams With Completed Aquatic Habitat Inventories in the Molalla Watershed.

Stream	Year Surveyed	No. of Reaches	Miles Surveyed
Bear Cr.	1995	3	2.66
Camp Cr.	1994	2	2.67
Copper Cr.	1994	1	3.66
Cougar Cr.	1993	5	5.44
Deadhorse Cyn. Cr.	1994	5	8.89
Lukens Cr.	1994	3	7.72
Molalla R.	1993	10	25.31
North Fork Molalla R.	1993/1994	7	12.34
Ogle Cr.	1994	2	0.78
Pine Cr.	1993	6	7.84
Shotgun Cr.	1995	1	2.1
Table Rock Fk. Molalla R.	1994	10	11.98
Table Rock Fk. Molalla R.[1]	1996	5	7.31
Trout Cr.	1993	9	8.22

[1] Resurveyed to assess changes resulting from the flood of February 1996.

Based on benchmarks established by ODFW for the various habitat parameters included in the surveys (Appendix E), instream habitat conditions are generally fair to good in the mainstem Molalla River and poor to fair in most of the surveyed tributaries. Key habitat parameters used to evaluate habitat quality in the five assessment areas are percent pool (by area), pool frequency, (channel widths per pool), percent secondary channel and LWD volume (m^3) per 100m. LWD volume is generally low throughout the watershed. Stream substrate composition is included in the surveys but is not used for analysis purposes in this document because substrate composition may not be a limiting factor in any of the surveyed streams. The following are narrative summaries of habitat conditions in the surveyed streams grouped by assessment area. Miles of stream occupied by anadromous fish species are estimates. Restoration potential is based on current habitat conditions, land ownership, accessibility to fish, and fish species present (resident or anadromous). Restoration benefit is based on anadromous fish use and habitat conditions. Appendix F displays data on surveyed reaches by assessment area in tabular form.

<u>South Fork Molalla Assessment Area</u>

-Ogle Creek- 2 reaches (0.78 miles); Pool % and frequency are fair in Reach 1. Good LWD volume in Reach 1. Reach 2 rates poor in all categories. High gradient (9%), no secondary channels. Fish bearing, but resident only. Mostly private ownership. Low restoration potential due to absence of anadromous fish.

-Copper Creek- 1 reach (3.66 miles); Rates fair in all categories. Moderate gradient (6.1%). Winter steelhead in lower 3 miles. Mostly private ownership. Low restoration potential due to current fish habitat conditions.

-Molalla River- Reaches 8-10 (6.75 miles); Good pool % and frequency, poor LWD volume. Low gradient. Anadromous fish throughout. Approximately half BLM, half private. Private ownership in upper 2 miles. High restoration potential for debris complexes along margins and whole tree placements.

<u>Middle Fork Molalla Assessment Area</u>

-Camp Creek- 2 reaches (2.67 miles); Reach 1 has fair pool frequency, secondary channel % and LWD volume. Reach 2 rates poor in all categories. Moderate gradient (5.8%). Winter steelhead in lower 2.5 miles.

-Table Rock Fork, Molalla River- 10 reaches (12 miles); Generally fair pool % and frequency; abundant secondary channels; poor-fair LWD volume. Low-moderate gradient (1.5-6%) Anadromous fish: spring chinook for 7 miles, winter steelhead for 10 miles. Mostly BLM land in lower half, mostly private in upper. Moderate restoration potential in lower 7 miles for debris complexes along margins.

North Fork Molalla Assessment Area

-Deadhorse Canyon Creek- 4 reaches plus 1 tributary reach (8.9 miles); Generally poor in all categories except secondary channel % which is high, and LWD volume which is good in reaches 2 and 5. Moderate gradient (6.1%). Winter steelhead in lower 2.5 miles, ending at a barrier falls. Lower half is private ownership, upper half BLM. No anadromous fish on BLM. Moderate restoration potential on private land in lower 2.5 miles.

-Lukens Creek- 3 reaches (7.72 miles); Poor in all categories except good LWD volume in reach 2. Low gradient (4%). Winter steelhead in lower 5 miles. Lower 2 miles in private ownership, remainder BLM. High restoration potential with good access.

-Cougar Creek- 5 reaches (5.44 miles); Poor condition in all categories. High gradient (8.3%). Winter steelhead in lower 3 miles (6.6% gradient in anadromous zone). Almost entire basin in private ownership. High restoration potential in lower 3 miles.

-North Fork Molalla River- 7 reaches (12.34 miles); Poor condition in all categories except pool % in reaches 1 and 2 (fair) and secondary channel % in reaches 4 and 5 (good). Moderate gradient (4.2%). Spring chinook in lower 6 miles, winter steelhead in lower 16 miles. The entire North Fork Basin is in private ownership except portions of Deadhorse Canyon and Lukens creeks. High restoration potential on private lands, particularly in lower 6 miles.

Upper Mainstem Molalla Assessment Area

-Gawley Creek- BLM survey, 1992; 2 reaches (2.7 miles); High LWD volume; high pool % in Reach 1. Low-moderate gradient (5%). Winter steelhead in lower 2.5 miles. Approximately half BLM, half private. Good habitat quality, low restoration potential.

-Bear Creek- 3 reaches (2.66 miles); LWD volume is high in all reaches, pool frequency and secondary channel % are good in Reach 1 and fair in Reach 2. Reach 3 (0.2 mile length) is without pools. High gradient (12%). Suspected use by steelhead in lower 1 mile, however, access for fish is difficult except at very high flows due to steep cascade at the mouth. Low restoration potential due to poor access and low benefit due to limited use by anadromous fish.

-Shotgun Creek- 1 reach (2.1 miles); Poor ratings in all categories. Fish-bearing, resident only. High gradient (14%). Private ownership except lower 0.75 mile. Low restoration potential due to absence of anadromous fish.

-Pine Creek- 6 reaches (7.84 miles); LWD volume is high in reaches 3 and 5, secondary channel % is good in reaches 1-5. Poor ratings in all other categories. High gradient (8%). Suspected use by winter steelhead in lower 1 mile. All but lower 0.25 mile in private ownership. Low restoration potential due to limited use by anadromous fish.

-Molalla River- Reaches 5-7 (7.64 miles); Excellent pool percentages, fair pool frequencies. Poor secondary channel % and LWD volume. Anadromous fish throughout. Entire corridor BLM administered. High restoration potential, mainly for debris complexes along margins.

<u>Lower Mainstem Molalla Assessment Area</u>

-Trout Creek- 9 reaches (8.22 miles); Poor ratings in all categories except pool % and frequency in Reach 1 and secondary channel % in Reach 5. Winter steelhead in lower 2 miles. Moderate gradient (5.5% in anadromous zone). Entire basin in private ownership. Moderate restoration potential on private lands in lower 2 miles.

-Molalla River- reaches 1-4 (10.92 miles); Excellent pool percentages, pool frequencies throughout. High secondary channel % in Reach 1 (6.13 miles). Low LWD volume throughout. Anadromous. Private ownership in lower 7 miles. Fair restoration potential, mainly for debris complexes along margins.

Social Setting

Human Uses and Activities

What are the major human uses and use trends in the watershed and where do they occur? What makes this watershed important to people?

Human use is the predominant disturbance factor in the Molalla River watershed. Many of the human influences on ecological processes in the watershed such as fire, forest management, and roads are discussed in the terrestrial and aquatic sections of this chapter.

The intent of this section is to provide information about the current social uses and human interaction within the watershed and the region in which the watershed is contained. Understanding the ecology of the watershed requires understanding of human interactions with the terrestrial and aquatic elements of the watershed and what potential future interactions to expect. Discussions of these interactions include all human disturbances, whether intentional such as commodity extraction and commercial or municipal use, preservation and recreation or unintentional such as fire or introduction of exotic species. This section also provides a brief description of the social and economic situation in the surrounding area. Human land uses and activities within the watershed include agriculture, forestry, recreation, limited residential development, as an upstream source for domestic and municipal water supply, and some cultural activities and values.

This summary of the social setting reviews and evaluates the relative importance of the watershed for the provision of social benefits from the larger perspective of the sub-basin and region. It briefly outlines the relationship and contribution of this watershed to the significant uses and needs of the region. This includes socioeconomic values provided by the watershed and how that fits with economic strategies of local communities.

Human Uses and General Socioeconomic Environment

Clackamas County was selected as the scale of analysis because it includes nearly all of the lands in the Molalla watershed and most of the communities within the zone of influence to those lands.

The Molalla watershed lies entirely within the southern portion of Clackamas County except a few hundred acres in the upper reaches of Copper Creek in Marion County. The major socioeconomic information sources for this analysis are the *1996 and 1998, Regional Economic Profile # 15*, prepared by the Oregon Employment Department.

The closest incorporated communities are Molalla, Scotts Mills, and Estacada. The larger nearby population centers in proximity to the watershed are Salem, Woodburn, and Canby.

Human History

The ecosystem of the upper Molalla watershed has long been influenced by humans. Very little is known about pre-Euro-American exploration and settlement. Several prehistoric human use sites have been recorded within the watershed. It is believed that the area was used incidently, and indigenous people did not occupy the watershed in large numbers. However, due to extensive private ownership and much historic land use activity in the watershed, most of the watershed has not been intensively surveyed. Cultural sites, if any, could have been disturbed or obliterated. It is known that when Euro-Americans first entered the area they encountered Native Americans speaking the Molalla language. The Native Americans in all likelihood used the watershed for hunting and gathering activities. They may have also used fire to manipulate vegetation for enhancing big game hunting and berry picking conditions.

Much of the watershed is still sparsely inhabited. The lower reaches near Dicky Prairie and downstream from the confluence of the North Fork Molalla have the most residential development. Earliest settlement occurred primarily near and downstream from Molalla. The landscape north of Highway 211 is marked by rolling hills, creek valleys and highlands. It was settled first as it was more suitable for farming. The lands in the watershed, to the south and east of Highway 211, are more rugged and remote, cut by streams and creeks, and were settled later. Much of the watershed remains in forested and largely undeveloped condition.

Socioeconomic Background

This analysis of the social setting and economy of the region around and including the upper Molalla watershed was based on Clackamas County demographic and employment data from the U.S.Bureau of Census, Clackamas County Department of Transportation and Development, and socioeconomic data obtained from the cities of Estacada and Molalla.

Clackamas County spans a geographically diverse area west from the crest of the Cascades to the Willamette Valley. The county also contains a broad range of social environments and conditions ranging from urban, highly developed cities and suburbs of the Portland Metropolitan area to rural areas including farms, forests, and primitive wilderness areas. The Molalla watershed is in the southwest portion of the county, a rural area bordering largely undeveloped public lands and forests. The watershed is dominated by agricultural and forestry land uses.

The economy of Clackamas County expanded considerably during the middle of the 19th century to satisfy demand for agricultural and forest products. Traditionally, these two industries have formed the economic base of the county. In the last twenty years, the county has absorbed many of Portland's industrial "move-outs" and developed a significant concentration of metals and machinery manufacturing and warehousing firms. In the 1970s, rapid in-migration to Oregon, especially into the Portland metropolitan area, fueled Clackamas County's lumber and construction industries. Retail development also expanded rapidly aided by new highways and transportation improvements. Agricultural products and environmental services are two key industries which have gained and contributed to regional job growth. Other industries such as forest products, high technology, metals, and tourism/recreation have been identified as critical components of economic development and diversification strategies.

Population

Clackamas County is the third most populous county in Oregon with a population of 313,000 (1996). The county has a population density of 160 persons per square mile; one of only five counties averaging over 100 people per square mile in the state. Clackamas County is one of the fastest growing counties in Oregon, with the population increasing more than 70 percent from 1970 to the present. Rural areas of the county have not grown as quickly, averaging about 40 percent.

The two closest incorporated cities are Estacada and Molalla to the north. Molalla, the nearest city to the watershed, has a population of 3,825 (1990). The population in the surrounding area (10-mile radius from Molalla) was 14,658 in the 1990 census. The population of nearby Estacada is about 2,025, with a total population of the surrounding area of 33,423. For every person who lives in town, six others live in rural unincorporated areas surrounding Estacada and Molalla.

Economy and Employment

Clackamas County has a diversified economy with employment distributed across many different economic sectors. Trade-related industries account for the most jobs in the county, followed by services, manufacturing, and government industry groups. While not the largest employment industries in the county, agriculture and forest products industries continue to be key components of local economy near the watershed. Employment within the county as a whole is less dependent on agriculture and manufacturing (forestry, lumber, wood, and paper products) than are the local communities. Historically, lumber and wood products had supplied the largest percentage of Clackamas County's manufacturing jobs, accounting for more than 40 percent in 1976 and 20 percent in 1986. However, that proportion had fallen to just under 17 percent in 1996. Less than five percent of the county's work force is directly dependent on farming, forestry or fishing industry occupations (Regional Economic Profile for Region 15, OED, 1998). This countywide average is in contrast to local areas where more than one third of all employment is related to manufacturing, agriculture, and forestry (Molalla Demographics, National Decision Systems, 1989).

Estacada and Molalla have been identified as economically depressed or stagnant communities, heavily dependent in the past on lumber and wood products related industries. Unemployment in both communities is twice the county's average, averaging more than eight percent primarily due to a combination industry automation and a decline in wood fiber availability. City and county economic development strategies continue to stress agriculture and forest products industries as key economic components. They also emphasize the need to diversify their economies with development of such industries as environmental services, high technology, metals fabrication, recreation, and tourism.

The Molalla watershed's major potential for contributing to the area's socioeconomic health is tied most to providing wood products, meeting water supply needs, and offering both developed recreation opportunities such as campgrounds and trails and dispersed recreation areas for activities such as hunting and fishing.

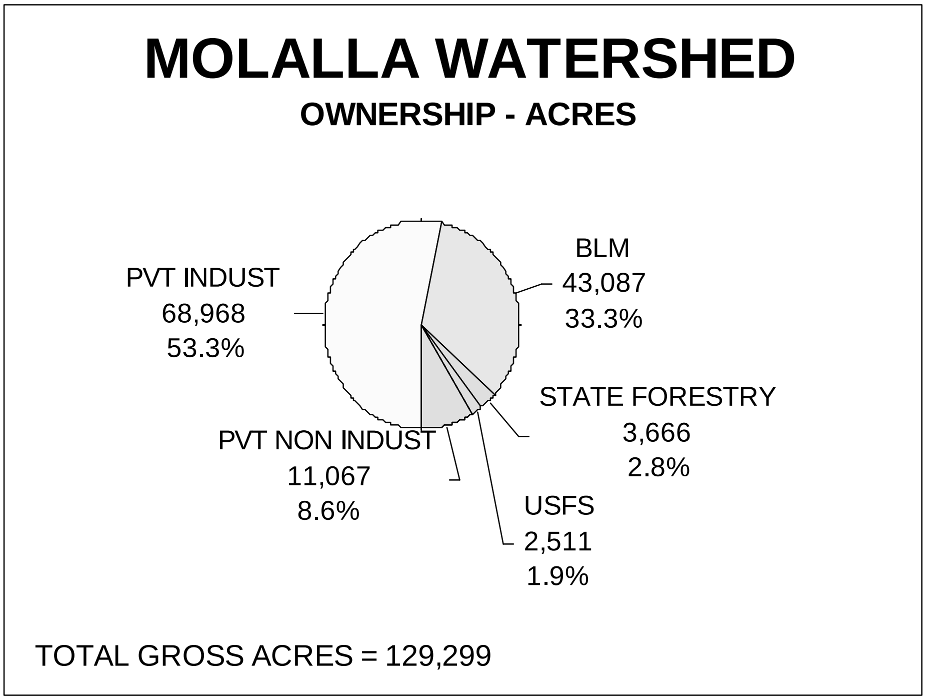


Figure 30

Forest Products and Agriculture Uses

Commodity values of the Molalla watershed are typical of the region. Agriculture and forest products contribute to basic elements of local and regional economies. Almost two-thirds of the watershed's acres are private lands managed for agricultural and forest uses. A continued but limited supply of forest products from public lands will contribute to a more sustainable and reliable source of timber for local mill operations over a multi-year period. Such a strategy is consistent with and supports economic development strategies for Molalla and Estacada. However, it should be noted timber production from public lands is not a major component of Clackamas County agricultural and forest products economy. The most significant component of the area's forest products economy is provided by private industrial forests and Christmas tree farming.

Current ownership patterns are reflected in Figure 30.

Industrial Forest Lands

Private industrial forestry is the predominant land use in the Molalla watershed. Approximately 53 percent (68,968 acres) of the lands in the watershed is managed by large private timber companies for the primary purpose of providing commercial timber products. About 9 percent (11,067 acres) of the lands in the watershed is owned by private nonindustrial wood lot owners.

Most of this land has been well used and roaded for some time. The current conditions are the direct result of post settlement fires in the mid to late 1800s and logging that began in the 1930s. Logging accelerated following WWII and continues to the present day. Logging was in large contiguous blocks resulting in the large uniform young age classes that dominate the landscape on private lands today. A dominant feature is a rather uniform stand of 40- to 50-year-old conifers in the North Fork Molalla and Trout Creek sub-watershed basins. These were the areas where logging and forest management first began. This early logging was probably in the largest concentration of old growth close to civilization and was probably one of the few areas missed by the early settlement fires. The last of the private old growth was cut in the early 1970s in the Copper Creek and Ogle Creek sub-watershed basins.

Most private industrial forest companies seek to meet the economic objectives by managing their lands on a sustained yield basis. However, changes in economic factors and company policy can significantly affect harvesting levels and practices in the short and long term. Therefore, general assumptions about the management of private industrial forest lands in the watershed must be made. These assumptions are based on observed past and present management practices, verified by local contacts and other available information. For the purposes of this analysis it is assumed private industrial forest land in the upper Molalla will continue to be managed for commercial timber products on a sustained yield basis, with an average rotation age of 50 to 60 years.

Management practices among the small percentage of private wood lot owners also vary. Therefore, it is assumed that these lands would be managed similar to private industrial forest land or combined with agricultural uses such as Christmas tree farming. Private industrial and small wood lot owners are required to meet standards and guidelines provided in the OFPA. These assumptions would be subject to any new information gathered in the future.

State of Oregon Forest Lands

The state of Oregon manages 2.8 percent (3,666 acres) of land in the Molalla watershed. These lands are mostly in the Gawley Creek sub-watershed basin (see Ownership Map B). They have historically been managed to provide a continued source of revenue to counties and the state general fund on a sustained yield basis and have been actively managed since the 1960s. Past cutting patterns reveal a patch work of current age classes ranging from young plantations to mature and over mature stands.

BLM and Forest Service Lands

The BLM manages 33.3 percent (43,087 acres) in the Molalla watershed and the USFS manages 1.9 percent (2,511 acres). Management activities on these lands follow the Northwest Forest Plan, the BLM's Resource Management Plan, and USFS planning documents.

Timber management activities on BLM-administered lands are tied to the land use allocation specified in the *Salem District Resource Management Plan (RMP*, 1995). The timber management activities on federal lands would exceed the protection requirements of the Oregon State Forest Practices Act. BLM/federal PILT payments and O&C revenues resulting from this watershed are a very small percentage of county revenues. This is primarily due to the private ownership of most of the lands within the watershed.

Most of the federal land is forested. A major portion is 100 to 120 years old that originated after settlement fires in the mid to late 1800s. See Figure 31 for current age class distribution. Intensive forest management began in the early 1960s and continued aggressively through the 1980s. The dominant feature is the Table Rock Wilderness that straddles an east-west oriented ridge between the Table Rock Fork and Upper Molalla sub-watershed basins. This is mostly an uncut forest about 110 years old that resulted from wildfires during settlement times. Most of the rest of the federal lands have been fragmented with patch cuts and are well roaded. Two major land exchanges resulted in picking up large blocks of young age classes along the Lower Molalla River and Nasty Rock sub-watershed basins. Note the bulge in the 20-to 30-year age class in Figure 31. The remaining old growth is along the east boundary of the watershed.

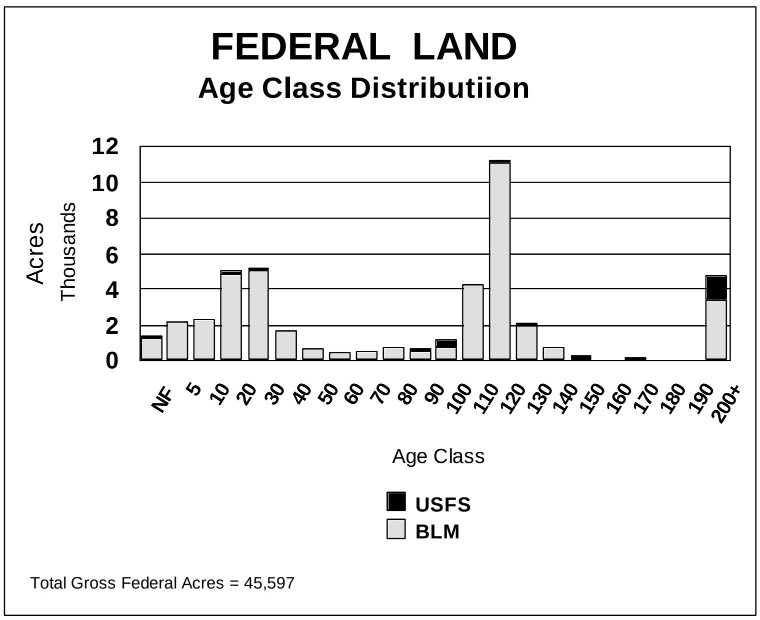


Figure 31

Agricultural Uses

Agriculture is limited to private lands along the ridges above the Lower Molalla, Dickey Creek, Russell Creek, and Glen Avon sub-watershed basins. These lands are less than one percent of the watershed. They are used for hay and pasture, Christmas trees, or grass and grain fields. This land use pattern is not expected to change.

Special Forest Products

The collection of Special Forest Products (SFP's) for personal and commercial use is allowed on BLM-administered lands in the watershed according to the guidelines identified in the RMP. No detailed inventory data on the type and amount of SFP's in the watershed is available. Permits for the collection of SFP's are issued in response to requests. Based on past permits issued, some SFP's most likely collected in the watershed include fir boughs, mosses, mushrooms, transplants, burls, edible plants and floral and greenery, and non-saw timber wood products like firewood. The collection of moss is the most popular commercial SFP in the area. Authorized and unauthorized collection of similar SFP's also probably occurs on private land.

Roads and Transportation Systems

Roads have obvious physical effects on the ecosystem from providing human access and resulting activity plus increasing runoff, sedimentation, and other effects on water quality. Water quality concerns related to roads are discussed in the hydrology section of this assessment. Highway 211 and Dickey Prairie Road access the watershed area from the north. The Molalla Forest Road, a paved, two-lane BLM-controlled county road, is the primary access route into the watershed as it parallels the Molalla River. Many turnouts are present and are used by visitors for parking and access to the river. Forest Service Road #7010, a primarily one-lane graveled forest road, reaches the watershed from the south. However, traveling it is difficult and usually only appropriate for high clearance vehicles.

Population growth has been somewhat limited due, in part, to the accessibility of the area from the urban centers and major travel corridors. The narrow and relatively poor condition of these roads may have contributed to the slower growth of the region.

In recent years, public use and visitation to most of the watershed has been limited due to the closing of roads on private lands. Many gates have been installed in the watershed which limit access to non-public lands. Additionally other roads are overgrown or have been blocked to allow for restoration. Approximately 64 percent of the total road miles in the watershed are closed to public use by gates or otherwise blocked or undrivable. An additional 20 percent are at least seasonally closed. Open (accessible) road densities across the watershed are estimated at 2.24 miles per section, which is considered low to moderate. Open (accessible) road densities on federal lands average 2.5 miles per section, which is considered moderate.

Major Concerns

With the increasing regulation and restriction of forest management activities on private and public forest lands, private industrial forest landowners are concerned with maintaining their ability to manage their lands according to the companies' objectives. This is a general concern that applies to many areas, not just the Molalla watershed. Because of the mixed ownership pattern in the Molalla watershed, access rights across BLM lands and other lands is also a concern. Other general concerns are associated with public use such as illegal dumping, equipment damage, vandalism, fire danger, long-term occupancy, and the unauthorized removal of forest products. Due to problems with long-term occupancy and fire concerns, access to private lands along Molalla Forest Road has been closed with gates. Many of these same access and public use concerns would be applicable to the other land owners and managers in the watershed.

In contrast to the landowner concerns, there are individuals and organizations at the local, regional, and national level, concerned about the impacts on overall forest and ecosystem health, resulting from timber harvest on private and public lands. *The Northwest Forest Plan and the Salem District Resource Management Plan* have attempted to address many of these concerns for BLM-administered lands in the Salem District. It is hoped that the data gained in this watershed analysis will also help identify and address more site specific concerns before project planning begins.

Rural Interface and Residential Use

Because of the BLM's patchwork pattern of ownership, BLM-administered lands, primarily in the lower Molalla watershed are interspersed with residential dwellings and non-forest uses such as Christmas tree farming or livestock raising. Many homes are directly linked with the agricultural and livestock raising uses. Much of the non-forest use is at lower elevations in the sub-watershed basins. Forest management activities on BLM-administered lands located beside or near private non-forest uses, especially residential dwellings, can create potential concerns for the BLM and the residential property owners. To address these concerns early in the project planning process, areas with a potential for high sensitivity were identified in the RMP as Rural Interface Areas (RIA's). The RIA's include areas where there are residential dwellings or zoning within ½ mile of BLM-administered lands.

The Molalla watershed has about 6,000 acres of RIA's. All identified RIA's are in the northwest corner (downstream end) of the watershed. This includes all lands within a ½-mile or rural residential areas. The residential concentration around most of the RIA's is low and is associated with farming or the raising of livestock. Timber management activities on private industrial forest lands occur next to or near many of the RIA's.

Most of the Molalla watershed is zoned by Clackamas and Marion counties for forest conservation uses. This zone requires a minimum lot size of 80 acres. If this zoning continues, replacement of agricultural or industrial forest lands with residential uses near the RIA's would be slow. Some rural residential and exclusive farm or farm/forest use zoning is found in the northwest corner of the watershed.

The expected intensity of forest management activities within the RIA zones is guided by the Land Use Allocation (LUA) listed in the RMP. All of the RIA's in the Molalla watershed fall into one or more of three LUAs. The four LUAs include GFMA, Connectivity (CONN), LSR, and Riparian Reserve (See Land Use Allocation/Riparian Reserve Map G). The intensity of forest management activities would be greater for RIA's in GFMA than CONN. Expected timber harvest activities in Riparian Reserves are generally low. Riparian Reserves are intermixed with the GFMA and CONN, so they may help provide buffers depending on the specific project proposal and site characteristics.

For this analysis, the RIA's were identified by levels of sensitivity to forest management activities. Only BLM-administered lands within RIA's greater than five acres are included.

High Sensitivity Rating

Areas rated as having high sensitively to forest management activities due to their proximity to BLM lands are in the residential development near Dickey Prairie and Glen Avon. Residents in these areas have expressed concerns about the removal of mature forest. The concerns were associated with impacts to water quality, flooding flows, wildlife, visual and recreation resources.

Moderate To Low Sensitivity Rating

The major determining factor for moderate to low ratings was the concentration and number of residential dwellings in proximity to BLM-administered lands. Those RIA's with several residences nearby received the higher sensitivity rating than those with one or two homes. RIA's with low ratings, especially a number of small inholdings surrounded by forest lands, also tended to be larger parcels and have more of a buffer private forest land between BLM-administered lands and private homes. These areas would include the Bee Ranch area and along Sawtell Road. No complaints or concerns from nearby property owners have been documented in the past for any of these RIA's.

Major Concerns

Many public use concerns described for the industrial forest owners would apply to the residential and agricultural landowners as well. Since most of these landowners are down stream from the forest lands, they have concerns about the potential for negative impacts of timber management activities on water quantity and quality, flooding flows, visual aesthetics, and recreational resources and disturbances associated with timber harvest activities (noise, smoke, etc.).

In addition, due to the proximity of the watershed to urban areas, rural interface issues such as criminal activity, illegal dumping, shooting, vandalism, drug manufacturing and marijuana production, gang-related activity, partying, and transient camps are critical management issues. Such activities pose visitor safety and resource damage threats within the watershed. More easily accessible areas, especially those along the Molalla Forest Road and the Molalla River are prone to these types of activities.

Recreation and Visual Resources

The Molalla watershed offers a variety of dispersed recreation opportunities in pastoral settings of the Willamette Valley and forested settings in the foothills of the Cascade Mountain Range. Federal public lands make up only a third of the watershed. The public lands are intermixed in a patchwork of ownership (see Ownership Map B) with private lands primarily owned by commercial timber companies.

The Molalla River and watershed offer exceptional recreation opportunities for fishing, hunting, day-hiking, dispersed camping, non-motorized boating, picnicking, and swimming/wading. The river corridor also offers opportunities for bike riding, horseback riding, and nature study. The river corridor and portions of the upper watershed are accessible by car and attract visitors from throughout the region and outside the region.

The river's proximity to Portland and Salem urban areas, combined with the river's relatively natural condition and easy access, makes it an outstanding local and regional recreational resource. The recreational values provided by the Molalla River have been recognized as an integral component of the region's recreational opportunity spectrum. From a regional and statewide perspective, few rivers in the state offer such ease of access and variety of recreational opportunities in a relatively natural and undeveloped setting so close to a major urban area.

Federal, state, and county agencies have noted the recreational values and regional importance of the Molalla River. High estimates of the river's visitor use also show the popularity and importance of the area as a local and regional recreation resource.

Recreation Opportunity Spectrum (ROS)

The ROS planning system was used to inventory the recreation resources on private and public lands; it was also used to more clearly classify the recreational experiences within the watershed. ROS considers access, remoteness, naturalness, facilities and site maintenance, social encounters, visitor impacts, and visitor management in classifying recreation opportunities. There are seven major categories: primitive, semi-primitive non-motorized, semi-primitive motorized, roaded natural (RN), roaded modified, rural, and urban. The Molalla watershed offers a wide range of recreation experiences, from primitive recreation opportunities in the wilderness, to the more accessible and developed rural and roaded opportunities.

The natural setting on private and public lands for most of the watershed has been significantly modified in many areas by timber harvest activities and high road densities. Most of the on-site controls of recreational use on private lands are associated with gates and restrictive signing. Recreational signs, trails, and limited development is provided on BLM-administered lands.

Existing Developed Recreation Facilities

There are limited developed recreation facilities in the roaded setting along the Molalla River within the watershed. The Hardy Creek trailhead has been developed to provide parking and vault toilet facilities for an extensive non-motorized trail system. The Molalla River Shared-Use Trail system offers more than 50 miles of single-track and old forest roads for hiking, mountain biking, and horseback riding. In addition, several primitive camping areas have been identified and developed with simple metal fire rings to help concentrate and direct campers to specific locations and reduce resource impacts.

The closest developed recreation site is Feyrer County Park and Campground located north of the watershed and just southwest of Molalla on the river. Feyrer County Park is a popular day-use and camping area with parking, restrooms, camping, and picnic facilities.

Recreation Activities

With few developed recreation sites, and little public access to private land, recreational activities within the roaded setting are primarily limited to those which occur on or near public roads, such as camping, hunting, fishing, picnicking, swimming and wading, nature study, and scenic driving. Extensive hiking, horseback and bicycle riding activities occur due to the Molalla River and Table Rock Wilderness trail systems. Old rock quarries on private and public lands are being used for target shooting. There is also evidence of target shooting in many of the dispersed campsites. Indications and impacts from low to moderate levels of OHV use are observable on and off existing roads. As private lands in the surrounding area are closed, OHV activities on public lands may increase.

The river is recognized for its fine steelhead fishery, especially the winter run. Ease of access, proximity to Portland and Salem, and the good fishing make it a popular sport fishing destination.

The Molalla River is considered a convenient day trip for rafters and kayakers looking for a one-day intermediate white water run. White water use occurs primarily between the Horse Creek Bridge area and the Glen Avon Bridge area. This segment is recognized in guidebooks as an easily accessible (from the Portland metro area) Class III and IV white water run during spring runoff. Most boating use occurs during the winter and spring when water levels allow easy passage. Smaller boats will use the river through much of the summer in wetter years. No reliable data exist regarding specific use levels for boaters on this segment. Informal observations consider use levels on weekends during late spring rafting/kayaking season quite high. The report on Recreational Values on Oregon Rivers (Oregon State Parks, 1987) found the Molalla to be an outstanding resource for fishing, drift-boating, canoeing, and kayaking. In addition, the North Fork Molalla River is considered a challenging opportunity for expert kayakers; however, the access road is controlled by private landowners and is closed by a gate.

Commercial recreational use of the watershed is limited to occasional horseback riding trips, nature study tours, guided upland hunting, and some river rafting activities.

Significant Features

The most significant features for recreation in the watershed include: the main river and the major tributaries of North Fork Molalla, Copper Creek and the Table Rock (middle) Fork; the Molalla River Shared-Use Trail System; Table Rock Wilderness and the Peachuck Lookout and the Joyce Lake area and the old Baty Butte Trail system in the upper reaches of the watershed.

The Molalla River from the confluence of the Table Rock (middle) Fork and Copper Creek to the Glen Avon Bridge was found eligible as a National Wild And Scenic River when inventoried as part of the Salem District RMP (1995). The river has a potential wild and scenic river classification of “recreational” due to its roads, road embankments, and forest management activities present throughout much of the segment. The river was determined to have outstanding values for scenic, recreational, geologic, and fisheries values. The overall scenic rating for the river qualified the area for the highest rating category under BLM "Upland Visual Resource Inventory and Evaluation." The rating is due to the diverse stream-side vegetation, striking river-related land forms and geology, and many water features.

Recreation Need and Demand

Projected demand is high for many available activities in the Molalla River corridor and vicinity (State Park Visitor Survey 1988; Pacific Northwest Regional Recreation Demand Study 1987) as contained in the *Oregon Statewide Comprehensive Outdoor Recreation Plan 1988*. Fishing, day-hiking/walking, viewing scenery, picnicking, non-motor boating, camping, and water activities were listed as moderate or high-growth activities with projected increases of 3 to 12 percent annually. The combination of increasing recreation demand and a decreasing availability of natural areas clearly shows that the Molalla River corridor and watershed play an important role in providing regional recreation opportunities.

Recreation-Related Economics and Tourism

Recreation in the Molalla watershed plays a minor role in the local economy. However, fishing, camping, trail and boating opportunities attract visitors to the surrounding communities on their way to and from the river. This additional economic stimulus may help to diversify and stabilize revenue to some economically depressed communities in the area. This role could be enhanced by comprehensive management of recreation and the development of a recreation infrastructure (trails, picnic areas, and campgrounds). On-site environmental education projects could further enhance visitor enjoyment of the corridor and provide facilities for use by the local community.

Visitor Use Estimates

There is limited quantitative field-based recreation visitation data available for the Molalla watershed. Field observation and visitor counts show that visitation to this watershed is moderate to high, with most of the visitor use occurring along the main river and developed trail systems.

The land-based activities of bank fishing, dispersed camping, and swimming/water play account for most of recreational use within the watershed. Little visitor use data are available, but preliminary recreation site surveys show heavy use by day-use visitors, especially during summer weekends. Camping, while popular, is restricted by the number of accessible and designated camping spots. On summer weekends, most of the available sites are occupied.

The Molalla watershed falls within the Molalla/Table Rock Special Recreation Management Area (SRMA). On average, the area receives over 60,000 visitor days annually; each of these visitors usually participates in at least two different recreational activities during their visit.

Recreation Demands

Besides estimating current and projecting future visitation levels, SCORP also analyzed the supply and demand relationship between ROS settings and recreational activities. While the same activity can occur in several different ROS settings, an individual's experience is expected to vary by class. A category of currently "Used" ROS setting was compared to a "Preferred" amount of use for a recreational activity in each ROS setting. Those activities that show a higher "Preferred" than "Used" suggest that there may be an inadequate supply of that setting for a particular activity in that region. The SCORP data show that there is a shortage of primitive and semi-primitive settings for most of the activities in Region 8. This is also true for most of the other regions in Oregon.

Public access to forest lands is decreasing as more industrial forest lands are either seasonally or permanently closed off.

Visual Resources

Several significant scenic attributes distinguish the Molalla from other rivers in the area. The river's clear water and cascade and pool character add significantly to the overall visual experience. The numerous vertical and near vertical cliffs descending to the river, a constricted canyon near the middle of the segment, large moss-covered boulders, and diverse stream-side vegetation provide a variety of stream-side and foreground views. Accessibility from the Portland metropolitan area also enhances the value of the overall scenic quality and potential of the corridor. Vistas from the highest point in the watershed on Table Rock are also viewed by many visitors.

The viewshed surrounding the river and high use areas is an important resource to those visiting an area. Much of the viewshed in the Molalla watershed has been modified by human use associated with residential activities, agricultural use, and timber management activities. While these modifications are evident, they often blend with the general characteristics of the landscape.

From the river, the scene is one of a large canyon with moderately steep walls covered by a blanket of primarily second-growth (40-80 year old) Douglas-fir. In some areas, stream-side vegetation or geologic features restrict the "seen" area to only a few hundred feet on either side of the river. In many other areas, the adjacent hillsides are clearly visible behind the narrow strip of riparian vegetation.

Geologic features along the upper and middle portions of the river and Table Rock Wilderness add to the scenic value of the watershed. The many vertical basalt cliffs and rock outcrops that descend to the river along with the narrow canyons and large moss-covered boulders add to the visual diversity of foreground views in several key portions of the river. Constricted canyons near the middle of the watershed force the river into a deep, narrow chute that flows beneath some picturesque columnar basalt cliffs. The Molalla River is a large part of the scenic value. The character of the rivers and streams of the watershed is a combination of cascades and riffles punctuated by deep, clear pools.

Public lands are classified for visual resource considerations. Special features, recreation visitation, view points, land form, character and modifications to the landscape are considered when lands are classified.

A visual resource inventory has been completed for BLM-administered lands. The Visual Resource Management (VRM) classification system was used to inventory all of the BLM-administered lands in the Salem District. There are four classes within the VRM system Management, with Class I being the most outstanding and protected and Class IV being in areas generally less seen with fewer modification restrictions. The RMP provides guidance for each VRM classification. Below is a summary of the VRM classes on BLM-administered lands in the Molalla watershed.

VRM Classifications in the Molalla Watershed

Class I	Class II	Class III	Class IV
6,224 acres	4,488 acres	3,339 acres	29,018 acres

.

Class I Lands

"Provide for natural ecological changes in visual resource management Class I areas. Some very limited management activities may occur in these areas. Change to the characteristic landscape should be very low and will not attract attention. Changes should repeat the basic elements of form, line, color, texture, and scale found in the predominant natural features of the characteristic landscape."

The 6,224 acres of Class I lands include the Table Rock Wilderness, Soosap Meadows, and Williams Lake areas (see Visual Resource Management Classification Map K).

Class II Lands

“ Manage visual resource management Class II lands for low levels of change to the characteristic landscape. Management activities may be seen but should not attract the attention of the casual observer. Changes should repeat the basic elements of form, line, color, texture, and scale found in the predominant natural features of the characteristic landscape.“

About 4,488 acres of Class II lands within the Molalla watershed are found along the Molalla River corridor, on the southwest side of the Table Rock Wilderness, and near Joyce Lake.

Class III Lands

“ Manage visual resource management Class III lands for moderate levels of change to the characteristic landscape. Management activities may attract attention, but should not dominate the view of the casual observer. Changes should repeat the basic elements of form, line, color, texture, and scale found in the predominant natural features of the characteristic landscape.”

About 3,339 acres of Class III areas recognize certain levels of visual sensitivity such as views from rural interface areas and key observation points such as Table Rock Wilderness. Sensitivity considerations within the Class III category are used as a general guide for management. Impacts to visual resources will vary depending on the specific project proposal and a number of mitigating factors such as the presence and location of Riparian Reserves, roadside vegetation buffers and vegetation buffers around homes. Class III areas include BLM lands north of Table Rock Wilderness and in the lower watershed in the Dickey Prairie and Glen Avon areas.

Class IV Lands

“ Manage visual resource management Class IV lands for moderate levels of change to the characteristic landscape. Management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the effect of these activities through careful location, minimal disturbance, and repeating the basic elements of form, line, color, and texture

The majority of public lands, more than 29,000 acres, within the watershed are classified to allow for moderate change to the character landscape. However, views of much of this land are protected through other restrictions on landscape changing activity due to status as LSR or riparian reserves. In addition, special consideration is given to Class IV lands with the highest sensitivity such as those found along certain viewable ridge top areas near the Molalla River corridor and areas viewed from the Table Rock Wilderness. In addition, areas near the Baty Butte Trail, Joyce Lake, Molalla River Trail, and other recreation use areas would also be considered for visual sensitivity.

A detailed field review of the VRM classifications was not conducted. VRM boundaries are best guess estimates from topographic maps. Specific areas and proposed activities would be individually assessed as projects affecting visual resources are proposed.

Other Human Uses

Other uses are those uses or resources associated with human use that do not dominate the landscape but are significant and should be mentioned.

Water Uses

The streams in the watershed directly supply any municipal water sources located downstream on the Molalla River. The watershed is a key municipal water source for Molalla and Canby. Municipal and domestic water supply issues and water rights are discussed in the hydrologic sections. There are no hydroelectric dams or water storage or treatment facilities within the watershed.

Lands and Minerals

The primary mining activities on public and private lands in the Molalla watershed are associated with rock quarries for road building and very limited gold panning and dredging. There is one inactive placer mining claim near the confluence of Copper Creek and the Table Rock Fork of the Molalla River. Communication with the claim holder indicates that it is unlikely that the claim will ever be commercially developed.

The BLM lands along the Molalla River corridor from the Glen Avon area to the Table Rock Wilderness are part of a cooperative Recreation and Public Purposes lease with Clackamas County. The lease provides opportunities for cooperative recreation management and developments. Lands under the lease are withdrawn from mineral claims. Recreational gold panning and dredging are allowed under certain restrictions provided by state laws.

A major utility corridor and right-of-way passes through the southeast portion of the watershed. There are no other known gas leases, communication sites, land withdrawals, or utility rights-of-way in the watershed.

Prohibited Uses

Prohibited uses on public and private lands generally involve illegal dumping, vehicle abandonment, long-term occupancy, equipment and sign vandalism, wildlife poaching, unauthorized removal of forest products, and growing or manufacturing illegal drugs.

In recent years, the work done by the Salem District’s Law Enforcement Officer, cooperative agreements, and law enforcement patrols with the Clackamas County Sheriff and the game division of the Oregon State Patrol have helped to curtail illegal activity and resource damage within the watershed. Oregon Department of Forestry and BLM regularly patrol the river corridor and watershed to help control the threat of wildfire. Private industrial forest employees patrol the watershed for similar activities and trespass violations. These entities have targeted the Molalla River area for increased law enforcement and patrol efforts. Representatives from these agencies meet on a regular basis to develop law enforcement strategies to cooperatively resolve these prohibited uses. One of the outcomes has been the cooperative funding of Clackamas County Sheriff patrols in 1997-98, whose sole responsibility is to patrol the watershed and river corridor during high use summer weekends. Combined efforts have been very effective in reducing illegal activities and reducing resource damage.

Cultural Resources

The prehistoric and historic use of lands in this watershed has been discussed in detail in Chapter 2 of this analysis. This section summarizes the actual prehistoric and historic artifacts and sites that have been documented in the Molalla watershed. Some analysis of these sites have occurred.

Prehistoric Resources

The Molalla River watershed was used by Native Americans over a long period of time. Several archaeological sites, aboriginal trails, and finds occur within the watershed boundaries, with numerous other sites and finds in the surrounding watersheds. With few exceptions, these sites have not been evaluated beyond initial recording. A more detailed inventory of potential and known cultural sites was completed in 1992 (Oetting 1992). This inventory focused on high potential sites along the mainstem Molalla River.

Although only a few artifacts have been recorded, these indicate that the sites span a time range starting around 6,000 years ago and extending up to the historic period around 250 years ago. Primary activities at the sites appear to be hunting although tool manufacture and maintenance is also indicated. This would suggest that the sites' inhabitants spent part or much of the year living on the east side of the Cascades.

Historic Resources

The watershed was used by early homesteaders. The earliest recorded historic use of the watershed dates to homesteaders' access trails developed in the 1850s. Starting in the early 1900s, a number of trails were built and/or maintained to access lookouts and fire camps in the Peachuck and Baty Butte area. Most of these trails went out of use in the 1940s and 1950s as they were replaced by roads.

Chapter 6 Potential Conditions and Trends

This chapter projects possible future trends of ecosystem processes in the watershed with application of resource management plans and assumptions on private land management. This incorporates the synthesis and interpretation of all available data and information about the watershed.

Terrestrial

Soils

Soil stability in the western portion of the watershed will decrease over time as conifer stands reach harvestable age and are removed. New and minimally maintained roads on steeper slopes may increase erosion or mass movement during larger precipitation or rain on snow events. Stability in the eastern sub-watersheds will remain the same due to the lack of forest harvest which maintains tree roots and soil root strength and the limited number of new roads added to the area. Natural and human-caused landsliding and erosion will continue to occur throughout the watershed as a result of past management, future management, and climatic conditions.

Soil compaction reduces site productivity by reducing the ability of roots to penetrate and restrict the movement of water and air through soil horizons. Compacted soils can require many years to ameliorate naturally; however, the use of winged soil rippers or other such devices can bring compacted soils to near their original densities in many cases. Future roading and harvesting will increase soil compaction in the watershed but will be mitigated somewhat by the use of mechanical methods to reduce compaction on closed roads and skid trails.

Information from the *Clackamas County Soil Survey*, for that part of the Molalla watershed located in Clackamas County, is found in Appendix G. A new soil survey for Marion County is planned and, when done, will complete soils information for the entire watershed.

Vegetation

Lands within the Molalla River watershed are managed by many landowners under a variety of management objectives. Future management of the federal lands was discussed in Chapter 1.

The existing conditions of the terrestrial domain are the result of altered processes (see Chapter 4). The current (altered) conditions in combination with the human processes that now dominate the ecosystem within the Molalla River watershed are expected to continue. Wildfire exclusion and resource extraction will continue to be the dominant forces influencing the future conditions. However, natural processes (erosion, mass wasting, disease, insect infestations, and storm-related changes) will continue to affect the terrestrial domain across the watershed and may be exacerbated by fire exclusion and resource extraction related activities.

Vegetation Patterns/Seral Stages

The current proportion of forest/non-forest types is expected to remain approximately the same at 94 percent conifer types, 4 percent non-forest types, and 2 percent hardwood types. The non-forest types in the rural residential/agricultural area may increase slightly over present conditions as urbanization continues its eastward expansion into the lower reaches of the watershed.

The amount of older forest habitat on private/state lands is expected to decrease under future management. Assuming an average 60-year rotation on private/state lands, approximately a third of the acreage would be distributed between each of the 20-year age classes (0 to 20; *21* to 40; and *41* to 60 years of age). Oregon Forest Practices Act (OFPA) riparian buffers on private/state lands may contribute small acreages to older forest habitat in the watershed.

On federal lands, the amount of older forest habitat is expected to increase under the RMP. The distribution of older forest habitat would generally follow Riparian Reserves in Matrix lands, consist of the 25 percent older forest in Connectivity blocks (CONN), and across the landscape within LSR's and the Table Rock Wilderness area.

About 20 percent of the watershed is in older forest habitats. The distribution of older forest with the majority being on federal lands would continue, and the total amount of older forest is expected to increase.

Ultimately, the Matrix (excluding Riparian Reserves) across all ownerships in the watershed will be evenly divided between early seral stages 0 to 15 years of age and 15 to 40 years of age, and mid seral stages 40 to 60 years of age. The patch elements of the watershed will continue to be older forests 80 to 200 years plus. The distribution of older forest habitats will include the LSRs and will follow Riparian Reserves on federal lands. The 15 percent older forest retention and the 25 to 30 percent CONN retention would be represented entirely within LSRs and Riparian Reserves in the long term. Distribution and connectivity of the older forest habitat will be discontinuous in some areas due to the isolation of scattered individual federal parcels. However, the development of corridors along Oregon Forest Practices Act riparian buffers on private/state lands would provide some degree of connectivity in the future.

Riparian Reserves

Vegetation Composition, Distribution, and Structure

With the implementation of the Oregon Forest Practices Act (OFPA) of 1994, streamside riparian protection buffers are now required on private and state-owned lands. Protection widths are variable depending on a stream's type and size (Appendix H). Over time, these protection buffers will allow some riparian vegetation to develop in age, structure, and species diversity. This will help to maintain a higher level of riparian functions such as providing shade and LWD input on many stream reaches. However, because mandated buffer widths are much less than those required on federal land, and the number of streams protected is less, a high quality late-successional forest habitat is not anticipated to develop in the OFPA riparian protection areas on private or state land. The benefits of improved natural riparian function will also be limited to the channels where the riparian buffers are mandated.

It is anticipated that in the long term, high quality habitat exhibiting late-successional attributes and good natural riparian function (increase in high potential LWD recruitment) will dominate the federal Riparian Reserve system of the watershed. This will be done by maintaining interim Riparian Reserve widths and treating them to maintain and restore Aquatic Conservation Strategy Objectives. Without large scale natural disturbances (wildfire), and if the present management guidelines are followed, it is anticipated that approximately 93 percent of the Riparian Reserve system would ultimately be classified older than 80 years of age as the younger types mature. The remaining acres would be classified as nonforest or nonstocked brush. The mixed conifer/hardwood stands will probably develop into stands with older forest characteristics. However, in stands of pure hardwood associated with salmonberry understories or in areas where hardwoods overtop most conifers, it is highly possible that succession will go to brush-dominated sites rather than to conifers (Tappeiner 1991).

Small scale disturbances such as landslides, debris torrents, and windthrow would be expected to maintain a small portion of the Riparian Reserve system in early seral. These disturbances would also contribute to natural LWD recruitment to the stream channels from the riparian vegetation.

1. Lower Mainstem Analysis Area

< The Riparian Reserves support a high percentage (55%) of acres with conifer vegetation less than 40 years old. It will take up to 50 years for most of these areas to enter the mature seral stage where older forest characteristics will start to develop. Late-seral habitat and good natural riparian function will develop, but it will take many decades for these older conditions to develop. Without further management or large disturbance, the early seral/open sapling seral stages will have largely disappeared here within 30 years.

2. Middle Fork Molalla Analysis Area

< The bulk (65%) of this analysis area is greater than 80 years and exhibits some older forest structural attributes. Continued stand structural development will occur with more dead wood, canopy gaps, and canopy layering continuing to develop naturally. The result will be excellent older forest structure on a large part of the Riparian Reserves within 30 to 50 years. Within 30 years, the early/open sapling acres of the analysis area will have entered mid-seral and, without further management or large disturbance, these early seral stages will have largely disappeared here.

3. North Fork Molalla Analysis Area

< The age class distribution of the Riparian Reserve vegetation here is similar to that of the Middle Fork analysis area. It should follow the same future course, with a high percentage of older forest structure and limited early seral vegetation anticipated in the ensuing decades.

4. South Fork Molalla Analysis Area

< A large part (58%) of this analysis area's Riparian Reserves are also older than 80 years. Continued stand structural development will also occur. More dead wood, canopy gaps, and canopy layering will continue to develop naturally. The result will be excellent older forest structure on a large part of the Riparian Reserves within 30 to 50 years. Within 30 years, the early seral/open sapling seral acres of the analysis area will have entered mid-seral. Without further management or large disturbance, these early seral stages will have largely disappeared.

5. Upper Mainstem Analysis Area

< The Riparian Reserves here represent the highest percentage (58%) of acres with conifer vegetation less than 40 years old in the watershed. Similar to the Lower Mainstem, it will take up to 50 years for most of these areas to enter the mature seral stage where older forest characteristics will start to develop. Late-seral habitat and good natural riparian function will be developing, but it will take many decades for these older conditions to develop. Without further management or large disturbance, the early seral/open sapling seral stages will have largely disappeared within 30 years.

For all analysis areas, density management in early to mid-seral stands may help to initiate older forest stand structural attributes earlier than would be expected with no such treatment. In some older mature seral stands that were previously managed, snag and LWD creation may help restore quality older forest stand structure to these areas.

Species and Habitats

Special Habitats

The majority of the identified special habitats on federal lands within the Molalla watershed are either within Riparian Reserves or LSR and would be protected from most human intrusion. These areas, however, are not immune to degradation. Meadows (dry and wet), wetlands, and lakes are slowly being intruded upon by regrowth of trees and invading brush. In the past, wildfires and beavers have helped maintain these systems. Due to fire exclusion and aggressive trapping, the process of forest encroachment has accelerated. Nasty Rock Meadow (dry), Baty

Butte Meadows (series of dry meadows), and Rooster Rock Meadow all exhibit signs of size reduction based on a comparison of aerial photos from the 1950s and 1993. This process can be expected to continue unless prescribed fire or other means is used to limit forest encroachment on the meadow ecosystems. Continued trapping of beaver in streams and wet meadows within the watershed will inhibit the renewal of wet lands as old dams are lost to floods and high water.

Wetlands adjacent to forest roads that are open to public vehicle use are at the greatest risk due to human impacts. An example would be Horse Creek Meadow which is directly adjacent to the Horse Creek road. OHV have entered the meadow on many occasions with the result being compaction, vegetation trampling, channeling and altering of water courses, and the destruction of beaver dams. With our current OHV management, these practices may continue and accelerate the degradation of these sensitive ecosystem components.

Habitat Quality

The estimated future amount of interior forest habitat was modeled 80 years into the future. Interior older forest habitat is expected to increase on federal lands as LSRs and Riparian Reserves develop into older forest. Interior forest habitat on private/state lands is expected to decrease as older forest is harvested. Future harvest and road construction will continue to alter the quality of interior older forest across the watershed.

Standing Dead/Down Logs

The number of standing dead trees (snags) is expected to decline in the short term as material in more advanced stages of decay fall and decompose. Implementation of the RMP's snag and coarse wood guidelines will increase snags on federal lands over the long run. Snags will approach 60 percent of potential for cavity dwelling wildlife species/populations as older forests develop within LSR's and Riparian Reserves. A slight increase of standing dead would occur on private/state lands as new OFPA requirements for standing dead continue to be implemented. In addition, OFPA buffers would help contribute to the standing dead resource on private lands.

Down log material is expected to decline in the short term as material in more advanced stages of decay continues to decompose. Over the long term, down log material on federal lands is expected to increase as older forest develops in LSRs and Riparian Reserves and green tree retention guidelines are implemented. The OFPA requirements for down logs and buffers would to a limited extent help contribute to down log material on private/state lands.

Roads and Transportation

Road densities may be expected to increase slightly within the watershed as additional roads are constructed for timber harvest on private and state lands. Currently, Bureau management direction for federal lands within the watershed calls for no net increase in roaded miles. This means that when a road is built it will either be removed (decommissioned) upon completion of timber harvest activities or a like amount of road will be decommissioned elsewhere in the watershed. See Appendix I and Map J. The habitat effectiveness index derived from open road densities is at or near .6, which is a threshold value between viable and limiting for elk Approximately 60 percent of the lands and 64 percent of the roads within the watershed are closed to public vehicle traffic and an additional 20 percent are seasonally closed (generally November-May due to snow). This results in a very low exposure of wildlife to harassment. This trend is anticipated to continue as private land owners maintain current closures and close additional areas, and federal roads are decommissioned or closed to meet the Aquatic Conservation Strategy Objectives.

Special Status/Special Attention Species

Wildlife

Habitat conditions for older forest species of concern are expected to improve slightly in the long term. Approximately one third of the watershed is managed by the federal government. This land is concentrated in relatively contiguous blocks of which some (LSR's and Riparian Reserves within GFMA) will develop into older forest habitat and connectivity corridors.

Habitat conditions for early and mid seral stage species are expected to remain approximately the same or improve slightly over time.

Habitats for priority species that use snags and/or down logs are expected to decrease in the short term and increase in the long term with increased retention requirements on federal, state, and private lands.

Threatened and Endangered Species (spotted owls)

Suitable habitat for the northern spotted owl is expected to follow the same trends as described previously for older forest habitat and species. Overall, habitat condition for the spotted owl is expected to decline in the short term then stabilize in the long term. The Molalla River watershed will continue to provide some dispersal to/from the Known Owl Site (KOS) to the south and east. However, dispersal of spotted owls is severally limited by the Willamette Valley to the west and private lands to the north. The distribution of suitable and dispersal habitat will follow Riparian Reserves on federal lands and will include the LSRs and the 25 percent older forest in the CONN blocks. Distribution and connectivity will be disrupted by the fragmented pattern of federal ownership in the watershed.

Of the 15 active KOSs in the Molalla River watershed, 10 are viable.

Plants

Several Special Status/Special Attention Species plant and fungi species known to occur in the Molalla watershed are associated with late seral forests: *Allotropa virgata*, *Cimicifuga elata*, *Sarcosoma mexicana*, *Otidea onotica*, and *Ptilidium californicum* in addition to several others which are suspected to occur in the watershed like *Bridgeoporus nobilissimus* and *Corydalis aquae-gelidae*. Habitat conditions for these species are expected to improve in the long term, especially on the federal ownership where reserves such as the LSR's and Riparian Reserves are established. Potential habitats for *Corydalis aquae-gelidae*, a riparian dependent species, will increase over time with the maturing of the trees in the Riparian Reserves.

Habitat conditions for Willamette Valley Special Status plant species known or suspected to occur in the Molalla watershed are expected to remain stable or degrade over time. These Willamette Valley species include: *Delphinium pavonaceum*, *Erigeron decumbens* var. *decumbens*, *Aster curtus*, *Delphinium leucapaheum*, *Montia howellii* and *Sullivantia oregana*. Many of these species inhabit prairie remnants along roadsides and are subjected to mowing, herbicides, and numerous other land management activities which are more frequent in the lower elevations. Over time the available habitat for these species has decreased dramatically with increased land management activities. Willamette Valley species habitat conditions will probably continue to degrade due to the lack of protective or active management mechanisms on private lands.

Aquatic

Hydrology

Peak flows, low flows, and annual water yields will continue to fluctuate depending on precipitation and temperatures. The nature of precipitation in the area was shown to cycle between wetter than average periods and dryer than average periods approximately every 20 years. The major uses in the watershed will continue to be recreation, wilderness, and forest products. The potential over allocation of stream flow during low flow periods will probably not escalate due to the expected lack of increase in consumptive use.

Stream flow in forested basins is affected by evapotranspiration. Forest harvest has been shown to reduce evapotranspiration for years after harvest, so continued harvesting would be expected to affect water yields and peak flows. Harvesting may also affect snow accumulations and melt. However, the magnitude of responses will vary by season and year. Seasonal variations in soil moisture will produce different responses in runoff from a storm. So, a storm in the fall with dry soils will result in a given runoff response. The same size storm received in the middle of winter, with saturated soils may result in a higher runoff response and higher peak flows. Yearly fluctuations in precipitation can also affect stream flow. This is compounded if several years of below or above average precipitation in a row are encountered.

Roads also affect stream flows and yields but in a different way than harvesting. While harvesting affects evapotranspiration, roads influence hillslope flow paths by converting subsurface flow to surface flow and allowing it to enter the stream more quickly. The combination of harvesting and roads in small watersheds has been shown to increase peak flows, produce higher storm volumes, and produce earlier rises in stream flow response to storms. (Jones et al. 1996).

Under the *Salem District BLM Resource Management Plan* and OFPA, the watershed will continue to be harvested on a rotational basis and additional roads built to increase access. On federal lands, the average age of forest stands will increase as areas classified as LSR mature. The average age of federal stands in areas classified as Matrix will reach an average age of 80 years. The average rotation age of private forest stands are assumed to remain around 50 years, with large areas expected to be harvested as they reach this age. Road densities on federal lands will probably decrease as unneeded roads are decommissioned and removed. Private land road densities may remain stable or increase as roads are added to harvest stands of trees in future rotations. State lands, which have in the past been oriented toward timber production, are now being tasked with meeting multiple uses and other resource values.

Future cumulative impacts in the Molalla sub-watershed basins were modeled one decade into the future using current conditions and several assumptions about future harvesting. Private lands were assumed harvested within a 10-year period once they reached 50 years of age or older. Harvest on federal ownership during a 10-year period was estimated from available Matrix stands in sub-basins with cumulative impacts in the less than high category using ECA as the indicator. In sub-basins where cumulative impacts Equivalent Clearcut Acres (ECA) were estimated to be above 20 percent, no federal regeneration harvest acres were included. Results of the cumulative effects modeling of ECA are illustrated in Figures 32-36. Only the sub-basins with federal lands available for harvest were included in the forecast. A detailed discussion and breakdown of estimated acres harvested by ownership is included in the social-land use planning section of this chapter. ECA is a general tool used to assess watershed cumulative effects, and values above 20 percent are considered high, while values of 15 to 20 percent are moderate and less than 15 percent low. See the hydrologic current condition section for a discussion of ECA.

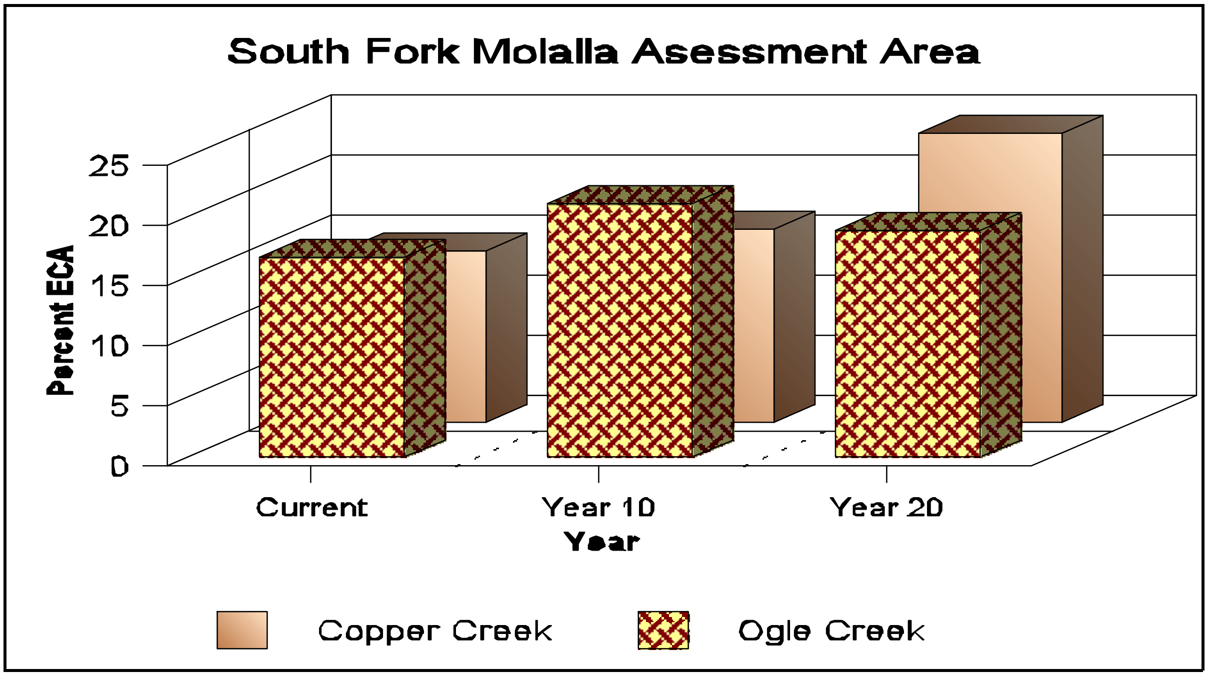


Figure 32. Estimated Future Equivalent Clearcut Acreage, South Fork Molalla Sub-Basins.

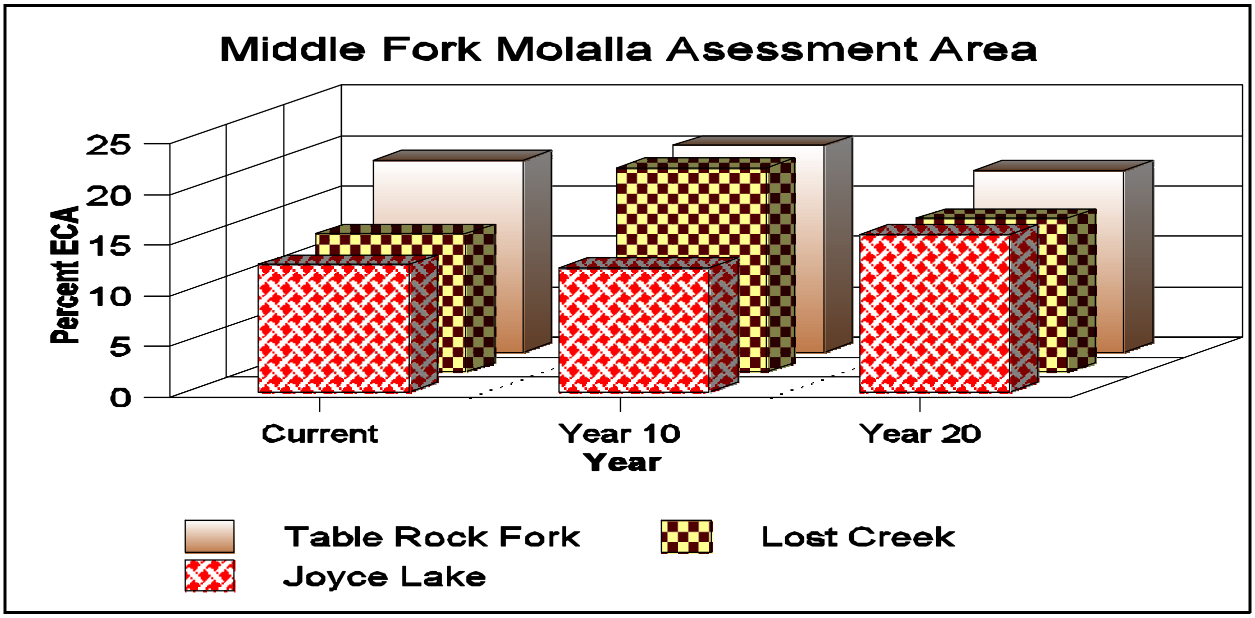


Figure 33. Estimated Future Equivalent Clearcut Acreage, Middle Fork Molalla Sub-Basins.

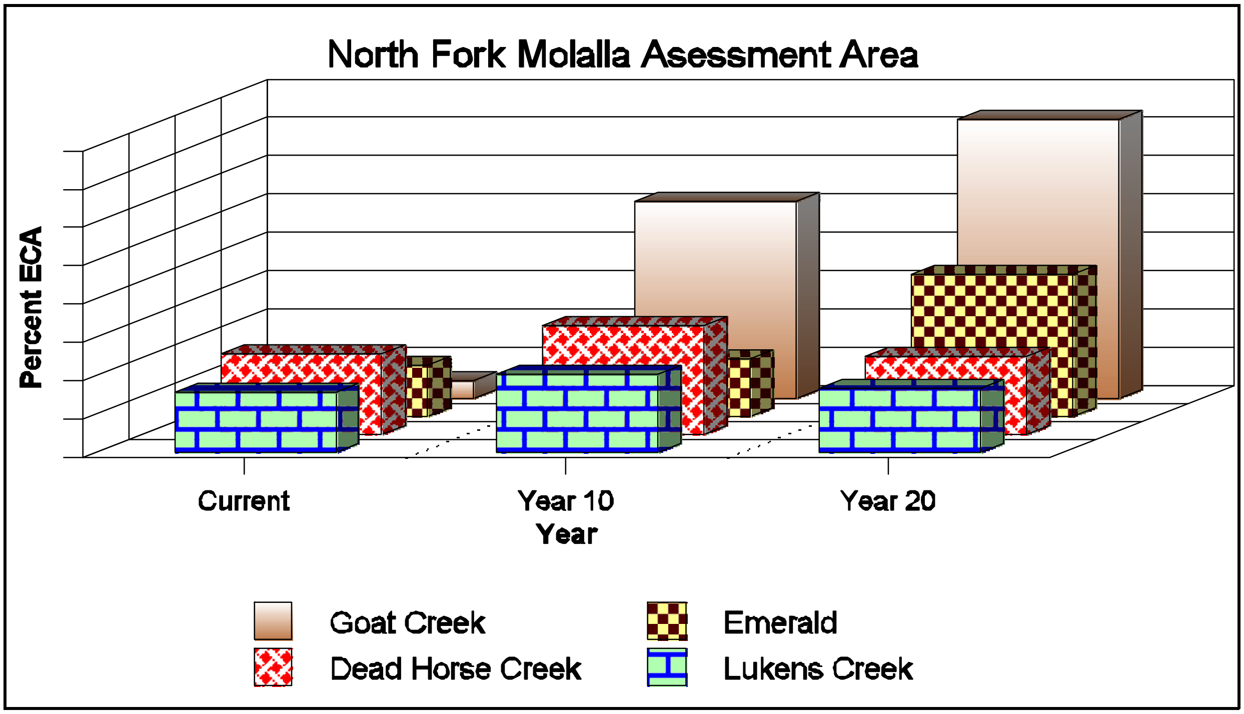


Figure 34. Estimated Future Equivalent Clearcut Acreage, North Fork Molalla Sub-Basins.

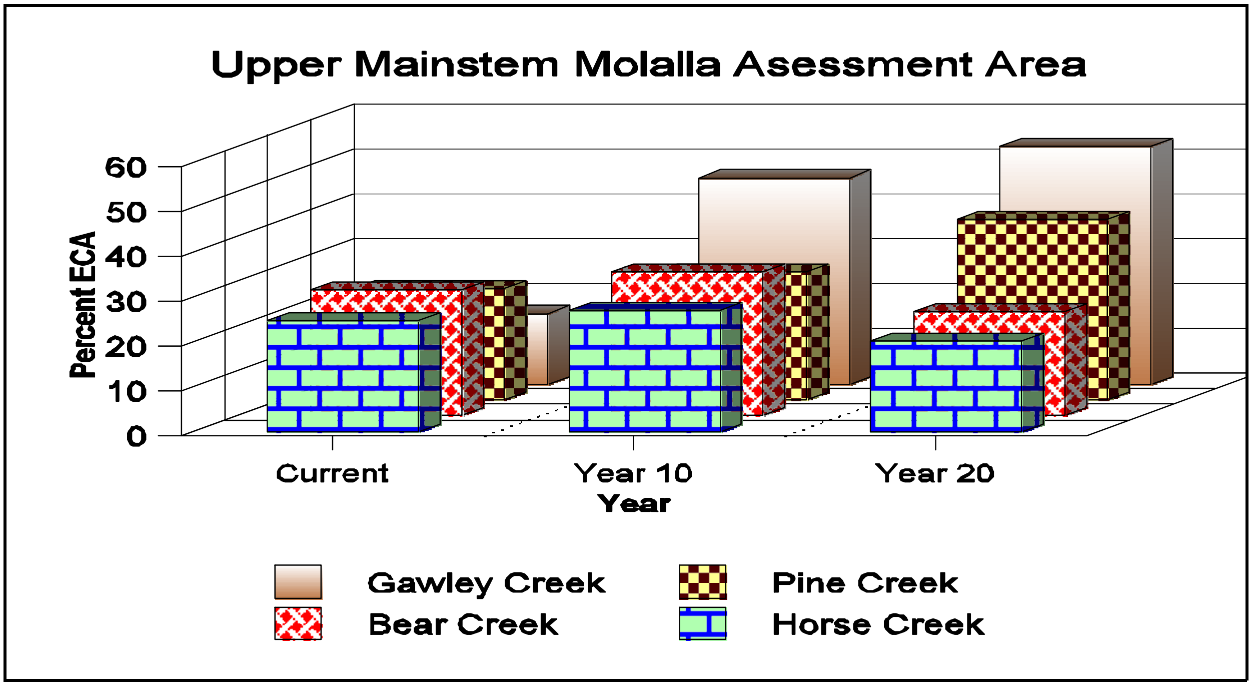


Figure 35. Estimated Future Equivalent Clearcut Acreage, Upper Mainstem Molalla Sub-Basins.

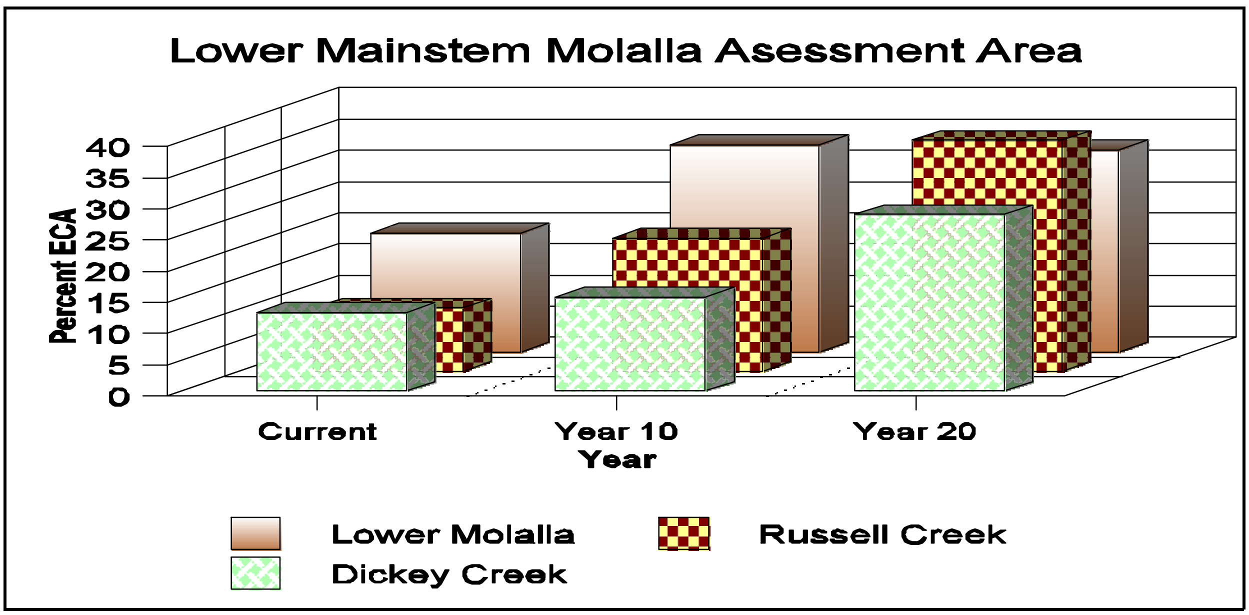


Figure 36. Estimated Future Equivalent Clearcut Acreage, Lower Mainstem Molalla Sub-Basins.

The sub-basins in the high category for ECA are Bear Creek, Dead Horse Creek, Horse Creek, and Pine Creek. Forecasting into the future, the following sub-basins are expected to be in the high ECA category at the end of the next decade: Bear Creek, Dead Horse Creek, Gawley Creek, Horse Creek, Lower Molalla, Ogle Creek, Pine Creek, Table Rock Fork, Goat Creek, Lost Creek, and Lukens Creek. Estimating the ECA two decades into the future (20 years from now), the sub-basins expected to be in the high ECA category are: Bear Creek, Copper Creek, Dead Horse Creek, Dickey Creek, Gawley Creek, Horse Creek, Lower Molalla, Pine Creek, Russell Creek, Emerald Creek, and Goat Creek. The patterns seen in sub-watersheds are the result of the distribution of conifer age classes, and the assumption that harvest on private and federal lands will remain the same in the future.

Water Quality

Water quality in the watershed will continue to be affected by commercial and recreational activities. With the current management guidelines, the trend on the federal forest lands will be stable or improving as forest stands and stream buffers mature. Improved OFPA protection measures, and requirements on federal agencies under the Northwest Forest Plan will improve overall water quality within the watershed. Natural and human influenced events, such as fire and landslides, will continue to affect water quality in the watershed, but will be cyclic in nature.

The closure of unneeded roads, regrowth of riparian overstory vegetation, and designation of Riparian Reserves on federal lands will reduce sediment inputs and water temperature enrichment to Molalla River tributaries.

Aquatic Species and Habitats

Invertebrates

Management of federal lands under the guidelines of the *Northwest Forest Plan* (NFP) is expected to result in increasing levels of LWD loading and instream habitat complexity. Increasing levels of LWD loading and habitat complexity should cause shifts in dominant functional feeding groups from collector-gatherers to shredders. Expected changes would be long-term and would occur slowly.

On non-federal lands improving trends in instream habitat conditions for aquatic species are not expected under the management guidelines provided by the OFPA. It is possible that voluntary restoration and conservation measures conducted by private landowners and state and local governments inspired by the Oregon Coastal Salmon Restoration Initiative will lead to improvement in instream habitat conditions.

Fish

Management of federal lands under the guidelines of the NFP is expected to result in increasing levels of LWD loading and instream habitat complexity. This should result in improving trends in fish populations. Specific management policies and actions expected to result in improvement in fish habitat conditions are retention of NFP Riparian Reserves, attainment and maintenance of Aquatic Conservation Strategy Objectives and watershed restoration, in upland plus riparian and instream areas.

Fish habitat conditions on non-federal lands, managed under the OPFA are expected to continue to decline until a more conservative revision of the Act is completed. However, voluntary restoration and conservation measures conducted by private landowners and state and local governments inspired by the *Oregon Coastal Salmon Restoration Initiative* may lead to improvement in fish habitat conditions.

Social Setting

Human Uses and Activities

What are the major human uses and use trends in the watershed and where do they occur? What makes this watershed important to people?

The intent of this section is to discuss potential future social uses and trends within the watershed and the region in which the watershed is contained. Continuing and potential human land uses and activities within the watershed include agriculture, forestry, recreation, limited residential development, as an upstream source for domestic and municipal water supply, and some cultural activities and values.

Introduction

The next 20 years will show a dramatic population increase in Oregon, particularly within the Willamette Valley. However, if land use and zoning, transportation systems, and urban centers remain similar in location as they are today, it is expected that much of the watershed will remain in forested and largely undeveloped condition. Primary changes in human use and demand on the watershed will be substantial new recreation demand generated by nearby urban and urban interface areas, continuing demand for forest products, increased reliance on the watershed as a municipal water source, and increased need for residential development on the fringes of the watershed.

Population

Population growth and migration into Clackamas County are expected to continue at a fast pace due to its proximity to Portland and the I-5 and I-205 travel corridors combined with the area's high quality of life. In 1996, the population of Clackamas County was projected to grow at more than 15 percent per year. It is expected to exceed 395,000 by 2010. While most of the increases in population would be expected to occur near the major population and economic centers in the county, additional residential pressure will be felt by rural areas. The Molalla watershed is at the fringes of the Willamette Valley and is within commuting distance to several larger economic centers such as Salem, Woodburn, Oregon City, and Tigard, potentially making private lands in the northern portion of the watershed desirable for residential activities. The area will also become increasingly popular as a regional recreation destination.

Economic Forecast

Agricultural products, retail trade, and environmental services are key industries which have gained and contribute to regional job growth. Other industries such as forest products, high technology, metals, and tourism/recreation have been identified as critical components of economic development and diversification strategies. While forest products industry and agriculture provided less than five percent of the jobs in Clackamas County during 1996, this percentage has not changed much in the past few years. It is not expected to change significantly in the future, showing that this sector of the economy continues to be a stable and key component of the regions' economy. However, tourism/recreation is a growing component of both the service and retail trade sectors of the region's economy. It is estimated that 5 to 6 percent of all service and retail trade jobs in the county are generated by recreation, amusement, and hotel industries. These economic trends are likely to continue. The Molalla watershed's major potential for contributing to the area's socioeconomic health is tied most closely to providing wood products, meeting water supply needs, and offering both developed recreation opportunities such as campgrounds and trails and dispersed recreation areas for hunting and fishing. In addition, increases to recreation opportunities in the county will contribute to a high quality of life in the area acting to attract businesses and supporting tourism and related industries.

City and county economic development strategies will continue to stress agriculture and forest products industries as key economic components while emphasizing the need to diversify their economies with development of such industries as environmental services, high technology, metal fabrication, recreation, and tourism. Many communities are cooperating to develop strategic plans for diversifying their economies. Several locally based organizations have been started to help these communities plan for their future. Common objectives of the smaller communities in Clackamas County include increasing the number of family wage jobs (both through new business and business expansion), improving infrastructure, improving education and workforce job skills, maintaining and improving quality of life, and improving human resource services.

One of the major challenges smaller, rural communities face is infrastructure requirements for major manufacturing. Until the needed infrastructure upgrades can be completed, some of these communities are exploring the feasibility of retrofitting old timber mills for other manufacturing activities, tourism/retail businesses, value-added wood manufacturing, cottage industries, and telecommuting. Another is supporting the establishment of a locally based cooperative business associated with the collection and marketing of SFP's such as tree boughs, bear grass, ferns, and firewood.

Forest Products and Agricultural Uses

A continued but limited supply of forest products from public lands will contribute to a more sustainable and reliable source of timber for local mill operations over a multi-year period. Such a strategy is consistent with and supports economic development strategies for Molalla and Estacada. However, timber production from public lands is not a major component of Clackamas County's agricultural and forest products economy. The most significant component of the area's forest products economy is now provided by private industrial forests and Christmas tree farming.

See Figure 1 in Chapter 2 for the current distribution of ownership within the watershed.

Private Timber Lands

It is expected that unless a desirable and cost-effective substitute becomes available, demand for wood products will continue. Some of this demand will be met through the importation of wood products. However, domestic wood products will also be an important component of supply. This means that the predominant land use on private lands in the Molalla watershed will continue to be industrial forestry. It is also expected that the general rotation age will continue to be 50 to 60 years. However, harvesting levels and practices may vary depending on individual company policy and economic and regulatory factors. Similar trends are expected for small woodlot lands and lands managed by the state of Oregon.

Most private industrial forest companies are in the business to make profits for their stock holders. They manage timberlands on short economic rotations of 40 to 60 years. They will invest in intensive forest practices such as fertilization, thinning, and release because they will yield a return. They generally keep their lands productively growing trees but not necessarily on a sustained yield basis. They tend to follow the agriculture model of forestry and will harvest timber based on markets and prices rather than a strict schedule.

Management practices among small non-industrial private woodlot owners will vary depending on the objectives of the landowner. Their lands are mostly located in the western portion of the Molalla watershed and include some cleared lands for agriculture. There is some mature forest on these lands, but generally they would not be expected to age beyond 60 years before harvesting.

State Forest Lands

State forest lands management has traditionally been oriented toward timber production, but they are now being tasked with meeting multiple uses and other resource values. Present and future management will be more balanced. Rotation ages will probably be similar to federal lands.

Federal Lands

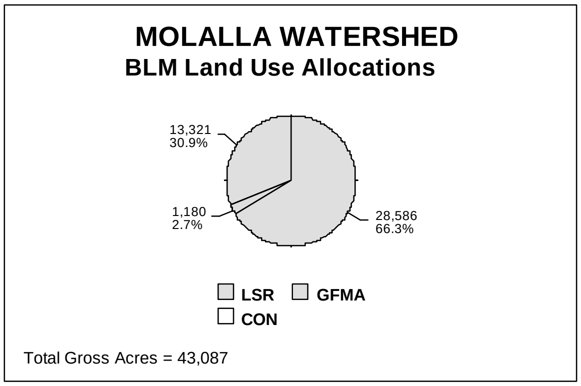


Figure 37

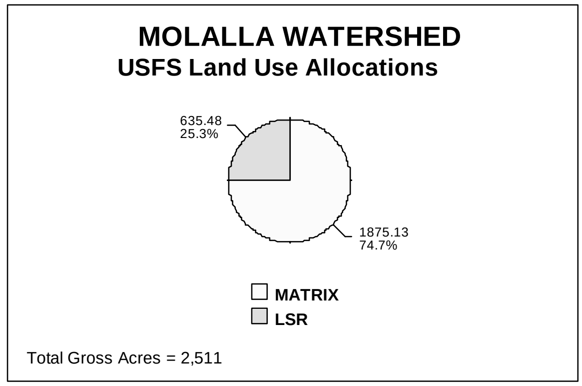


Figure 38

Federal land use allocations are depicted in Figures 37 and 38. These are taken from current planning documents for the two agencies.

Within and across all land use allocations are Riparian Reserves. These are one- or two-site potential tree height width buffers from all streams both permanent and intermittent. Fish-bearing streams would have a two-tree height buffer and non-fish bearing streams a one tree height buffer.

Along both sides of the Molalla River are Visual Resource Management Class II lands (VRM II). These lands are to be included with the GFMA when scheduling timber harvest. Consideration should be given in the allowable sale quantity for their management. Management activities may be seen but should not attract the attention of the casual observer.

GFMA lands are to be managed for timber using even-aged rotations of 80 to 100 years depending on site. Connectivity lands are to be managed on a 150-year rotation. USFS Matrix lands are managed similar to BLM's GFMA lands. LSR and Riparian Reserves are managed for wildlife and aquatic objectives with no regeneration harvest planned. More details on how each land use allocation is to be managed can be found in the respective agency's planning documents.

Timber Harvest Scheduling--Federal Lands

Timber sale planning within the Matrix starts with determining the net acres over age 80 that can be managed within each sub-watershed basin. Table 39 shows BLM's and USFS's share of each of the sub-watershed basins and how much is available for harvest.

Table 39 Federal Acres Available for Harvest.

SUB WATERSHED BASIN	GROSS AC	GROSS AC		FEDERAL PER CENT OF TOTAL	AVAIL AC[4]		AVAIL HARV AC 80 +[1]	
		BLM	USFS		BLM	USFS	BLM	USFS
Bear Creek	7,174	4,095	0	57.1%	1,837	0	643	0
Camp Creek	6,444	2,356	0	36.6%	0	0	0	0
Copper Creek	4,358	954	0	21.9%	417	0	82	0
Cougar Creek1	3,963	169	0	4.3%	0	0	0	0
Dead Horse Creek	4,849	2,342	20	48.7%	110	12	74	12
Dickey Creek	3,782	53	0	1.4%	45	0	4	0
Emerald	5,810	87	8	1.6%	0	8	0	8
Gawley Creek	5,822	1,436	0	24.7%	712	0	335	0
Glenn Avon	2,413	0	0	0.0%	0	0	0	0
Goat Creek	3,162	67	32	3.1%	54	29	0	29
Horse Creek	3,385	3,046	0	90.0%	1,265	0	527	0
Joyce Lake	3,528	1,716	5	48.8%	0	5	0	5
Lost Creek	4,456	3,267	618	87.2%	0	415	0	414
Lower Dead Horse Creek	987	0	0	0.0%	0	0	0	0
Lower Molalla	6,912	2,140	0	31.0%	819	0	39	0
Lukens Creek	7,702	3,896	1,199	66.2%	0	842	0	648
Nasty Rock	4,424	3,309	34	75.6%	0	0	0	0
NFK Molalla	7,406	0	0	0.0%	0	0	0	0
Ogle Creek	5,236	380	595	18.6%	121	0	52	0
Pine Creek	6,456	563	0	8.7%	385	0	292	0
Russell Creek	4,516	571	0	12.6%	265	0	76	0
Table Rock Fork	8,770	6,495	0	74.1%	747	0	381	0
Trout Creek	9,342	8	0	0.1%	8	0	0	0
Upper Molalla	8,400	6,136	0	73.0%	0	0	0	0
	129,297	43,086	2,511	35.3%	6,785	1,311	2,505	1,116
RMP Assumptions - BLM[5]		42,988			6,078		1,926	

1 These are net acres after deducting all TPCC withdrawals, Riparian Reserves, Table Rock Wilderness, roads, and other nonforest lands.

2 Numbers used during BLM's allowable cut calculations.

The table indicates about 2,500 acres on BLM land and over 1,100 acres on USFS land are over age 80 and should be available for harvest. Note that the acres used for the BLM's allowable cut calculations are very close to the current calculations.

Before any of these acres can be scheduled, an analysis of the cumulative impacts on water quality and wildlife within each sub-watershed basin must be completed. This analysis incorporates the past and predicted future harvesting on all private and public lands within the sub-basin.

The method of analysis used to estimate future watershed cumulative impacts is called Equivalent Clearcut Acreage (ECA). ECA evaluates the total acreage in a clearcut, like condition within each sub-basin, by multiplying the number of acres by a factor depending on the age of the clearcut. ECA analysis recognizes that the most recent harvest activity causes the most impact, decreasing over time to a point called hydrologic recovery. ECA is a general tool, and there are no absolute thresholds associated with a given level. Therefore, ECA should not be used by itself to assess watershed cumulative effects. However, taken in context with other watershed indicators, impacts to sub-basins with ECA values below 15 percent may be considered low, while 15 to 20 percent is considered moderate, and above 20 percent high. For a more complete description of ECA, see the Hydrology Cumulative Effects section of Chapter 5. Future impacts were modeled for the next decade by taking existing ECA values and assuming all non-federal forest lands older than 50 years would be harvested within the decade. The ECA was calculated and, if below 20 percent, federal harvestable acres were added until the ECA value reached 20 percent. The estimated harvest units were then aged 10 years, and non-federal lands between 40 and 50 years in age were assumed harvested 10 to 20 years from the present to determine ECA two decades into the future. If ECA values were below 20 percent after harvest of non-federal lands, harvestable federal acres were again added until ECA reached 20 percent.

Estimates of the number of acres BLM and USFS can regeneration harvest during the next two decades without surpassing 20 percent ECA value by sub-basin are shown in Table 40.

Table 40 ECA and Federal Regeneration Harvest Acre Estimates[6]

Sub-Basin	Existing ECA (%)	Private Harvest (50yr+) Acres [7]	1st Decade BLM Harvest (80yr+) Acres [8]	1st Decade USFS Harvest (80yr+) Acres	Estimated ECA 1st Decade (%)	2nd Decade Private Harvest (50yr+) Acres	2nd Decade BLM Harvest (80yr+) Acres	2nd Decade USFS Harvest (80yr+) Acres	2nd Decade Predicted ECA (%)
Bear Creek	**28**	268	0	0	**29**	336	150	0	**20**
Copper Creek	**14**	16	82	0	**16**	943	0	0	**24**
Dead Horse Creek	**21**	430	0	0	**29**	219	0	0	**21**
Dickey Creek	**13**	113	4	0	**15**	883	0	0	**28**
Emerald Creek	**14**	108	0	8	**15**	2127	0	0	**37**
Gawley Creek	**16**	227	75	0	**20**	975	0	0	**26**
Goat Creek	**5**	1754	0	0	**52**	872	0	0	**73**
Horse Creek	**25**	100	0	0	**27**	145	100	0	**20**
Joyce Lake	**12**	9	0	5	**13**	446	0	0	**16**
Lost Creek	**14**	0	0	350	**20**	134	0	64	**15**
Lower Molalla	**19**	1185	0	0	**33**	806	0	0	**32**
Lukens Creek	**16**	136	0	300	**21**	222	0	348	**17**
Ogle Creek	**17**	287	0	0	**21**	492	52	0	**19**
Pine Creek	**25**	292	0	0	**29**	2013	0	0	**40**
Russell Creek	**10**	625	0	0	**21**	1144	0	0	**37**
Table Rock Fork	**19**	161	0	0	**21**	209	465	0	**18**
Total		5711	161	663		11966	767	412	

[6] Future projection of federal harvest based on cumulative effects on all lands within a sub-watershed. Assumes a 50-year rotation on private lands. This analysis is for modeling purposes only. Site specific and detailed cumulative effects analysis would be required on all proposed projects.

[7] Includes all private timber stands older than 50.

[8] Includes available federal stands older than 80 if ECA is below 20 percent.

Discussion

The ECA analysis is based on the worst case scenario assumption that all non-federal timber lands would be harvested when they reach age 50. This may or may not happen. Harvesting on private lands is controlled by more variables than just merchantability.

If we follow this worst case assumption and the ECA analysis, then it is apparent that the harvest potential on federal lands may be restricted by the cumulative impacts of unrestricted harvesting on private lands. The BLM's and USFS's planning documents assume that all 2,500 and 1,100 acres over age 80 are available for harvest scheduling. Restricting the BLM to 161 acres of regeneration harvest and the USFS to 663 acres in the first decade is a major contradiction to the assumptions that were in the agencies' plans and their associated Probable Sale Quantity assumptions. The second decade picture is improved but well below the potential of what is available for harvest.

Special Forest Products (SFPs)

SFPs have potential for growth as demand for existing products grow and if noncommercial products become more marketable. Efforts such as new inventory and modeling systems may increase the marketability of SFP's on private and public forest lands.

Roads and Transportation Systems

There are no known major improvements or realignments of existing major roads in the watershed or changes to access roads such as Highway 211 and Dicky Prairie Road that would significantly alter transportation systems in the watershed. The Molalla Forest Road will continue to be the primary access route into the watershed. Molalla Forest Road projects are underway to improve road stability and decrease erosion potential. Safety, alignment, and access improvements will occur in the future to reduce accidents and impacts from visitors and improve access to high use areas. No major upgrades or improvements are expected on the USFS roads accessing the watershed from the south via the Clackamas River area.

Population growth will continue to be hampered and limited by the area's transportation system. This is due, in part, to the narrow and relatively poor condition of the area's access roads from the urban centers and major travel corridors. However, as home prices increase in the closer-in urban areas, more rural residents will be willing to commute to the Portland or Salem metropolitan areas to work. This will cause increased traffic on the watershed's access roads and increased traffic and visitation to the watershed for recreational purposes.

Recreation

Increases in demand for semi-primitive and primitive settings for dispersed recreational activities will continue to grow. In the lack of such settings at the regional level, use of Roaded Natural (RN), and Roaded Modified areas would be expected to increase. Because of time and economic constraints, recreational opportunities close to communities will become more popular. Given the proximity of the Molalla River and watershed to the I-5 corridor, increases in dispersed recreation use and increased demand for developed recreation areas such as campgrounds and trails are expected. If the trend of closing (gating off) private lands to public use continues, demands for dispersed recreation on public lands will intensify. The increases in use would most likely occur in the corridor where road access is easier and where trail and water access opportunities are found.

Semi-primitive, RN, and Roaded Modified will continue to be the predominant setting on BLM-administered lands and on most of the private industrial forest lands. Recreation settings in the Molalla watershed are not expected to significantly change in the next ten years. However, some recreation development such as primitive campgrounds, toilets, parking areas, and trailheads will be necessary to satisfy increased demand and to reduce recreation-caused impacts to natural resources. There may also be opportunities to provide additional opportunities for semi-primitive settings in the LSR's, where compatible with LSR values.

Recreation Need and Demand

Research by Oregon's *Statewide Comprehensive Outdoor Recreation Plan* (SCORP) documents a continued high demand and regional need for recreation values associated with the Molalla River and watershed. The population growth rate for the region is one of the highest in the country. Projected demand is high for many available activities in the Molalla River corridor and vicinity (State Park Visitor Survey 1988; Pacific Northwest Regional Recreation Demand Study 1987 as contained in the Oregon *SCORP* 1988). Fishing, day-hiking/walking, viewing scenery, picnicking, non-motor boating, camping, and water activities were listed as moderate or high-growth activities with projected increases of 3 to 12 percent annually.

As the table shows, most of these activities were listed as the most popular among Oregon residents with large percentages of all Oregon households participating in them each year (*SCORP* 1988).

Recreation Activity Participation from Pacific Northwest Demand Survey (1987)

Activity	Percent of Oregon Households
Picnicking	67
Hiking/Walking/Climbing	66
Fishing	52
Nature Study/Food Gathering	47
Sports/Games	47
Water Activities	43
Camping	32
Hunting/Shooting	33
Off-Road Vehicle Driving	29
Non-Motorized Riding: bike/horse	28

The combination of increasing recreation demand and a decreasing availability of natural areas clearly shows that the Molalla River corridor and watershed will continue to play an important role in providing regional recreation opportunities. In addition, demand for these types of recreational opportunities is compounded by the lack of public campgrounds in the region, resulting in crowding at existing facilities and areas at nearby USFS areas. Overflow and additional demand is then placed on areas like the Molalla.

Overall Statewide Recreation Activity Demand (SCORP 1988)

Activity	Percent Yearly Increase
Sightseeing/Picnicking	12.2
Hiking/Walking/Climbing	8.9
Nature Study	8.5
Biking/Horseback Riding	6.8
Sports/Games	6.3
Camping	5.5
Water Activities	5.2
Fishing	4.9

Recreation Demands

Besides estimating current and projecting future visitation levels, SCORP also analyzed the supply and demand relationship between Recreation Opportunity Spectrum (ROS) settings and recreational activities. While the same activity can occur in several different ROS settings, an individual's experience is expected to vary by class. A category of currently "Used" ROS setting was compared with a "Preferred" amount of use for a recreational activity in each ROS setting. Those activities that show a higher "Preferred" than "Used" suggest that there may be an inadequate supply of that setting for a particular activity in that region. The SCORP data indicates that there is a shortage of primitive and semi-primitive settings for most of the activities in the region. This is also true for most of the other regions in Oregon. The Molalla watershed offers high potential for providing semi-primitive or primitive settings; the lack of these settings in the region means that the Molalla river will be an increasingly important regional recreational resource.

Public access to forest lands is decreasing as more industrial forest lands are either seasonally or permanently closed to public access and use. This makes public lands in the Molalla watershed, which provides RN and roaded modified settings close to population centers, important to meeting overall recreational demand for dispersed recreational activities.

Recreation-Related Economics and Tourism

Recreation in the Molalla watershed plays a minor role in the local economy. However, fishing, camping, trail and boating opportunities attract visitors to the surrounding communities on their way to and from the river. This additional economic stimulus may help to diversify and stabilize revenue to some economically depressed communities in the area. This role could be enhanced by comprehensive management of recreation and the development of recreation infrastructures (trails, picnic areas, and campgrounds). On-site environmental education projects could further enhance visitor enjoyment of the corridor and provide facilities for use by the local community.

Issues and Concerns

Visitor and public use issue topics already identified and are expected to continue include:

- increasing site-specific overuse and resource degradation if no actions are taken
- increased crowding and competition for campsites, trails, and day-use parking
- continued high demand for recreation improvements and site developments
- increasing potential for vandalism and litter
- more use and activity resulting in visitor conflicts and threats to visitor safety
- continued impacts to water quality and riparian condition from human use
- increased traffic and road safety concerns
- increased demand for designated shooting areas, campgrounds, trails, parking, and toilet facilities.

Data Needs and Further Research

A comprehensive recreation use study would help to accurately determine overall use, recreation use patterns and demographics, facility and access needs, potential conflicts, and user preferences. A study would also help guide recreation planning and management by determining baseline criteria and standards for the application of the "Limits of Acceptable Change" planning process.

Visual Resources

It is expected that modifications associated with timber harvest on private and public lands would continue to be observable in most of the watershed. The sensitivity of future projects on BLM-administered lands with a VRM Class II or III rating would have to be evaluated on a site specific basis. More modifications would be evident on lands under the GFMA land use allocation. Riparian Reserves within the GFMA may help buffer project areas from view. There would be very limited and noticeable modifications evident in the LSR's and CONN land use allocations in the long term as older forest characteristics become more dominant in the landscape.

Other Human Uses

Water Uses

The existing water rights will be maintained, and more applications are expected. There will be increased concerns and focus on water quantity and quality of the Molalla River specifically as it relates to municipal water sources. These concerns will increase as the demand for water use increases in the Portland metropolitan area and Willamette Valley. Protection of municipal water sources will continue to be a significant factor in watershed management.

Lands and Minerals

Rock quarries for road building and maintenance will continue to be the primary mining activity on both public and private lands in the watershed. No other commercial mining is expected. There are also no planned leases or rights-of-way other than those associated with roads.

Prohibited Uses

If deterring actions such as increased law enforcement and agency patrol presence, better signage and visitor information, and improved recreation facilities are implemented, prohibited uses would decrease in the watershed. However, increased recreation use, potential for fire, and effects of population growth on urban interface lands such as crime, illegal dumping, homeless camps, etc will be on the rise over the next decade and beyond. Effects of these pressures will be felt primarily on public lands as private lands are increasingly closed to public access. Cooperative and coordinated law enforcement efforts combined with improved information and facilities will reduce or mitigate effects of increased recreation use and urban interface pressures.

Cultural Resources

No changes in the cultural resources on public lands are expected unless more sites are discovered or existing sites are found to have uninventoried artifacts.

Chapter 7 Management Recommendations

Introduction

This section describes specific actions and types of activities that the BLM and USFS can implement within the Molalla River watershed to improve conditions and positively influence trends. This information will help guide the agencies in setting priorities, selecting more critical locations, and in allocating limited funds to projects. These management recommendations will help specialists in determining which projects and areas will generate the greatest benefit for combined resources. It also provides general guidance for all future management activities such as forest management, habitat enhancements or restoration, recreation developments, and water quality improvements actions.

The watershed analysis IDT, with information and assistance from interested publics, boiled down the resource management issues into four basic and primary key questions. Management recommendations are designed to answer the following questions:

, Given the watershed's ownership pattern, BLM land use allocations, and resource conditions, what timber harvest pattern and silvicultural treatments can we implement while meeting all other resource objectives?

, What and where are the restoration opportunities to improve functioning riparian conditions, maintain viable special plant populations, reduce erosion, and best retain structural components for the watershed while providing sustainable timber harvest levels?

, Given the species present and their habitat conditions and trends, what opportunities exist to restore fish and wildlife habitat conditions?

, Given the social uses and trends and resource conditions, what recreation developments or management opportunities exist to manage human activities while protecting important resources and meeting recreational demand?

Terrestrial

Riparian Reserves

Recommendations:

Management activities should be used in the early to mid-seral age classes of selected Riparian Reserves to promote and maintain older forest characteristics. Some older stands (greater than 80 years) that have had structure altering activities in the past may also be good candidates for structural restoration work. Underlying objectives of any project within the Riparian Reserves would be attainment/maintenance of the Aquatic Conservation Strategy Objectives and maintenance of existing suitable spotted owl habitat. Desired vegetation characteristics in the Riparian Reserves would include:

< Diverse species composition appropriate to the site.
< Diverse age classes, multi-layered canopies with well developed understory vegetation, and a range of diameter classes.
< Horizontal spacing diversity, including limited small canopy gaps.
< A limited number of large diameter "wolfy" dominant conifers with high crown ratios.
< Mature conifers where they have occurred prior to past management.
< Moderate to high amounts of standing and down dead wood component (with high future recruitment potential).
< Trees with physical imperfections such as cavities, broken tops, and large deformed limbs.

Riparian Reserve vegetation management at the site-scale would need to address the major functions provided by the riparian vegetation. Appendix J, Riparian Reserve Function and Role of Vegetation, lists the major riparian functions to address while assessing local conditions. Table 41 should be used as a guide when considering management options in Riparian Reserves.

Management priorities for potential Riparian Reserve treatment would include:

Areas that would promote improved late-seral connectivity within the watershed and to adjacent watersheds;
Areas where past management activities have altered forest stand structure or species composition;
Areas adjacent to where instream enhancement projects are planned;
Areas currently deemed to have low to moderate LWD recruitment potential;
Areas next to other planned timber management activities, and;
Previously thinned stands.

Table 41 Criteria for Potential Management Activities in Riparian Reserves.

Current Condition	Potential Management Activities
Mixed hardwood/conifer stands or pure hardwood stands	
C No conifer stumps present/ No evidence that conifer is suited to the site or historically present	ý No Treatment
C Evidence of past conifers exists/ Conifers overtopped by competing hardwood canopy	ý Release and/or underplant conifers. Decision to treat and the treatment prescription would be determined on a site specific basis. Treatment would be appropriate to the geomorphic context of the site and objectives would be based on the site's physical and biological potential. Small patch cuts or overstory thinning may be desired treatments to provide adequate light for conifer development.
Conifer stands less than 20 years old	
C Dense uniform stands	ý Control stocking to maintain growth of dominant trees and maintain health of stand. ý Prescription would be determined on a site specific basis and may include a range of spacing densities for each site. ý Maintain a component of minor species in the stand, including hardwoods. ý Some conifers may be released to an open- grown condition to promote wolfy limbs.
C Stands with a large component of hardwoods	ý Release conifers to maintain a conifer component in the riparian reserves.

Current Condition	Potential Management Activities
Conifer Stands 20-80 years Previously thinned or unthinned stands with relative densities greater than .35, with or without developing understories. Maintain adequate crown closure as recommended by the area wildlife biologist to meet spotted owl dispersal habitat goals in 40-80 year old stands. Using LSRA and area wildlife biologist recommendations, develop site-specific guidelines for amounts of standing and down dead wood to leave on site. This would restore this structural component to the Riparian Reserve system. Remove excess merchantable material where it may pose a forest health problem.	ý Maintain adequate crown closure as recommended by the area wildlife biologist to meet spotted owl dispersal habitat goals in 40-80 year old stands. ý Manage density to encourage initiation or further enhancement of existing understory growth. ý Prescription would be determined on a site specific basis and may include, a wide range of residual tree densities, small patch cuts, small unthinned patches, snag/LWD creation, and opening specific dominant trees to maintain high crown ratios. ý Maintain a component of minor species and trees with desirable wildlife characteristics, including hardwoods. ý Leave enough green trees to ensure future standing/down dead wood recruitment. ý Using LSRA and area wildlife biologist recommendations, develop site-specific guidelines for amounts of standing and down dead wood to leave on site. This would restore this structural component to the Riparian Reserve system. Remove excess merchantable material where it may pose a forest health problem. ý Do not treat *Phellinus* areas to eradicate it, and use only native planting stock ý Prescriptions would include all subsequent treatments to maintain understory growth, achieve dead down/standing wood goals, achieve older forest characteristics, or any other identified goals.
Conifer Stands over 80 Years Previously managed stands with altered structure or stagnating understories. Maintain adequate crown closure as recommended by the area wildlife biologist to meet suitable spotted owl habitat goals.	C ý Maintain adequate crown closure as recommended by the area wildlife biologist to meet suitable spotted owl habitat goals. ý Manage density to encourage understory growth. ý Do not treat *Phellinus* areas to eradicate it, and use only native planting stock ý Using LSRA and area wildlife biologist recommendations, develop site-specific guidelines for amounts of standing and down dead wood to leave on site. This would restore this structural component to the Riparian Reserve system. Remove excess merchantable material where it may pose a forest health problem. ý Prescription would be determined on a site specific basis and may include any of the treatments for younger stands.

Other Potential Management Activities in Riparian Reserves

< Fire: Prescribed fire can be used at any age to achieve management objectives within the guidelines of the RMP. Site-specific analysis would be done by an IDT.

< Salvage:
- C Guidelines from the RMP would be followed, and logs would only be salvaged if required to attain the Aquatic Conservation Strategy Objectives.
- C CWD would be left on site that would meet the requirements of the LSRA.
- C A site-specific analysis would be done by an IDT to find the need and feasibility of any proposed project.

< SFP's: The guidelines set out in the Salem District environmental assessment would be followed in the Riparian Reserves.

< Inventory: Systematically use field reconnaissance and stand exams to assess current conditions, treatment needs, and feasibility on young conifer stands with competing hardwoods, well-stocked conifer stands less than 80 years old, and older conifer stands that had prior structure altering management.

Species and Habitats

Wildlife

Wildlife and their habitats within the Molalla watershed can be divided into two broad groups: habitat generalists and habitat specialists.

Habitat generalists are the most mobile and have the greatest ability to use a variety of habitat types from grass/forb seral stages to interior older forest habitat using a variety of habitat elements. The Douglas squirrel can be seen foraging, caching food, and nesting in nearly all forest seral stages.

Habitat specialists are highly dependent on specific habitat elements either for nesting or foraging or a combination of both. For example, the pileated woodpecker may use openings (clearcuts) and an interior mature forest habitat, but the key element for this species within both habitats would be snags for nesting and foraging. For other species such as the Oregon slender salamander, it may be a combination of features that may make a habitat suitable such as a closed canopy for thermal and moisture regulation and dispersal, and highly decayed logs for nesting and foraging.

Within the context of the Molalla River watershed, five features appear to influence wildlife use and presence.

1. Availability of snags and down logs for foraging, nesting, and roosting. Except for scattered old-growth patches at higher elevations, snag and down log quantities are substantially below *Northwest Forest Plan* recommended levels.

   Recommendation: Implement snag and down log augmentation projects within LSR's and stands less than 80 years old in the GFMA for long-term habitat improvement.

2. Whether roads are open or closed to public travel. Currently greater than 90 percent of the land with the watershed is closed to public vehicle access.

   Recommendation: Some additional roads may be closed within the Gawley and Horse Creek sub-basins to further reduce effect on wildlife. See Map J.

.

3. Relative availability of interior forest for thermal regulation.

   Recommendations: Avoid further fragmentation of late-successional forest stands within the GFMA and connectivity specifically with the Lower Molalla and Bear Creek sub-basins. When final harvesting, cut from the edges.

4. Abundance and availability of special habitats: Wetlands, wet and dry meadows and rocky outcrops, talus and cliffs are considered the primary special habitats within the Molalla Watershed representing less than two percent of the total watershed. Degradation of dry and wet meadows due to wildfire suppression and OHV use, drainage of wetlands due to road maintenance and beaver trapping, and loss of rocky areas due to road construction and quarry development.

   Recommendations:
   - Consider the use of fire to maintain dry meadows.
   - Close (Federal Register) all lands, trails, and natural surfaced roads to OHV's.
   - Prohibit beaver trapping within the watershed (federal lands)
   - Avoid road construction and quarry development/expansion in rocky habitats.

5. Connectivity between like habitats (primarily late-successional forests) is limited to higher elevations and federal lands.

   Recommendations: Enhance riparian forest development to promote connectivity corridors.

Plants

Finding:

Certain special status/special attention species of concern are associated with older forest habitats.

Recommendations:

Protect and manage known sites of special status/special attention species of concern which are associated with older forest habitats.

Where possible and required, actively manage to develop old-growth-like characteristics in younger age classes (Riparian Reserves, LSRs, Connectivity areas outside Riparian Reserves).

Implement RMP/ROD standards and guidelines for green tree retention for the creation, recruitment, and development of standing/down dead habitat and to contribute to the development of older forest stand characteristics. Due to the scarcity of standing/down dead habitat, protect existing material.

Emphasize older forest near special habitats.

Finding:

New invader and established infestation noxious weed species are present along many roadsides in the watershed. The new invader species infestations identified in the Molalla watershed include spotted knapweed, meadow knapweed, and diffuse knapweed. Established infestation noxious weed species include: Scotch broom, St Johnswort, tansy ragwort, Canada and bull thistles.

Recommendations:

Use the principles of integrated weed management to eradicate and prevent the spread of the new invader noxious weed infestations. Integrated weed management is a management system that uses all suitable methods (cultural, physical, biological, chemical) in a compatible manner to reduce weed population to levels below those causing acceptable economical or ecological consequences.

Take management action to eradicate all new invader infestations and to control the established infestations. Past management efforts to eradicate the knapweed infestations included hand pulling of the plants. This method has not been effective at any of the sites. Chemical treatments followed by hand pulling and establishing competitive native vegetation may be more successful.

Control established infestations primarily by biological control agents and by revegetating disturbed ground with desirable species. Make biological control releases in the Molalla watershed as new agents come available.

Encourage the washing of ground disturbing equipment that has been operating in weed infestations to limit the spread of all exotic and noxious weed species.

Aquatic

Hydrology and Water Quality

Hydrology Summary

Eighty percent of the flow and 73 percent of the precipitation occurs between November and April. The lowest average monthly discharges normally occur June through October, averaging 53 to 293 cubic feet per second (cfs), and highest average discharges were from December through February, averaging 917 to 1003 cfs. A long-term climatic trend with three distinct periods of precipitation and discharge were found. A below average precipitation and discharge period occurred from 1936 to 1944, an above average period from 1945 to 1975, and a below average period from 1976 to 1993.

Groundwater recharge in an average year occurs until approximately April 1st, then groundwater discharge occurs until approximately September 15th when fall storms begin to recharge groundwater again. No major dams or reservoirs exist in the analysis watershed, and most of the summer stream flow is derived from groundwater. In an average year, there are 52 days of base flow from groundwater in reserve at the end of the dry season. In an unusually dry year, there are only 27 days of base flow available before the river would become dry.

Finding 1. During an average year, there is sufficient discharge to allocate between consumptive and instream water rights. However, during certain low flow conditions, the Molalla River may be over allocated which may result in potential conflicts between users.

Recommendation: Recommend Oregon Department of Fish and Wildlife look at the potential impact of over allocation during extreme low flows on fisheries.

Water Quality Summary

Protection and enhancement of water quality in the Willamette River Basin were identified by ODEQ as two of the most critical long range environmental issues facing the state. Most of the non-point pollution in the basin occurs in the winter and spring when heavy rains wash pollutants into rivers. Due to the lack of industry within the Molalla watershed, non-point sources are the main sources of pollution. Oregon Department of Fish and Wildlife found after a review of literature that low summer flows and high water temperatures are the most important limiting factors for winter steelhead and fall chinook in the watershed.

Finding 1. The publication, *1988 Oregon Assessment of Non-point Sources of Water Pollution* (ODEQ 1988) lists a section of the mainstem Molalla River from the city of Molalla upstream to Bear Creek as moderately impacted by sediment. Probable causes were landslides, road locations, and road runoff. The impacted values listed were fisheries. The ODEQ publication, *303(d) list of water Quality Limited Waterbodies*, is a compilation of water bodies where existing required pollution controls are not stringent enough to achieve the state's water quality standards. The Molalla River is listed as water quality limited for high stream temperatures from the analysis watershed boundary upstream to the headwaters on the Table Rock Fork, South Fork Molalla, and Pine Creek. The affected use is listed as fish rearing. BLM temperature monitoring confirmed the high stream temperatures.

Recommendations: Complete a Water Quality Management Plan to ODEQ standards, covering BLM lands in the Molalla watershed. Contact other large landowners in the watershed and attempt to produce a cooperative plan. The plan would provide an objective-driven, long-term approach to achieving state water quality standards.

Expand the stream temperature recording network to delineate problem tributaries and identify areas that may benefit from restoration activities such as improving canopy cover.

Finding 2. Canopy cover over streams is an important factor for controlling stream temperatures. The sub-watersheds with the greatest number of miles of BLM streams with open canopy are: Table Rock Fork, Lower Molalla, Upper Molalla, Bear Creek, Nasty Rock, Lukens Creek, and Lost Creek.

Recommendations: Identify opportunities for improvement of stream cover. Do not reduce existing riparian cover.

Finding 3. BLM water quality sampling found that the levels of total coliforms, turbidity, solids, and pH increase as water moves downstream in the Molalla River. The level of fecal coliforms and entrococci bacteria decrease in a downstream direction from river mile 39 to river mile 31. Although the difference was relatively small, it may indicate a greater input of fecal material above river mile 39 than below. Fecal and enteric bacteria levels appeared to be within the state standards as no samples were above 200 coliforms per milliliter.

Recommendations: Develop limits of acceptable change for the criteria listed above. Continue to monitor water quality on a periodic basis for changes or trends. Collect additional samples in the fall-winter season to acquire sufficient samples for development of limits of acceptable change for the time period.

Finding 4. High stream turbidities were found during storms on Pine Creek, Upper Molalla, Table Rock Fork, and Trout Creek.

Recommendations: Continue storm turbidity monitoring to identify potential sources. Develop restoration projects to reduce inputs from human activities where problems are identified.

Finding 5. Roads crossing or adjacent to streams increase the channel network during storms by channeling runoff and sediment directly to streams. Twenty sub-watersheds are estimated to have high road impacts to streamflow, while six sub-watersheds have high sediment impacts.

Recommendations: Reduce roaded miles that contribute flow or sediment to streams by decommissioning. On roads that can not be decommissioned, upgrading culverts to handle 100- year flood events, maintaining the road surface, leaving some vegetation in the ditch line, and maintaining proper road drainage will help reduce sediment additions to streams.

Finding 6. Recent slope and stream related failures were inventoried using 1996 aerial photographs. Roads played the biggest role in mass movement and were involved in 60 percent of failures. Half of all failure affected stream channels. Upper Molalla, Camp Creek, and Table Rock Fork sub-watersheds had many failures (6 or more). Sub-watersheds with several failures (3 to 5) include Nasty Rock, Ogle Creek, Copper Creek, Joyce Lake, Lukens Creek, and Gawley Creek.

Recommendations: Identify roads crossing unstable slopes and relocate where possible. Upgrade stream culverts that do not meet 100-year flood standards or are damaged or worn. Clean culvert inlets prior to fall storms. Avoid concentrating road runoff onto unstable slopes when designing or relocating roads. Maintain some tree cover on slopes at risk for mass movement to preserve root strength.

Finding 7. ECA analysis evaluates the total acreage in a sub-watershed in clearcut-like condition by applying a factor to each harvest unit depending on age. This method is used in conjunction with other methods and additional watershed information to make professional judgments regarding the relative hydrologic health of a sub-watershed. Sub-watersheds with high ECA values were Glen Avon, Dead Horse Creek, Bear Creek, Pine Creek, and Horse Creek.

Recommendations: Consider ECA values when designing ground-disturbing activities in these sub-watersheds. Look for opportunities to reduce the openings in the forest canopy using road decommissioning or heavy thinnings in forest stands rather than regeneration harvests.

Finding 8. Potential increases in the magnitude of flood flows due to harvesting were analyzed using the method called WAR. This method examines openings in the forest canopy. Increasing openings in the forest canopy can increase the amount of snow accumulating on the ground and increase runoff during rain-on-snow storm events. Peak flows were estimated for the Molalla from 5-year and 50-year return period precipitation events assuming a heavier than normal snowpack and a warm storm. The sub-watersheds with high potential increases in the magnitude of Peakflow are Glen Avon, Bear Creek, Dickey Creek, Lower Molalla, and Russell Creek.

Recommendations: Consider WAR values when designing ground-disturbing activities in these sub-watersheds. Look for opportunities to reduce the openings in the forest canopy such as road decommissioning or heavy thinnings in forest stands rather than regeneration harvests.

Fisheries/Aquatic Habitat

Column six of Table 2 contains ratings of the ‘Fish Habitat Restoration Potential’ for streams within the various sub-watersheds of the Molalla River Watershed Analysis Area. Ratings of “high,” “moderate,” and “low” restoration potential are based on current habitat conditions, fish species present in the stream (resident or anadromous), land ownership (federal or private), and accessibility of the stream for machinery commonly used to conduct instream restoration projects.

Habitat in “fair-good” condition generally rates lower for restoration potential than habitat in “poor” condition. Streams that support only resident fish are rated “low” for restoration potential because restoration of habitat used by “at risk” anadromous fish species is a higher priority at this time. (Upper Willamette River chinook and steelhead were listed in March 1999 as ‘threatened’ by the National Marine Fisheries Service.) Streams on federally administered lands have generally received higher restoration potential ratings; however, many opportunities exist for cooperative projects with private landowners and the state of Oregon. Accessibility of a stream or stream segment for machinery has been used as a rating factor; however, instream restoration projects are possible in streams where access is poor using unconventional methods such as log placement by helicopter.

Instream restoration projects involve log and boulder placements to increase habitat complexity, create localized reductions in stream velocity, trap bedload materials and woody debris, and slow the nutrient cycling process. Sometimes, restoration or creation of secondary channels may be feasible. The type of instream restoration that is feasible in a particular stream or stream segment is largely dependent on stream size.

In larger streams within the watershed (5^{th} - 7^{th} order), such as the mainstem Molalla River (6^{th} - 7^{th}), Table Rock (Middle) Fork (5^{th}) or North Fork (6^{th}), large, tree-length logs with root wads could be placed in the stream by various means (yarding, pulling, blasting, or helicopter). If the materials are placed carefully and do not span most of the channel width, it is reasonable to expect that they would remain in the stream long enough to provide some benefit to the instream habitat. However, using smaller materials, placement along the margins of the stream and anchoring to existing stable structures would be necessary if they are to be expected to remain in the channel long enough to be beneficial.

In smaller streams (4^{th} - 5^{th} order) such as Lukens, Cougar, and Trout creeks, log and boulder complexes that span the entire channel width can be constructed and anchored in place with a reasonable expectation that they will remain functional and provide the anticipated benefits to instream habitat.

Based on the rating system used for this analysis, the stream segments that presently appear to have the highest priority for instream restoration projects are as follows:

1) Mainstem Molalla River within the Upper Molalla sub-watershed of the South Fork Molalla Analysis Area from RM 40 to RM 43, approximately from the confluence with the Middle Fork to the confluence with Avalanche Creek.

Recommendation:

Placement of whole trees, from existing riparian stands into the river, leaving roots attached to the ground and boles wedged between standing trees or aligned to become wedged between standing trees when pushed by water. Approximately 40-50 trees per mile.

2) Mainstem Molalla River within the Bear Creek and Horse Creek sub-watersheds of the Upper Mainstem Molalla Analysis Area from RM 32 to RM 39.

Recommendation:

Construction of woody debris complexes along the river margins where equipment access allows. Complexes would consist of clusters of 3-6 logs anchored to existing stable structures (bedrock, boulders, and riparian hardwoods) in forms designed to trap bedload and debris and provide cover. Approximately 10-15 structures per mile. Usually, logs used for construction would need to be imported from off site.

3) Table Rock Fork within the Middle Fork Molalla Analysis Area from RM 0 to RM 7, approximately up to the confluence with Camp Creek.

Recommendation:

Placement of whole trees, where existing riparian stands are dense enough to remove some, into the river, leaving roots attached to the ground and boles wedged between standing trees, in combination with construction of woody debris complexes along the river margins where equipment access and streambed and bank geomorphology allow. Frequency of structures should be determined by site surveys. Secondary channel opening as determined feasible by site surveys.

4) North Fork Molalla River within the Glen Avon and North Fork Molalla sub-watersheds from RM 0 to RM 6, approximately up to the confluence with Dead Horse Canyon Creek. All private land. This would need to be a cooperative project with private landowners.

Recommendation:

Construction of woody debris complexes along the river margins where equipment access allows. Complexes would consist of clusters of 3-6 logs anchored to existing stable structures (bedrock, boulders, and riparian hardwoods) in forms designed to trap bedload and debris and provide cover. Approximately 15-20 structures per mile. Most logs used for construction would need to be imported from off site.

5) Lukens Creek within North Fork Molalla Analysis Area from RM 0 to approximate RM 4. RM 0 to RM 0.7 is private land; project could be cooperative with private landowner.

Recommendation:

Construction of log and boulder structures in weir, deflector and scour agent configurations. Frequency of structures should be determined by site surveys. Most logs used for construction would need to be imported from off site.

6) Cougar Creek within the North Fork Molalla Analysis Area from RM 0 to RM 3. All private land. This would need to be a cooperative project with private landowners.

Recommendation:

Construction of log and boulder structures in weir, deflector and scour agent configurations. Frequency of structures should be determined by site surveys. Logs used for construction would need to be imported from off site. Secondary channel opening as determined feasible by site surveys.

7) Mainstem Molalla River within the Lower Molalla sub-watershed from RM 28 to RM 31.

Recommendation:

Placement of whole trees, where existing riparian stands are dense enough to remove some into the river, leaving roots attached to the ground and boles wedged between standing trees, in combination with construction of woody debris complexes along the river margins where equipment access and streambed and bank geomorphology allows. Frequency of structures should be determined by site surveys.

Social Settings

Recreation

Recreation opportunities within the Molalla watershed are regionally significant. Much of the watershed, especially along the main river and larger tributaries, is used extensively for recreation activities by thousands of visitors each year. Participation in both camping and day-use activities is increasing within the watershed. Trends suggest that recreation use of the area and demand for outdoor recreation opportunities will increase significantly correspondingly with projected population growth of urban and rural areas of the Willamette Valley. Resource damage and impacts related to recreation use and other public use (trash dumping, abandoned and stolen vehicles, and other illegal activity) will continue to increase if recreation management actions are not carried out. The BLM is also obligated to provide adequate recreation opportunities and support facilities to meet recreation demand in the watershed.

Recommendations:

It is recommended that the BLM continue to implement both direct and indirect recreation management techniques to reduce visitor impacts while providing primitive recreation opportunities. The BLM should take an active and leading role in the management of recreation use within the watershed. Indirect recreation management methods include emphasizing visitor signing to direct visitors to appropriate use areas for certain activities and inform visitors of area rules and regulations. The BLM should continue to develop and start visitor education programs, including the development and dissemination of education materials, publications, and maps to promote minimum impact use etiquette and build awareness resource stewardship.

The BLM should also emphasize appropriate direct visitor and recreation management techniques including:

< Increase BLM law enforcement patrols and recognize increased need for law enforcement by designating the area as a law enforcement emphasis area, conducting regular patrols, conducting law enforcement sweeps during high use periods, and developing law enforcement agreements with local police and sheriff agencies.

- Close sensitive areas to motorized access or recreation use by placing appropriate signing and barriers if needed.

- Designate and manage specific areas or sites for camping (overnight use) and picnicking (day-use).

- Provide primitive recreation facilities such as parking areas, camp grounds, rest rooms, potable water, and trails.

Recommendations for developed recreation sites include:

- Development of at least two moderate capacity drive-in camp grounds along the mainstem Molalla River. These 25- to 30-unit primitive camp grounds would include simple gravel camp site pads, surfaced access roads, vault toilets, and potable water. Potential campground locations include the Pine Creek Bridge area, River Bend area, Table Rock Fork, and Copper Creek confluence area.

- Development of at least six limited capacity drive-in camp grounds along the mainstem Molalla River and main tributaries. These small camp grounds (one to three units) would include simple gravel camp site pads, hardened or graveled access roads, and vault toilets.

- Continue to develop the existing network of non-motorized trails, parking areas, and trail heads associated with the Molalla River Shared-Use Trail System and the Table Rock Wilderness.

Campgrounds, trails, and trail heads may be located in appropriate riparian areas where developable and accessible terrain exist after required surveys and clearances have been conducted and where any development impacts can be acceptably mitigated. Installation of designated and developed camp grounds will allow closing of other dispersed locations resulting in a net decrease of recreation related riparian impacts in the watershed.

We will also continue to work to acquire lands within the watershed from willing landowners to consolidate lands, improve wildlife habitat, protect viewsheds, or enhance recreation opportunities. This would be accomplished via land exchanges or acquisition inholdings.

Forest Products

Federal Lands - Harvest Scheduling

The primary constraints to harvesting timber on federal lands are the land use allocations from each agency's planning documents and the results of cumulative effects analysis for each sub-watershed basin.

One of the objectives of this watershed analysis was to determine when and where the federal agencies could harvest timber and to determine if this was consistent with their current land use plans. This analysis confirms that deductions from the land base for Riparian Reserves, LSR's nonproductive land, non forest land, and other take outs are consistent with those used in sale quantity projections. This analysis also reveals that Cumulative Effects Analysis within each sub-watershed basin adds another major constraint not addressed in the agencies' planning documents and projections.

The federal government owns about 33 percent of this watershed. What happens on private lands may substantially restrict what can be done on federal lands. The current trend is toward shorter rotations (40 to 60 years) on private lands. This means less time for the watershed to be in a recovered state (70% crown closure over age 30). The federal lands are then tasked with providing enough crown cover in each sub-watershed basin to keep the cumulative impacts within an acceptable risk. This constraint is displayed in Table 39 in Chapter 6.

One alternative is to manage federal lands for a continuous canopy. This would mean not scheduling any clearcut regeneration harvest on those lands in the timber base. Instead, BLM could manage these stands for the first few decades by thinning from below. Canopy closure should not be reduced below what could recover back to 70 percent within a few years. This approach would take advantage of the tremendous growth potential of Douglas-fir. Experience and observations have shown that if these stands are kept well spaced with good crowns they will continue to grow at an accelerated rate for an extended period. An understory of conifers will likely develop after these stands are thinned.

This does not rule out the possibility of regeneration harvest. It only requires that any proposed regeneration harvest be made without affecting downstream water quality. In addition, these stands could eventually be groomed for development of their understory which could lead to future uneven-aged management.

Chapter 8 Data Gaps, Inventory, Monitoring

This chapter lists where information gaps were found during the analysis and what information should be collected in the future.

Soils

Information Gaps

TPCC type classification on non-public land.

Compacted acres on private land.

Synthesis of riparian surveys done during 1995/1996.

Inventory Needs

Riparian inventories of all non-inventoried areas.

Post flood inventories of all riparian areas inventoried in 1995.

Monitoring

Monitor post harvest soil disturbance (erosion, compaction, sediment from roads, etc.).

Research

Study damage to tree roots from using winged subsoiler to ameliorate compaction in density management areas.

Study stream channel stability, condition, and slope stability in sub-watersheds with high cumulative effects indices.

Riparian Reserves

Information Gaps

- Lack of accurate number of acres and correct spatial location of sites within Riparian Reserves that have had structure altering management in the past.

- Lack of accurate amount and condition of snag and large down wood habitat within Riparian Reserves.

< Lack of an accurate amount of acres exhibiting good multi-layered stand structure within Riparian Reserves.

< Lack of information regarding conifer status in hardwood dominated stands.

Inventory Needs

< Stand exams, including the dead wood component, in appropriate Riparian Reserves to help eliminate data gaps.

< Inventory of hardwood-dominated stands to assess current condition and possible treatment needs.

Monitoring

< Monitor Riparian Reserve habitat before and after implementing management prescriptions.

Wildlife and Habitats

Information Gaps

Comprehensive data on coarse woody debris size, quantity, and distribution within the watershed.

Comprehensive data on snag size, quantity, and distribution within the watershed.

Lack of information on special status/special attention species within the watershed.

Inventory Needs

Survey for special status/special attention species (including Survey & Manage species) within the watershed - with an emphasis on non-matrix lands.

Inventory special habitats within the watershed.

Monitoring

Monitor golden eagle known and potential sites.

Monitor selected known survey strategy 1 and protection buffer botanical species sites.

Monitor noxious weed treatment sites to evaluate treatment effectiveness.

Fisheries and Fish Habitat

Information Gaps

Lack of information on upstream limits of fish distribution

Inventory Needs

Quantitative habitat inventories in some tributary streams

Recreation and Visitor Use

The BLM should actively seek additional information concerning visitor use levels and use patterns within the watershed. It is recommended that surveys of visitors and monitoring of camp site and user site impacts are conducted using the levels of acceptable change planning process. Vehicle counting systems should be installed and monitored on main roadways within the watershed. Trail counting systems should be installed and monitored at primary access points to the shared-use trail system and Table Rock Wilderness. Law enforcement incidents and reports should be reviewed for indications of trends and effectiveness of management actions.

Appendices

Appendix A

Summary of Public Comments on Molalla Watershed Analysis Issues/Concerns

Most Important Issues

Over harvest of timber with little or no stream buffers.

Wild fish runs; how do we reverse their collapse?

Public use along the lower main stem of the Molalla River.

Road and stream crossing failures throughout the watershed.

More patrols in the area; perhaps use volunteers.

Type and increasing level of recreational use

Interaction and effect on private lands

Continued management of forest lands for timber production.

Specific Locations of Particular Concern

The main stem downstream from the Table Rock fork. It is a primary area for spring chinook spawning and rearing; also for winter steelhead.

Gawley Creek area; lots of garbage dumping and use of fire arms.

Areas owned and managed by Willamette Industries.

South Clackamas County beyond urban areas.

Section 8, T. 7 S., R. 3 E.

Lands owned by Longview Fibre

Headwaters from Horse Creek through Batty Butte to No-Horn Butte and Nasty Rock.

How Would You Like to See Federal Lands Managed in the Watershed?

More protection for stream habitat through modified timber harvest.

More patrols to ensure public safety.

Full implementation of Aquatic Conservation Strategy.

Maintain LSRs.

Manage timber for harvest where applicable and try to lessen impacts of public on adjoining private properties.

With an iron fist.

Multiple Use.

Reopen roads into Joyce Lake

More emphasis on timber sales

More emphasis on recreation management along the Molalla River

Accelerate closure of unneeded roads, especially short spurs that facilitate dumping of garbage.

What Kind of Watershed Restoration Would You Like to See Planned; Where?

Reduce logging in unstable areas.

Improve streamside cover through plantings.

Rehab scoured channels from floods

Block roads to prevent garbage dumping; more garbage removal.

As little as possible.

Reforestation of all BLM lands, especially the lands traded by Cavenhan Industries.

Other Comments, Concerns, Issues

Advance notification of any meetings related to the WSA

Develop a network of volunteers who could provide assistance in managing the watershed.

Don’t let management of public lands be dictated by public sentiment/opinion instead of by scientific and historic data.

Use the Molalla River Corridor to showcase good forest management and recreation.

Appendix B

Special Status/Special Attention Wildlife Species
Known & Suspected

	SPECIES & STATUS	HABITAT DESCRIPTION
	HERPETOFAUNA	
D	RHYACOTRITON CASCADAE BT/SV Cascade torrent salamander	Documented to occur in MOWA. Prefers small cold streams and springs with water seeping through moss-covered gravel. Most common in mature and old-growth conifer forests below 4000 feet.
D	ANEIDES FERREUS BT/SU clouded salamander	Documented to occur in MOWA. Prefers the spaces between loose bark on down logs in forests, forest edges, and clearings created by fire.
D	BATRACHOSEPS WRIGHTI BS/SU Oregon slender salamander	Documented to occur in MOWA. West slope of Cascades. Prefers down logs and woody material in more advanced stages of decay. Most common in mature and old-growth conifer forests.
D	ASCAPHUS TRUEI SOC/BS/SV tailed frog	Documented to occur in MOWA. Cold, fast-flowing permanent springs and streams in forested areas. Has a very narrow temperature tolerance.
D	RANA AURORA SOC/BS/FS/SU red-legged frog	Documented to occur in MOWA. Common in marshes, ponds, and streams with little or no flow, from the valley floor to about 2700 feet in mountain forests. Can occur in seasonal waters if wet until late May or June.
D	RANA CASCADAE SOC/BS/SV Cascades frog	No documented sites in MOWA. Historic locations to the east at higher elevations. Found in higher elevation bogs, ponds and stream edges associated with moist meadows.
	BIRDS	
D	HISTRIONICUS HISTRIONICUS SOC/BS/FS/SU harlequin duck	Documented to occur in MOWA. An uncommon summer resident. Found in whitewater mountain rivers and streams during nesting season. Winters on rocky coasts.
S	BUCEPHALA ISLANDICA BT/SU Barrow's goldeneye	Likely to occur in MOWA. Uncommon to rare migrant and winter visitor in open water areas.
D	BUCEPHALA ALBEOLA BA/SU bufflehead	Likely to occur as a migrant and winter visitor in open water areas. Has been documented in ponds within the watershed.
S	HALIAEETUS LEUCOCEPHALUS LT/ST bald eagle	Suitable habitat present in MOWA. Detroit reservoir to south and Big Cliff Reservoir to the north. Rare summer resident in Cascades. Uncommon winter resident in Willamette Valley. For nesting and perching, prefers large old-growth trees near major bodies of water and rivers.
D	ACCIPITER GENTILIS SOC/BS/SC Northern goshawk	Know to occur within the MOWA. Unknown nesting status. Rare Summer resident in Cascades. Prefers mature or old-growth forests with dense canopy cover at higher elevations. Winters at lower elevations.
S	FALCO COLUMBARIUS BA merlin	Highly likely to occur in MOWA during Migration and winter. Fields, open areas and edges
S	FALCO PEREGRINUS LE/SE peregrine falcon	Probable occurrence within the watershed. Documented to occur to the east and south of MOWA during the nesting season and fall migration. Suitable cliff habitat for nesting is present in MOWA. Likely to occur as a transient/migrant and winter visitor Found in a variety of open habitats near cliffs or mountains. Prefers areas near larger bodies of water and rivers.

S	GRUS CANADENSIS BT/FS/SV sandhill crane	Suspected as a rare spring/fall overhead migrant in MOWA.
S	TRINGA MELANOLEUCA BA greater yellowlegs	Suspected to occur rarely in the lower end of MOWA. A common transient and uncommon winter resident in Willamette Valley. Wetlands, flooded fields, and mud flats.
S	TRINGA SOLITARIA BT solitary sandpiper	Suspected to occur rarely in the lower end of MOWA. Uncommon spring/fall migrant and transient in Willamette Valley. Wetlands, flooded fields, and small water bodies.
D	GLAUCIDIUM GNOMA BT/SU Northern pygmy owl	Common permanent resident in MOWA. Coniferous/mixed forests and edges.
D	STRIX OCCIDENTALIS CAURINA LT/ST Northern spotted owl	Permanent resident in MOWA, especially the upper end. (9 known sites). Prefers mature and old-growth conifer forests with large down logs, standing snags in various stages of decay, high canopy closure and a high degree of vertical stand structure.
?	STRIX NEBULOSA BT/B/SV great gray owl	Possible resident in the MOWA. Known breeding resident to the west. However it is primarily an east side species. On the west side, associated with natural and manmade openings, mostly at higher elevations.
S	MELANERPES LEWIS BS/SC lewis' woodpecker	Formerly a common summer resident and uncommon winter visitor in Willamette Valley. Today it is a rare transient and migrant. Oak woodlands and hardwood forests.
D	PICOIDES ARCTICUS BS/B/SC black-backed woodpecker	Documented to occur in the upper end of MOWA. Primarily an eastside species. On the westside, it's found in mature/older forests with abundant snags at higher elevations.
D	DRYOCOPUS PILEATUS BT/SV pileated woodpecker	Common permanent resident in MOWA. Prefers to nest in old-growth and mature forests. Also forages in younger forests containing mature or old-growth remnants. Requires larger snags and down wood.
S	CONTOPUS COOPERI SOC/BS olive-sided flycatcher	Uncommon summer resident in more open coniferous forest and edge with prominent tall snags or trees that serve as foraging and singing perches.
S	EREMOPHILA ALPESTRIS BT/SC horned lark	Suspected in extreme western edge of MOWA. Rare and local summer resident in Willamette Valley. Uncommon in winter. Open fields, grassy areas.
S	PROGNE SUBIS BT/SC purple martin	Suspected as a rare summer resident in MOWA. Documented to occur in the North Santiam to the south and west. Typically occurs along rivers and other water bodies. Nests colonially in cavities in old buildings, abandoned woodpecker holes, and nest boxes.
D	SIALIA MEXICANA BT/SV western bluebird	Documented in to occur in MOWA. Uncommon permanent resident in Willamette Valley and adjacent foothills. Open areas with standing snags, or small farms with diversified agriculture. Nests in natural woodpecker cavities or artificial nest boxes.
S	POOECETES GRAMINEUS BT/SC vesper sparrow	Suspected to occur in extreme western portion MOWA. Rare and local summer resident in Willamette Valley. Very rare in winter. Dry, grassy areas.

	MAMMALS	
S	LASIONYCTERIS NOCTIVAGANS B silver-haired bat	Documented to occur in MOWA. Associated with cliff/cave and snag habitat. Forages in a variety of forest habitats and riparian areas.
S	MYOTIS EVOTIS SOC/BS/B long-eared myotis	Highly likely to occur in MOWA. Associated with snags and cave habitat. Prefers older forests. Forages over water and riparian areas.
S	MYOTIS VOLANS SOC/BS/B long-legged myotis	Highly likely to occur in MOWA. Associated with cliff/cave and snag habitat. Prefers older forests. Forages over water and riparian areas.
S	MYOTIS YUMANENSIS SOC/BS yuma myotis	Highly likely to occur in MOWA. Associated with cliff/cave and snag habitat. More closely associated with riparian areas than the other myotis. Prefers older forests. Forages over water and riparian areas.
D	PLECOTUS TOWNSENDII SOC/BS/FS/B/SC pacific western big-eared bat	Documented to occur in MOWA. Feeds on flying insects in a variety of habitats in forested areas. Primary habitat is caves, rock outcrops, buildings and abandoned mines.
U	GULO GULO SOC/BS/FS/ST wolverine	Found in higher elevation mountainous and isolated coniferous forests.
S	MARTES AMERICANA BS/SV pine marten	Suspected to occur in MOWA. Mature and old-growth forests containing large quantities of standing snags and downed logs, in the upper end of MOWA. Prefers wetter forests, often near streams.
S	PHENACOMYS LONGICAUDUS SM red tree vole	Highly likely to occur in the MOWA. This arboreal vole prefers mature/older forests with closed canopies.

KEY

Occurrence:
S = Suspected
D = Documented
U = Unknown

Status:
LE = Federal endangered
LT = Federal Threatened
SOC = Species of Concern & Bureau Sensitive
BS = Bureau Sensitive
BA = Bureau Assessment
BT = Bureau Tracking
FS = Forest Service Sensitive
SM=ROD Survey and Manage
B=ROD Buffer or extra protection species
SE = State Endangered
ST = State Threatened
SC = State Critical
SV = State Vulnerable
SU = State Uncertain
SP = State Peripheral

Appendix C

Special Status/Special Attention Invertebrate Species

SPECIES	SP CODE	BLM/FS STATUS	ONHP LIST	GEOGRAPHIC RANGE or HABITAT NEEDS
MOLLUSKS Oregon megomphix	MEHE	SM/BS	1	CR,WV,WC: Moist conifer/hardwood forest, bigleaf maple logs/litter at low/mid elevations
Blue-gray tail dropper (slug)	PHCO	SM/BS	1	CR,WC: Moist conifer/hardwood forest in moss logs,litter at mid/high elevations
Papillose tail-dropper (slug)	PHDU	SM/BS	1	CR,WV,WC: Moist conifer/hardwood forest in moss, logs, litter at low/mid elevations
Malone jumping-slug	HEMA			WC
Warty jumping-slug	HEGL			WC
EARTHWORMS Oregon giant earthworm	DRMA	SOC/BS	1	WV: Associated with undisturbed vegetation and uncultivated soils at low elevations
INSECTS Beer's false water penny beetle	ACBE	SOC/BS/FS	3	WC: Rocky or gravelly stream margins
Cascades apatanian caddisfly	APTA	SOC/BS	2	WC,EC: Found in small streams on coarse gravel and cobble in areas of low current at mid/high elevations
Vertree's ceraclean caddisfly	CEVE	SOC/BS	3	CR,WV: Found in large streams and river systems at low/mid elevation
Mt. Hood brachycentrid caddisfly	EOGE	SOC/BS/FS	3	WC: Cold spring fed streams at mid/high elevations
Mt. Hood farulan caddisfly	FAJE	SOC/BS	3	WC,EC: Small spring fed streams associated with older forests
Tombstone Prairie farulan caddisfly	FARE	SOC/BS/FS	3	WC: Small spring fed streams with moderate to fast currents on coble and wood at high elevations
Tombstone Prairie oligophlebodes caddisfly	OLMO	SOC/BS/FS	3	WC: Small to large streams at high elevations
One-spot rhyacophilian caddisfly	RHUN	SOC/BS/FS	3	WC,EC: Clear streams at high elevations
Siskiyou caddisfly	TISI	SOC/BS	3	WC: Collection sites widely scattered thru OR and includes Little North Fork of North Santiam

KEY: WV=Western Valleys WC=Western Cascades EC=Eastern Cascades CR=Coast Range
SOC = Species of Concern & Bureau Sensitive
BS = Bureau Sensitive
FS = Forest Service Sensitive
SM=ROD Survey and Manage

Appendix D

Botanical Species of Concern
Special Status Plants to Search for in the Molalla Watershed

SPECIES & STATUS	**HABITAT**	ELEVATION (FT)	BEST I.D. SEASON
FEDERAL CATEGORY 1 CANDIDATES (FC1)			
DELPHINIUM PAVONACEUM Ewan peacock larkspur	WV clac, Mari, mult	<1500	MAY-JUNE
ERIGERON DECUMBENS Nutt. VAR. *DECUMBENS* Willamette daisy	WV Clac, Linn, Mari GRASSLANDS	<1000	JUNE-EARLY JULY
BUREAU SENSITIVE (BS)			
ASTER CURTUS Cronq. white-topped aster	WV Clac. Linn, Mari, Mult.		
ASTER GORMANII (Piper) Blake Gorman's Aster	WC Clac, Linn, Mari OPEN OR SPARSLEY TIMBERED, ROCKY RIDGETOPS & MEADOWS	>3500	LATE JULY-AUGUST
BRIDGEOPORUS NOBILISSIMUS W.B. Cooke giant polypore fungus, fuzzy sandozi	WC Clac, Linn OLD GROWTH NOBLE FIR		
CIMICIFUGA ELATA Nutt. tall bugbane	WV, WC, Clac, Linn, Mari, Mult MOIST WOODS	<2000	JUNE-MID JULY
CORYDALIS AQUAE-GELIDAE Peck & Wilson cold-water corydalis	WC Clac, Linn, Mari, Mult COLD SPRINGS & STREAMS	>1000	MID JUNE-JULY
DELPHINIUM LEUCAPHAEUM Greene white rock larkspur	WV Clac, Mari, Mult	<1000	MAY-EARLY JUNE
ERIGERON HOWELLII A. Gray Howell’s daisy	WC Clac, Mult		
MONTIA HOWELLII S. Watson Howell's montia	WV, WC Clac, Linn, Mult ROCKY RIVER BANKS ESP. IN DISTURBED SITES	<2500	APRIL-EARLY MAY
SISYRINCHIUM SARMENTOSUM Suksd. Ex Greene pale blue-eyed grass	WC Clac		
SULLIVANTIA OREGANA S. Watson Oregon sullivantia	WV, WC Clac, Mult		

Noxious Weeds to Search for in the Molalla Watershed

PRIORITY I SPECIES - POTENTIAL NEW INVADERS * known populations in the Cascade Resource Area		
SCIENTIFIC NAME	**COMMON NAME**	**BEST ID. SEASON**
CARDUUS PYCNOCEPHALUS	Italian thistle	May - June
CARTHAMUS LANATUS	distaff thistle	
CARTHAMUS LEUCOCAULOS	whitestem distaff thistle	
CENTAUREA SOLSTITIALIS	yellow starthistle	
CENTAUREA VIRGATA	squarrose knapweed	
CHONDRILLA JUNCEA	rush skeleton weed	mid July - Frost
CENTAUREA CALCITRAPA	purple starthistle	
CENTAUREA IBERICA	Iberian starthistle	
CARDUUS TENUIFLORUS	slender flower thistle	
LYTHRUM SALICARIA	purple loosetrife	Aug. - Sept.
SILYBUM MARIANUM	milk thistle	Late April - Early June
PRIORITY II SPECIES - ERADICATION OF NEW INVADERS		
**** CENTAUREA DIFFUSA***	diffuse knapweed	July - Sept.
**** CENTAUREA MACULOSA***	spotted knapweed	July - Oct.
**** CENTAUREA PRATENSIS***	meadow knapweed	July - Oct.
**** ULEX EUROPARUS***	gorse	April - Sept.
PRIORITY III SPECIES - ESTABLISHED INFESTATIONS		
**** CIRSIUM ARVENSIS***	Canada thistle	July - Aug
**** CIRSIUM VULGARE***	bull thistle	July - Sept
**** CYTISUS SCOPARIUS***	Scotch broom	May - June
**** HYPERICUM PERFORATUM***	St. Johnswort	June - July
**** SENECIO JACOBAEA***	tansy ragwort	July - Sept

Survey & Manage and Protection Buffer Species in the Cascades Resource Area

The species listed below are included in the survey and manage and the protection buffer species portion of the Northwest Forest Plan. The species included on this list and their respective survey strategies could change in the future.

* Known sites of these species are the Molalla Watershed Analysis area

Bryophytes (Survey Strategies)

** Antitrichia curtipendula* (4)
** Ptilidium californicum* (1,3)
Racomitrium aquaticum (1,3)
** Ulota megalospora* (PB)

Fungi

Asterophora lycoperdoides (3)
Bondarzewia montana (1,2,3)
Bridgeoporus nobilissiuus (1,2,3)
Cantharellus cibarius (3,4)
** Cantharellus formosus* (1,3)
** Cantharellus tubaeformis* (3,4)
Clavariadelphus pistilaria (3,4)
Clavulina cinerea (3,4)
** Clavulina cristata* (3,4)
Cordyceps capitata (3)
Cudonia monticola (3)
Gomphus floccosus (3)
Gymnopilus puntifolius (1,3)
Gyromitra esculenta (3,4)
Gyromitra infula (3,4)
** Helvella compressa* (1,3)
Hydnum repandum (3)
Hydnum umbilicatum (3)
Hypomyces luteovirens (3)
Neournula pouchetti (1,3)
** Omphalina ericitorium* (3,4)
Otidea leporina (3,PB)
** Otidea onotica* (3,PB)
Phaeocollybia californica (1,3)
Phaeocollybia kauffmanii (1,3)
Plectania latahense (1,3)
** Plectania melastoma* (3)
Ramaria araiospora (1,3)
Ramaria stuntzii (1,3)
** Sarcosoma mexicana* (3,PB)
Sparassis crispa (3)
Sowerbyella rhenana (1,3,PB)

Lichens

** Calicium viride* (4)

Cetrelia cetrariodes	(4)
Chaenotheca chrysocephala	(4)
* *Chaenotheca ferruginea*	(4)
Cyphelium inquinans	(4)
Lobaria hallii	(1,3)
* *Lobaria oregana*	(4)
* *Lobaria pulmonaria*	(4)
* *Lobaria scrobiculata*	(4)
Nephroma bellum	(4)
* *Nephroma helveticum*	(4)
* *Nephroma laevigatum*	(4)
Nephroma parile	(4)
* *Nephroma resupinatum*	(4)
* *Pannaria saubinetii*	(4)
* *Peltigera collina*	(4)
* *Platismatia lacunosa*	(4)
* *Pseudocyphellaria anomola*	(4)
* *Pseudocyphellaria anthraspis*	(4)
* *Pseudocyphellaria crocata*	(4)
Pseudocyphellaria rainierensis	(1,2,3)
Ramalina thrausta	(4)
* *Sticta fuliginosa*	(4)
* *Sticta limbata*	(4)
Usnea longissima	(4)

Appendix E

ODFW Benchmarks of Stream Habitat Parameters

ODFW Benchmarks of Stream Habitat Parameters for “Desirable” (good) and “Undesirable” (poor) Conditions (measurements that fall between “desirable” and “undesirable” are considered “fair”). “Good” habitat conditions are based on values from surveys of reference areas with known productive capacity for salmonids and from the 65th percentile of values obtained in surveys of late successional forests. “Poor” habitat conditions are based on values associated with known problem areas and from the lower 25th percentile of combined data for each region.

Percent pool area (pool quantity): “desirable” - >35%; “undesirable” - <10%.

Channel widths per pool (pool frequency): “desirable” - <8; “undesirable” - >20
Avg. residual pool depth (pool quality):
Low gradient streams (<3%) or small (<7m feet active channel width)
“desirable” - >0.5m
“undesirable” - <0.2m
High gradient streams (>3%) or large (>7m feet active channel width)
“desirable” - >1.0m
“undesirable” - <0.5m
Gravel quantity (percent area in riffles): “desirable” - ≥35; “undesirable” - <15
Gravel quality (percent of fines, ie. silt, sand & organics present in surface layers of spawning gravels): “desirable” - <10; “undesirable” - >25
Off-channel habitat(percent area of secondary channels): “desirable” - ≥10; “undesirable” - <10
Large woody debris:
# of pieces per 100m stream length (minimum size 15cm diam. & 3m length)
“desirable” - >20; “undesirable” - <10
of “key pieces” per 100m stream length (minimum size >50cm diam. & >active channel width in length)
“desirable” - >3; “undesirable” - <1
Riparian conifers within 30m of stream on both sides:
>20 in. dbh per 1,000 ft. of stream length: “desirable” - >300; “undesirable” - <150
>35 in. dbh per 1,000 ft. of stream length: “desirable” - >200; “undesirable” - <75

Appendix F

Summary of Stream Habitat Parameters in the Molalla River Watershed

Stream	Reach	Year of Survey	Length (miles)	Avg. AC Wid. (ft)	% Pool	Chan. wid./pool	% 2º Chan.	LWD Volume (m^3/100m)	Rip. Conifers /1000 >20"	>35"
SOUTH FORK MOLALLA ASSESSMENT AREA										
Molalla R.	8	1993	3.71	81.0	22.9	6.4	5.7	14.9	12	0
Molalla R.	9	1993	0.08	98.4	5.5	0.2	58.1	9.0	0	0
Molalla R.	10	1993	2.96	73.5	36.9	4.3	6.3	7.7	48	0
Copper Cr.	1	1994	3.66	33.5	15.2	9.5	2.2	21.8	0	0
Ogle Cr.	1	1994	0.39	25.6	12.3	11.4	0	34.5	0	0
Ogle Cr.	2	1994	0.39	23.0	1.3	90.6	0	0.3	0	0
MIDDLE FORK MOLALLA ASSESSMENT AREA										
T.R. Fork[1]	1	1996	1.56	58.1	22.9	10.1	0	2.4	61	0
T.R. Fork	2	1996	0.97	52.5	9.9	21.6	0.8	11.9	61	0
T.R. Fork	3	1996	0.71	69.9	6.4	21.6	5.7	13.0	0	0
T.R. Fork	4	1996	2.37	51.2	4.7	47.5	20.0	53.4	61	0
T.R. Fork	5	1996	1.70	59.7	15.1	14.2	16.3	33.7	30	0
T.R. Fork	6	1994	0.94	39.0	19.4	6.1	8.4	6.7	0	0
T.R. Fork	7	1994	1.85	35.1	10.1	7.0	10.5	22.4	0	0
T.R. Fork	8	1994	1.20	21.3	24.8	8.3	13.2	18.6	0	0

T.R. Fork	9	1994	0.17	14.1	28.0	10.7	7.0	21.3	0	0
T.R. Fork	10	1994	0.51	6.6	20.8	51.4	2.7	5.4	14	0
Camp Cr.	1	1994	1.65	29.9	6.5	18.3	6.0	20.9	0	0
Camp Cr.	2	1994	1.02	24.9	3.4	53.8	0	16.8	102	0
NORTH FORK MOLALLA ASSESSMENT AREA										
NF Mol. R.	1	1993	1.66	46.3	13.0	9.0	3.1	1.9	0	0
NF Mol. R.	2	1993	0.85	44.9	24.5	9.0	1.5	3.1	0	0
NF Mol. R.	3	1994	5.48	32.8	10.6	13.8	3.7	9.1	0	0
NF Mol. R.	4	1994	0.94	33.5	2.5	49.2	7.2	15.4	0	0
NF Mol. R.	5	1994	1.58	24.6	6.0	24.2	5.2	13.9	0	0
NF Mol. R.	6	1994	0.98	20.7	1.4	83.8	0	16.0	0	0
NF Mol. R.	7	1994	0.85	No data	0	N/A	0.7	7.2	0	0
DHC Cr.[2]	1	1994	1.73	34.1	9.1	13.4	6.0	17.0	41	0
DHC Cr.	2	1994	0.96	33.5	16.3	5.2	8.1	33.5	0	0
DHC Cr.	3	1994	1.11	23.9	6.6	15.3	8.2	10.5	0	0
DHC Cr.	4	1994	3.36	18.7	4.0	31.6	8.1	17.9	41	0
DHC Trib.	1	1994	1.73	23.9	10.6	22.5	1.2	28.1	0	0
Lukens Cr.	1	1994	6.09	30.5	12.3	10.0	2.7	10.6	46	8
Lukens Cr.	2	1994	1.37	27.6	0.7	43.7	0.5	40.5	244	30

Lukens Cr.	3	1994	0.26	No data	N/A	N/A	0	0	85	0
Cougar Cr.	1	1993	0.34	14.8	13.3	17.4	0	6.8	0	0
Cougar Cr.	2	1993	2.85	21.0	11.7	10.5	4.3	14.3	0	0
Cougar Cr.	3	1993	0.51	16.4	0	N/A	4.3	18.9	0	0
Cougar Cr.	4	1993	1.49	14.1	8.5	22.3	2.1	12.7	0	0
Cougar Cr.	5	1993	0.25	9.8	3.8	66.7	0	1.6	0	0
UPPER MAINSTEM ASSESSMENT AREA										
Molalla R.	5	1993	0.27	150.9	67.1	2.3	2.7	0.3	121	0
Molalla R.	6	1993	4.27	82.3	36.1	8.3	3.8	2.0	36	0
Molalla R.	7	1993	3.10	96.8	38.9	7.0	2.7	1.9	0	0
Pine Cr.	1	1993	1.53	23.9	9.5	9.9	4.9	28.5	0	0
Pine Cr.	2	1993	0.23	18.0	6.6	22.4	6.7	10.4	0	0
Pine Cr.	3	1993	2.90	22.0	9.1	13.2	6.6	53.8	0	0
Pine Cr.	4	1993	0.61	20.3	11.7	13.2	2.7	51.2	0	0
Pine Cr.	5	1993	1.66	19.0	7.5	17.1	5.4	75.5	0	0
Pine Cr.	6	1993	0.91	10.8	12.8	49.1	1.2	9.1	0	0
Shotgun Cr	1	1995	2.10	10.8	6.8	68.2	0.7	19.5	37	12
Bear Cr.	1	1995	1.51	21.7	10.9	7.5	6.4	30.7	105	44

Bear Cr.	2	1995	0.95	14.8	11.8	10.3	2.7	36.2	12	0
Bear Cr.	3	1995	0.20	7.9	0	N/A	3.3	33.8	0	0
LOWER MAINSTEM ASSESSMENT AREA										
Molalla R.	1	1993	6.13	166.7	17.0	4.9	8.3	2.5	145	36
Molalla R.	2	1993	2.42	94.8	30.5	5.6	2.0	3.8	362	260
Molalla R.	3	1993	1.05	103.3	33.0	7.7	1.3	3.0	60	0
Molalla R.	4	1993	1.32	86.3	49.7	4.7	0.3	9.2	30	60
Trout Cr.	1	1993	0.23	26.2	24.9	7.7	3.5	5.3	0	0
Trout Cr.	2	1993	1.54	23.0	8.9	16.8	0	9.3	0	0
Trout Cr.	3	1993	0.63	18.7	2.0	89.1	3.3	17.4	0	0
Trout Cr.	4	1993	0.93	22.3	4.7	24.6	1.9	15.0	0	0
Trout Cr.	5	1993	1.02	24.3	3.1	36.9	7.0	10.3	0	0
Trout Cr.	6	1993	0.62	18.7	0	N/A	2.7	10.5	0	0
Trout Cr.	7	1993	1.79	17.7	3.0	88.9	1.5	21.2	0	0
Trout Cr.	8	1993	0.49	13.1	0.3	199.0	0	11.8	0	0
Trout Cr.	9	1993	0.97	13.1	0	N/A	0	0	0	0

[1] Table Rock Fork (Middle Fork), Molalla River
[2] Deadhorse Canyon Creek

Appendix G

Clackamas County Soil Survey

Molalla Watershed/Lower Mainstem Molalla Analysis Area/Dickey Creek Sub-Watershed

Soil Series	Slope Percent	Acres
Amity silt loam		230.2
Camas gravelly sandy loam		14.9
Canderly sandy loam	0 - 3	148.3
Clackamas silt loam		50.9
Coburg silty clay loam		50.6
Conser silty clay loam		13.0
Dayton silt loam		12.3
Hardscrabble silt loam	7 - 20	32.4
Kinney cobbly loam	3 - 20	354.7
Kinney cobbly loam	20 - 50	119.3
Klickitat stony loam	30 - 60	197.6
Klickitat-Kinney complex	5 - 30	745
McCully gravelly loam	2 - 15	92.8
McCully gravelly loam	15 - 30	80.4
Molalla cobbly loam	2 - 8	106.2
Molalla cobbly loam	8 - 15	203.1
Nekia silty clay loam	2 - 8	46.4
Nekia silty clay loam	8 - 15	77.6
Nekia silty clay loam	15 - 30	17.9
Newberg fine sandy loam		39.1
Pits		5
Ritner cobbly silty clay loam	5 - 30	147.6
Riverwash		31.3

Salem silt loam	0 - 7	348.7
Salem gravelly silt loam	0 - 7	39.4
Sawtell silt loam	0 - 8	174.8
Sawtell silt loam	8 - 15	7.8
Witzel very stony silt loam	3 - 40	211.5
Witzel - Rock Outcrop complex	50 - 75	60.6
Xerochrepts and Haploxerolls	very steep	115.6
Water		7.2
Total		3,782.2

Molalla Watershed / Lower Mainstem Molalla Analysis Unit / Lower Molalla sub-watershed

Series Name	Slope	Acres
Alspaugh clay loam	2 - 8	267.9
Alspaugh clay loam	8 - 15	378
Aschoff / Brightwood complex	60 - 90	459.1
Camas gravelly sand loam		33.6
Cottrell silty clay loam	2 - 8	49.4
Fernwood very gravelly loam	30 - 60	174.8
Fernwood / Wilhoit complex	5 - 30	439.8
Kinney cobbly loam	3 - 20	37.2
Kinney cobbly loam	20 - 50	0.4
Klickitat stony loam	30 - 60	862.1
Klicitat - Kinney complex	5 - 30	2,292.4
McCully gravelly loam	2 - 15	357.5
McCully gravelly loam	15 - 30	921.5
McCully gravelly loam	30 - 60	188.8
Molalla cobbly loam	2 - 8	17.1
Newberg fine sandy loam		64.2
Riverwash		1.8

Wilhoit-Zygore gravelly loams	5 - 30	253.9
Zygore-Wilhoit gravelly loams	30 - 60	46.2
Water		65.2
Total		6,910.9

Molalla Watershed / Lower Mainstem Molalla Analysis Unit / Russell Creek sub-watershed

Series Name	Slope	Acres
Alspaugh clay loam	2 - 8	234.9
Alspaugh clay loam	8 - 15	408.4
Alspaugh clay loam	15 - 30	247.2
Aschoff-Brightwood complex	60 - 90	24.4
Borges silty clay loam	0 - 8	7.9
Camas gravelly sandy loam		71.6
Canderly sandy loam	0 - 3	2.1
Clackamas silt loam		1.1
Coburg silty clay loam		44.1
Conser silty clay loam		7.1
Cottrell silty clay loam	2 - 8	55.2
Hardscrabble silt loam	2 - 7	45.6
Jory silty clay loam	2 - 8	580.3
Jory silty clay loam	8 - 15	172.4
Jory silty clay loam	15 - 30	235.5
Jory stony silt loam	8 - 15	21.8
Jory stony silt loam	15 - 30	63.5
Kinney cobbly loam	3 - 20	61.0
Klickitat stony loam	30 - 60	288.5
Klickitat - Kinney complex	5 - 30	134.2
McCully gravelly loam	2 - 15	145.7

McCully gravelly loam	15 - 30	52
Molalla cobbly loam	2 - 8	36.1
Molalla cobbly loam	15 - 30	92.6
Nekia silty clay loam	2 - 8	128.9
Nekia silty clay loam	8 - 15	247.4
Newberg fine sandy loam		27.9
Pits		6.3
Ritner cobbly silty clay loam	5 - 30	230.2
Ritner cobbly silty clay loam	30 - 60	119.7
Riverwash		37.4
Salem silt loam	0 - 7	48.4
Salem gravelly silt loam	0 - 7	59.2
Saum silt loam	3 - 8	12.7
Saum silt loam	8 - 15	65.6
Saum silt loam	15 - 30	212.8
Saum silt loam	30 - 60	196.9
Xerochrepts and Haploxerolls	very steep	46.0
Water		43.4
Total		4,516

Molalla Watershed / Lower Mainstem Analysis Area / Trout Creek Sub-watershed

Series Name	Slope	Acres
Andic Cryaquepts	moderately steep	94.4
Aschoff-Brightwood complex	60 - 90	88.9
Fernwood very gravelly loam	5 - 30	173.4
Fernwood very gravelly loam	30 - 60	1,146.4
Fernwood-Rock Outcrop	50 - 90	6.5
Fernwood/Wilhoit complex	5 - 30	1,580
Highcamp very gravelly loam	30 - 60	306

Highcamp/Soosap complex	5 - 30	598.8
Humaquets	2 - 20	8.8
Kinney cobbly loam	3 - 20	176.5
Klickitat stony loam	30 - 60	978.7
Klickitat - Kinney complex	5 - 30	716
McCully gravelly loam	2 - 15	153.9
McCully gravelly loam	15 - 30	715.2
Memaloose loam	5 - 30	76.9
Wilhoit/Zygore gravelly loams	5 - 30	2,046.3
Zygore/Wilhoit gravelly loams	30 - 60	476.2
Total		9,342.9

Molalla Watershed / Middle Fork Molalla Analysis Area / Camp Creek sub-watershed

Soil Series	Slope	Acres
Andic Cryaquepts	Moderately steep	10.1
Andic Cryaquepts	Steep	46.3
Aschoff cobbly loam	5 - 30 %	19.1
Fernwood very gravelly loam	30-60	199.6
Fernwood - Rock outcrop complex	50 - 90	489.6
Fernwood-Wilhoit complex	5 - 30	39.9
Highcamp very gravelly loam	30 - 60	1,458.8
Highcamp - Rock Outcrop complex	50 - 90	1,202.6
Highcamp - Soosap complex	5 - 30	247.9
Kinzel - Divers complex	5 - 30	55.6
Kinzel - Divers complex	30 - 60	272.4
Newanna - Rock Outcrop complex	60 - 90	349.5

Newanna - Thader	30 - 60	93.8
Riverwash		23.8
Rock Outcrop - Cryochrepts complex	Very steep	33.5
Rubble land		65.1
Talapus - Lastance complex	30 - 60	434.5
Wilhoit - Zygore gravelly loams	5 - 30	430.1
Zygore gravelly loam	5 - 30	444.7
Zygore gravelly loam	30 - 60	117.7
Zygore-Wilhoit gravelly loams	30 - 60	409.4
Total		6,444

Molalla Watershed / Middle Fork Analysis Area / Joyce Lake Sub-watershed

Series Name	Slope	Acres
Andic Cryaquepts	moderately steep	23.2
Fernwood very gravelly loam	30 - 60	2.2
Highcamp very gravelly loam	30 - 60	196.4
Highcamp - Rock Outcrop complex	50 - 90	326.3
Highcamp / Soosap complex	5 - 30	81.5
Kinzel - Divers complex	5 - 30	542.7
Kinzel - Divers complex	30 - 60	801.5
Newanna - Rock Outcrop complex	60 - 90	397.3
Newanna-Thader complex	30 - 60	45.2
Talapus - Lastance complex	5-30	312.9
Talapus - Lastance complex	30 - 60	248
Wilhoit/Zygore gravelly loams	5 - 30	262.2

Zygore/Wilhoit gravelly loams	30 - 60	275.4
Water		2.6
Unaccounted		10.9
Total		3,528.1

Molalla Watershed / Middle Fork Molalla Analysis Area / Lost Creek Sub-watershed

Series Name	Slope	Acres
Andic Cryaquepts	moderately steep	8.8
Highcamp very gravelly loam	30 - 60	488.7
Highcamp - Rock Outcrop complex	50 - 90	385.6
Highcamp/Soosap complex	5 - 30	141
Kinzel - Divers complex	5 - 30	404.6
Kinzel - Divers complex	30 - 60	1,537.9
Kinzel - Divers complex	60 - 90	106.2
Newanna - Rock Outcrop complex	60 - 90	359.4
Newanna-Thader complex	30 - 60	184.5
Rock Outcrop - Cryochrepts complex	very steep	91.2
Talapus - Lastance complex	5-30	159.6
Talapus - Lastance complex	30 - 60	211.9
Wilhoit/Zygore gravelly loams	5 - 30	70.2
Zygore/Wilhoit gravelly loams	30 - 60	240.4
Unaccounted		65.9
Total		4,455.9

Molalla Watershed / Middle Fork Molalla Analysis Area / Table Rock Fork Sub-watershed

Series Name	Slope	Acres
Andic Cryaquepts	moderately steep	61.9
Andic Cryaquepts	steep	109.3
Aschoff cobbly loam	5 - 30	396.2
Aschoff cobbly loam	30 - 60	639.7
Aschoff-Brightwood complex	60 - 90	98.1
Fernwood very gravelly loam	30 - 60	159.3
Fernwood-Rock Outcrop	50 - 90	2120.7
Highcamp very gravelly loam	30 - 60	948.7
Highcamp - Rock Outcrop complex	50 - 90	751.9
Highcamp/Soosap complex	5 - 30	242.6
Humaquets	2 - 20	51.5
Kinzel - Divers complex	5 - 30	85.1
Kinzel - Divers complex	30 - 60	460.9
Klickitat stony loam	30 - 60	287.6
Klickitat - Kinney complex	5 - 30	3.9
McCully gravelly loam	15 - 30	96.4
Newanna - Rock Outcrop complex	60 - 90	183.4
Newanna-Thader complex	30 - 60	79.6
Pits		7.0
Rock Outcrop - Cryochrepts complex	very steep	359.1
Rubble land		150.2
Salem gravelly silt loam	0 - 7	89.4
Wilhoit/Zygore gravelly loams	5 - 30	263.6
Zygore gravelly loam	30 - 60	499.1
Zygore/Wilhoit gravelly loams	30 - 60	625

Total		8,770.2

Molalla Watershed / North Fork Molalla Analysis Area / Cougar Creek Sub-watershed

Soil Series	Slope	Acres
Andic Cryaquepts	Moderately steep	36
Fernwood very gravelly loam	30-60	236.3
Fernwood - Rock outcrop complex	50 - 90	539.4
Highcamp very gravelly loam	30 - 60	969.9
Highcamp - Rock Outcrop complex	50 - 90	696.6
Highcamp - Soosap complex	5 - 30	339
Kinzel - Divers complex	5 - 30	112.9
Kinzel - Divers complex	30 - 60	513.2
Newanna - Thader	5-30	23.3
Rock Outcrop - Cryochrepts complex	Very steep	138.7
Wilhoit - Zygore gravelly loams	5 - 30	50.9
Witzel - Rock Outcrop complex	50 - 75	102.5
Zygore-Wilhoit gravelly loams	30 - 60	196.4
Water		7.8
Total		3962.9

Molalla Watershed / North Fork Molalla Analysis Area /Dead Horse Creek Sub-watershed

Soil Series	Slope	Acres
Andic Cryaquepts	Moderately steep	41.1
Andic Cryaquepts	Steep	91.9
Fernwood very gravelly loam	30 - 60	157.6
Fernwood - Rock outcrop complex	50 - 90	874.1
Fernwood-Wilhoit complex	5 - 30	504.6
Highcamp very gravelly loam	30 - 60	639.4
Highcamp - Rock Outcrop complex	50 - 90	377.8
Highcamp - Soosap complex	5 - 30	871.1
Kinzel - Divers complex	5 - 30	69.5
Kinzel - Divers complex	30 - 60	330.9
Memaloose loam	5 - 30	8.5
Newanna-Thader complex	5 - 30	96.8
Newanna-Thader complex	30 - 60	39.8
Rock Outcrop - Cryochrepts complex	Very steep	134.5
Talapus - Lastance complex	5-30	229.6
Talapus - Lastance complex	30 - 60	187.7
Wilhoit - Zygore gravelly loams	5 - 30	28.5
Zygore-Wilhoit gravelly loams	30 - 60	133.5
Unaccounted		32.8
Total		4,849.7

Molalla Watershed / North Fork Molalla Analysis Area / Emerald Sub-Watershed

Series Name	Slope Percent	Acres
Andic Cryacquepts	moderately steep	
Fernwood very gravelly loam	5 - 30	12.6
Fernwood very gravelly loam	30 - 60	428.7
Fernwood - Rock Outcrop	50 - 90	683.9
Highcamp very gravelly loam	30 - 60	1,282.7

Highcamp - Rock outcrop complex	50 - 90	610.1
Highcamp - Soosap complex	5 - 30	361.4
Kinzel-Divers complex	5-30	630.3
Kinzel-Divers complex	30 - 60	805
Newanna-Thader complex	5 - 30	82.5
Newanna-Thader complex	30 - 60	16.3
Rock Outcrop - Cryochrepts complex	very steep	399.2
Rubble land		45.3
Talapus - Lastance complex	30 - 60	8
Wilhoit-Zygore	5 - 30	1.2
Witzel - Rock Outcrop	50 - 75	112.3
Zygore gravelly loam	5 - 30	30.1
Zygore gravelly loam	30 - 60	159.8
Zygore - Wilhoit gravelly loams	30 - 60	85.3
Water		6.5
Unaccountable		4.2
Total		5,810.1

Molalla Watershed - North Fork Molalla Analysis Unit - Glenn Avon Sub-watershed

Series Name	Slope	Acres
Alspaugh clay loam	8 - 15	0.1
Aschoff - Brightwood complex	60 - 90	317.1
Conser silty clay loam		8.8
Gapcot gravelly loam	3 - 30	26.0
Kinney cobbly loam	3 - 20	173.1
Kinney cobbly loam	20 - 50	0.1
Klickitat stony loam	30 - 60	329.4

Kickitat - Kinney complex	5 - 30	1,028.4
McCulley gravelly loam	2 - 15	63.3
McCulley gravelly loam	15 - 30	115
Molalla cobbly loam	2 - 8	106.1
Molalla cobbly loam	8 - 15	31.5
Newberg fine sandy loam		7.6
Salem gravelly silt loam	0 - 7	186.1
Wilhoit - Zygore gravelly loams	5 - 30	8.1
Water		11.7
Total		2,412.4

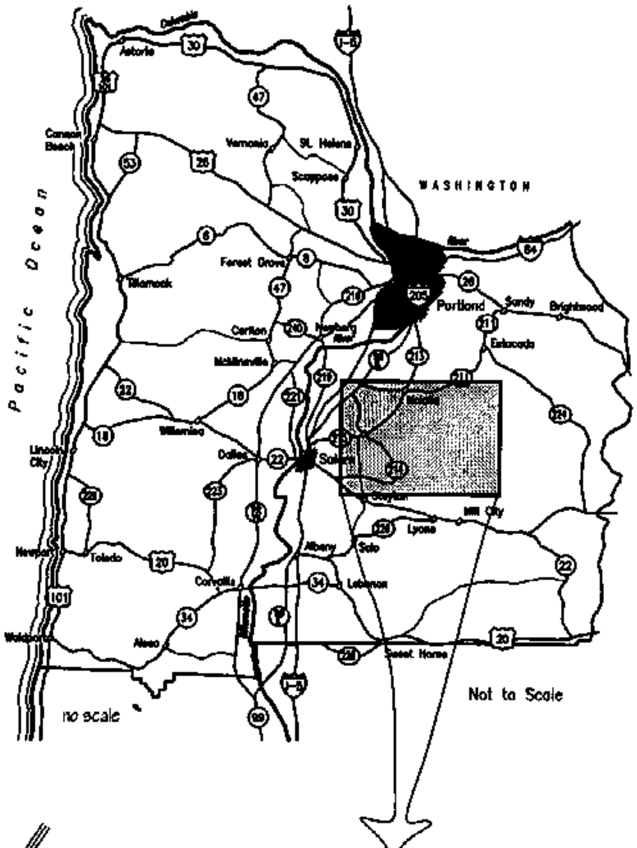
Molalla Watershed - North Fork Molalla Analysis Unit - Goat Creek Sub-watershed

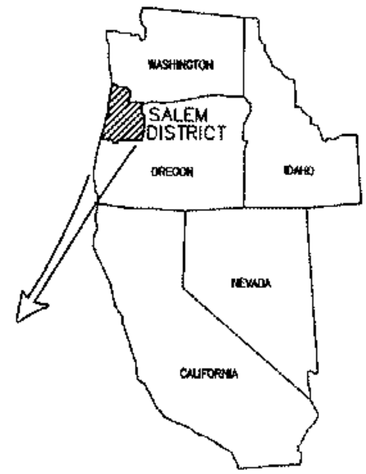
Series Name	Slope	Acres
Andic Cryaquepts	Moderately steep	10.6
Fernwood very gravelly loam	5 - 30	57.4
Fernwood very gravelly loam	30 - 60	193.7
Fernwood - Rock Outcrop complex	50 - 90	400.8
Fernwood - Wilhoit complex	5 - 30	596.3
Highcamp very gravelly loam	30 - 60	113.2
Highcamp - Soosap complex	5 - 30	1,319.4
Kinzel - Divers complex	5 - 30	156.9
Kinzel - Divers complex	30 - 60	114.7
Memaloose loam	5 - 30	158.7
Nevanna - Thader complex	5 - 30	0.8
Zygore-Wilhoit gravelly loams	30 - 60	39.8
Total		3,163.3

Molalla Watershed / North Fork Molalla / Lower Dead Horse Sub-watershed

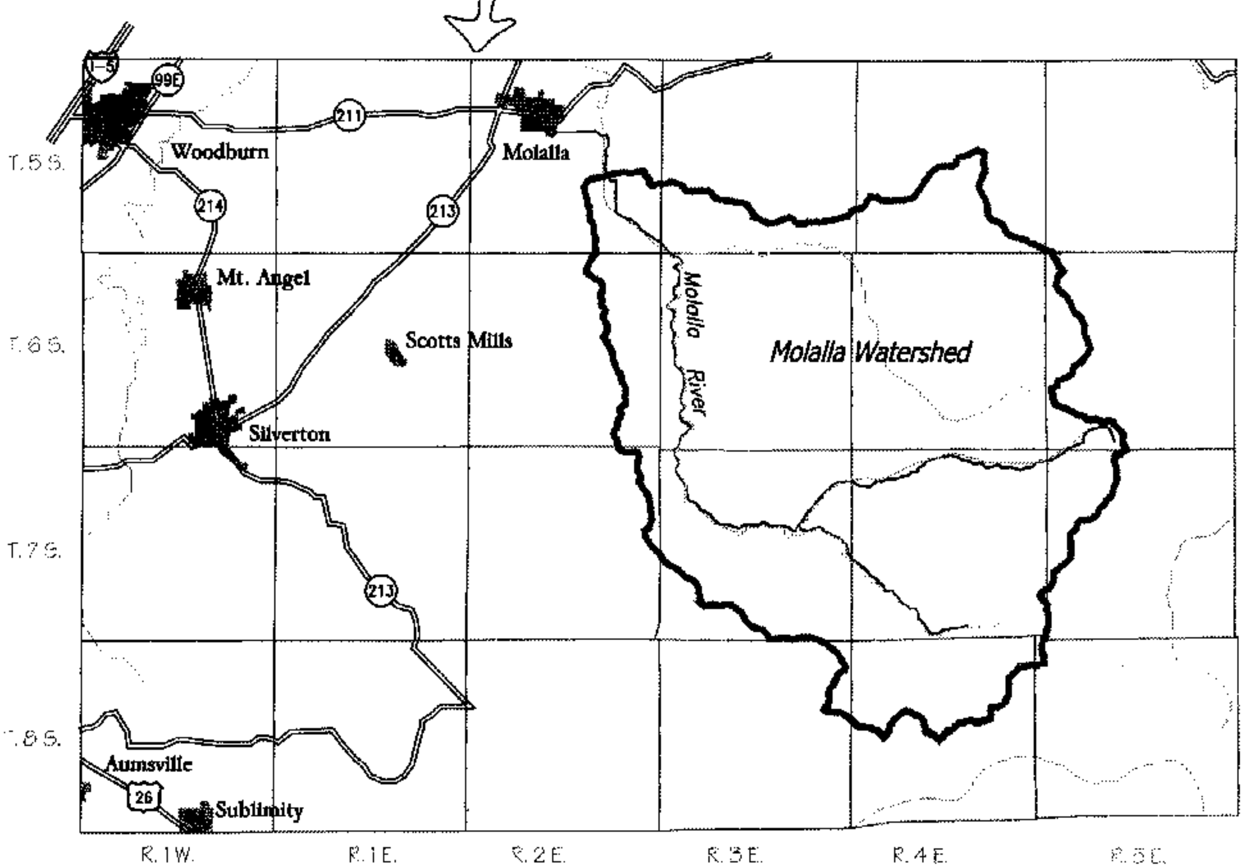
Series Name	Slope	Acres
Aschoff cobbly loam	5 - 30	46.6
Aschoff cobbly loam	30 - 60	139
Aschoff-Brightwood complex	60 - 90	233.6
Fernwood very gravelly loam	5 - 30	8.4
Fernwood very gravelly loam	30 - 60	89.9
Fernwood-Rock Outcrop	50 - 90	58.7
Fernwood/Wilhoit complex	5 - 30	44.3
Memaloose loam	5 - 30	68.6

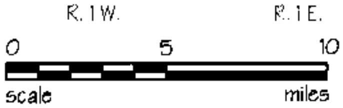
U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
SALEM DISTRICT - ORGEON





Salem District

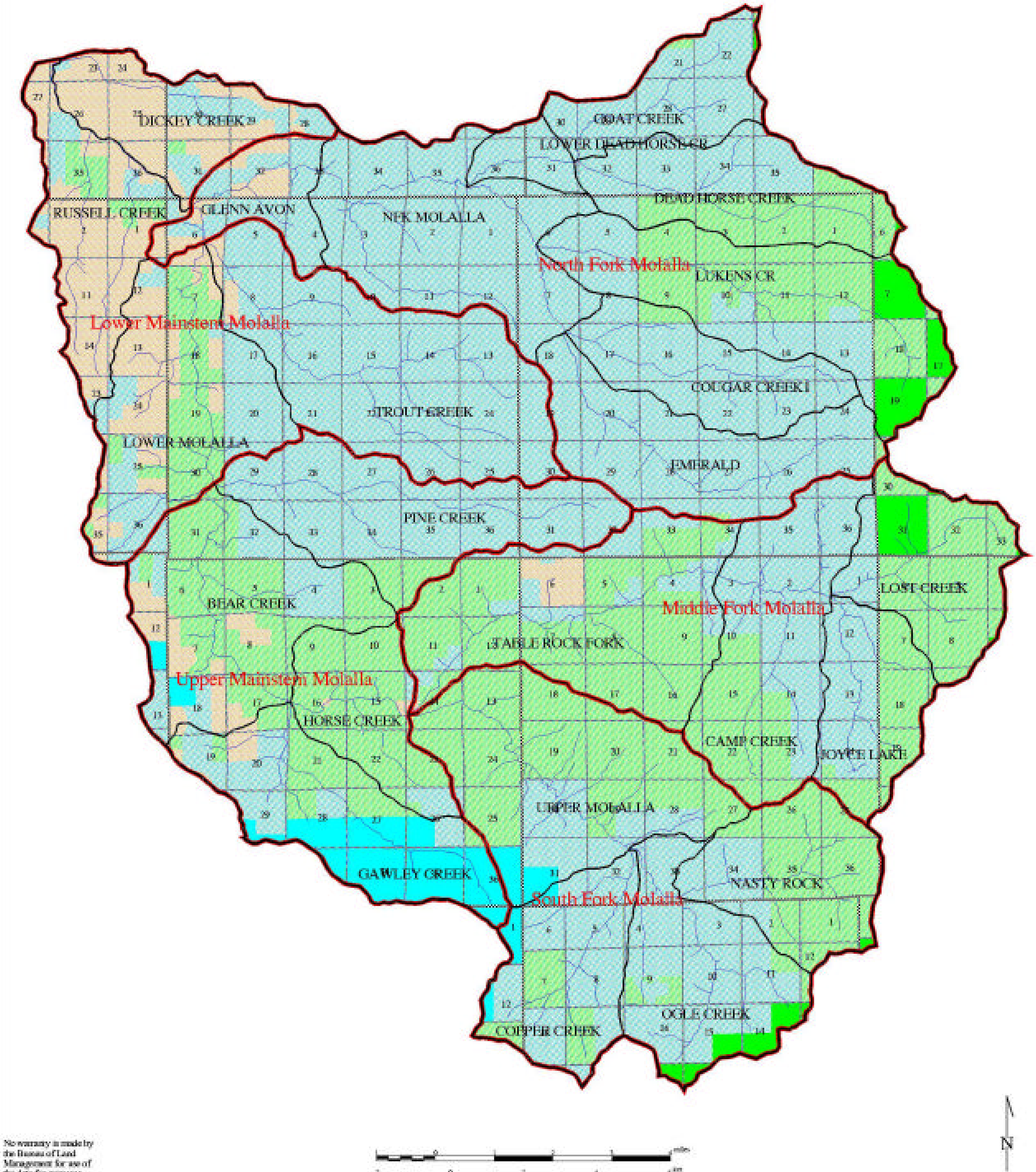




Location of the Molalla Watershed

Molalla River Watershed

OWNERSHIP



No warranty is made by the Bureau of Land Management for use of the data for purposes not intended by BLM.

LEGEND

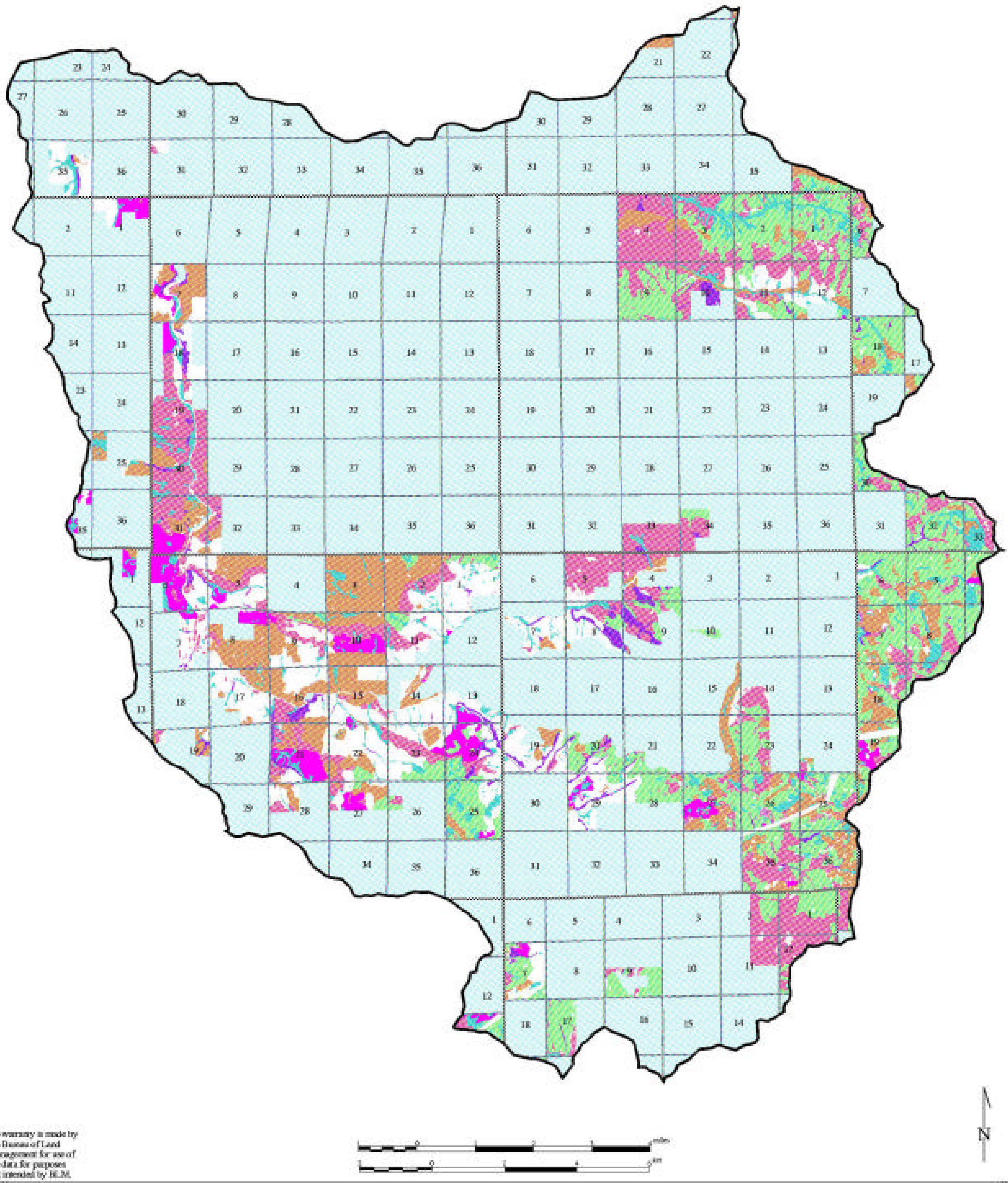
- BLM Lands
- USFS Lands
- Private Industrial
- Private Non-Industrial
- State Forest Lands

Map #: B

OWNERSHIP

Molalla River Watershed

BLM LAND FRAGILE SOILS



No warranty is made by the Bureau of Land Management for use of the data for purposes not intended by BLM.

LEGEND

- Compacted Soil
- High Water Table/ Hydric Soil Cond.
- Other
- Pvt / Unassessed
- Soil Moisture Limitations
- Soil Nutrient Limitations
- Steep, Non-Stream Adjacent
- Steep, Stream Adjacent
- Unstable Soils

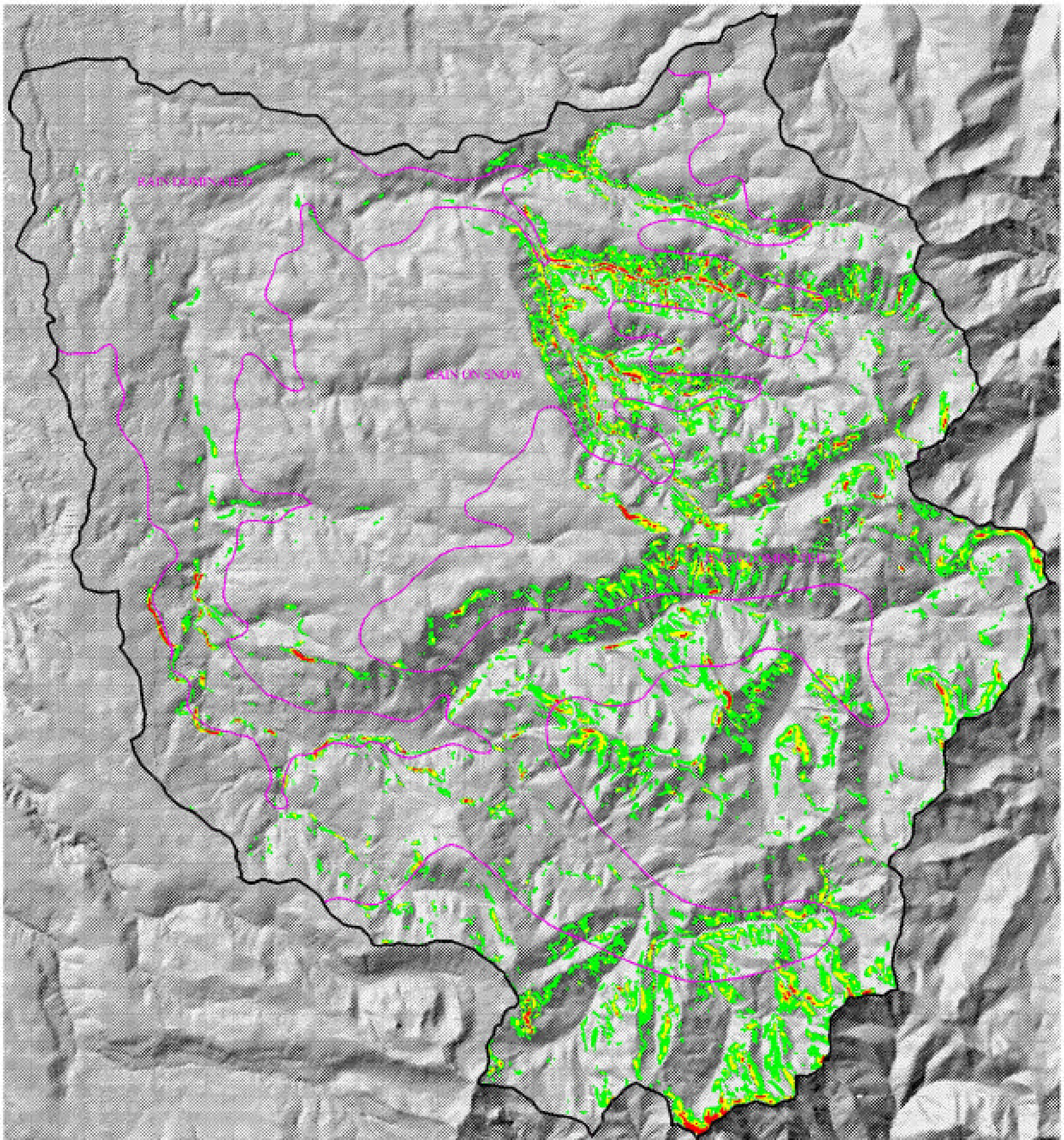
Map #: C

BLM LAND FRAGILE SOILS

Map Created: 05/04/99 6:25 AM

Molalla River Watershed

SLOPE HAZARD/SNOW ZONE



No warranty is made by the Bureau of Land Management for use of the data for purposes not intended by BLM.

Map #: D

SLOPE HAZARD/SNOW ZONE

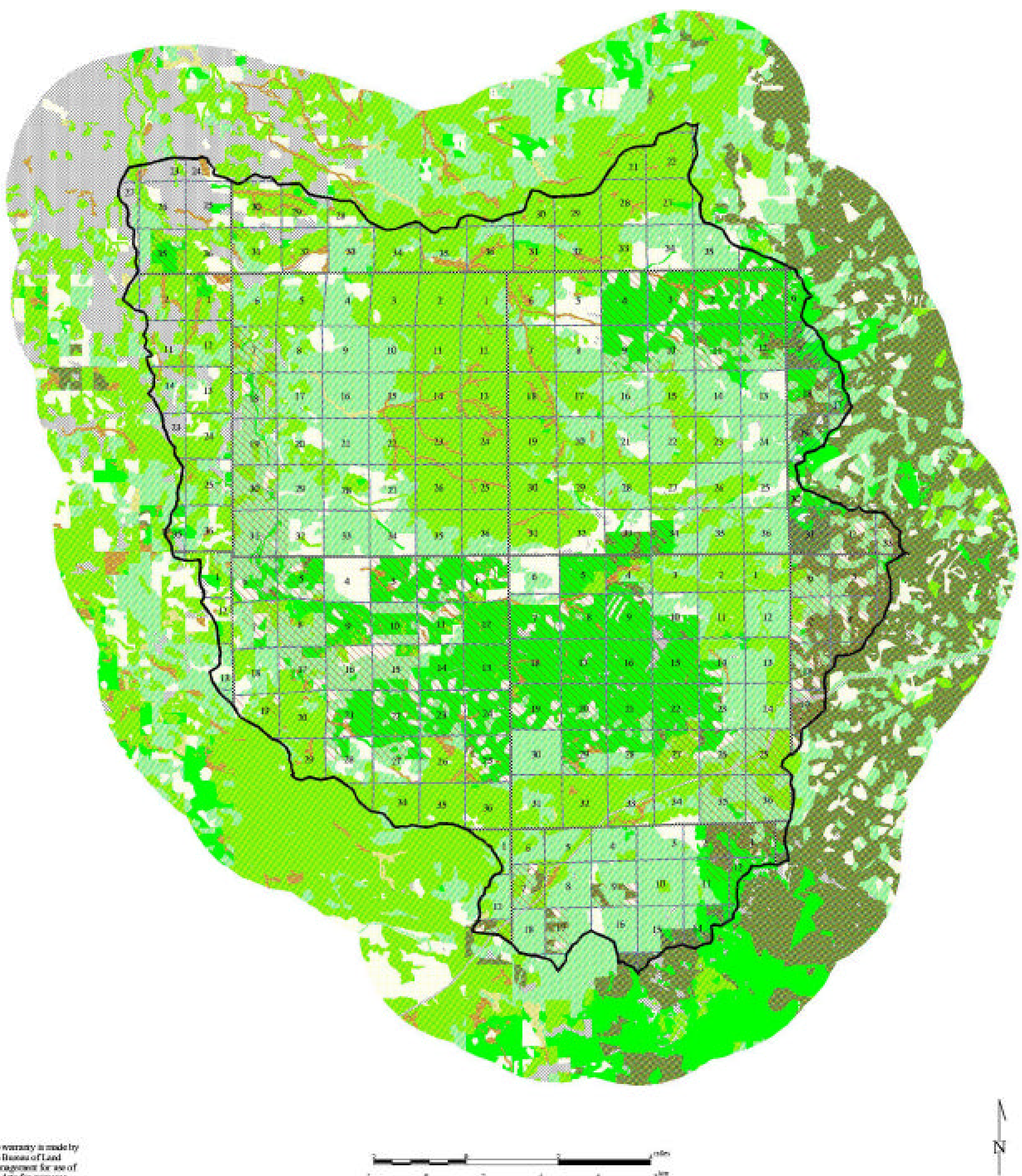
LEGEND
(Hazard Rating - Slope %)

- Severe (> 90%)
- Moderate (60% - 75%)
- High (76% - 90%)
- Snow Zone Boundary

Map Created:
03/24/99 10:05 AM

Molalla River Watershed

SERAL STAGES



No warranty is made by the Bureau of Land Management for use of the data for purposes not intended by BLM.

LEGEND

- Non-Forest
- Early/Grass/Forb
- Open Sapling
- Closed Sapling
- Young Hardwood
- Mature Hardwood
- Mature Conifer
- Old Growth
- Unclassified
- BLM Lands
- USFS Lands

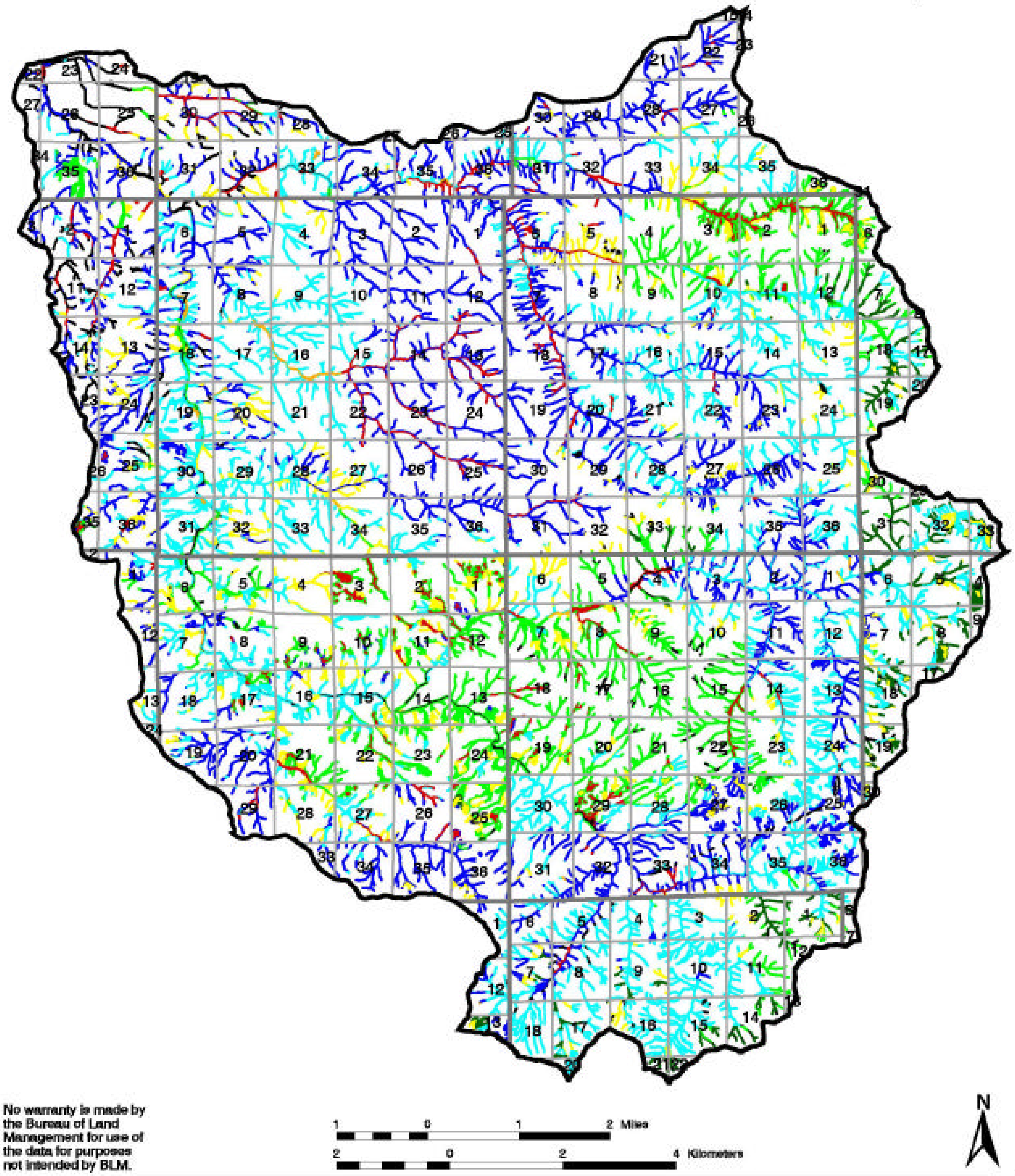
Map #: E

SERAL STAGES

Map Created: 03/24/99 10:16 AM

Molalla River Watershed

RIPARIAN STREAM BUFFERS (SERAL STAGE)



No warranty is made by the Bureau of Land Management for use of the data for purposes not intended by BLM.

LEGEND

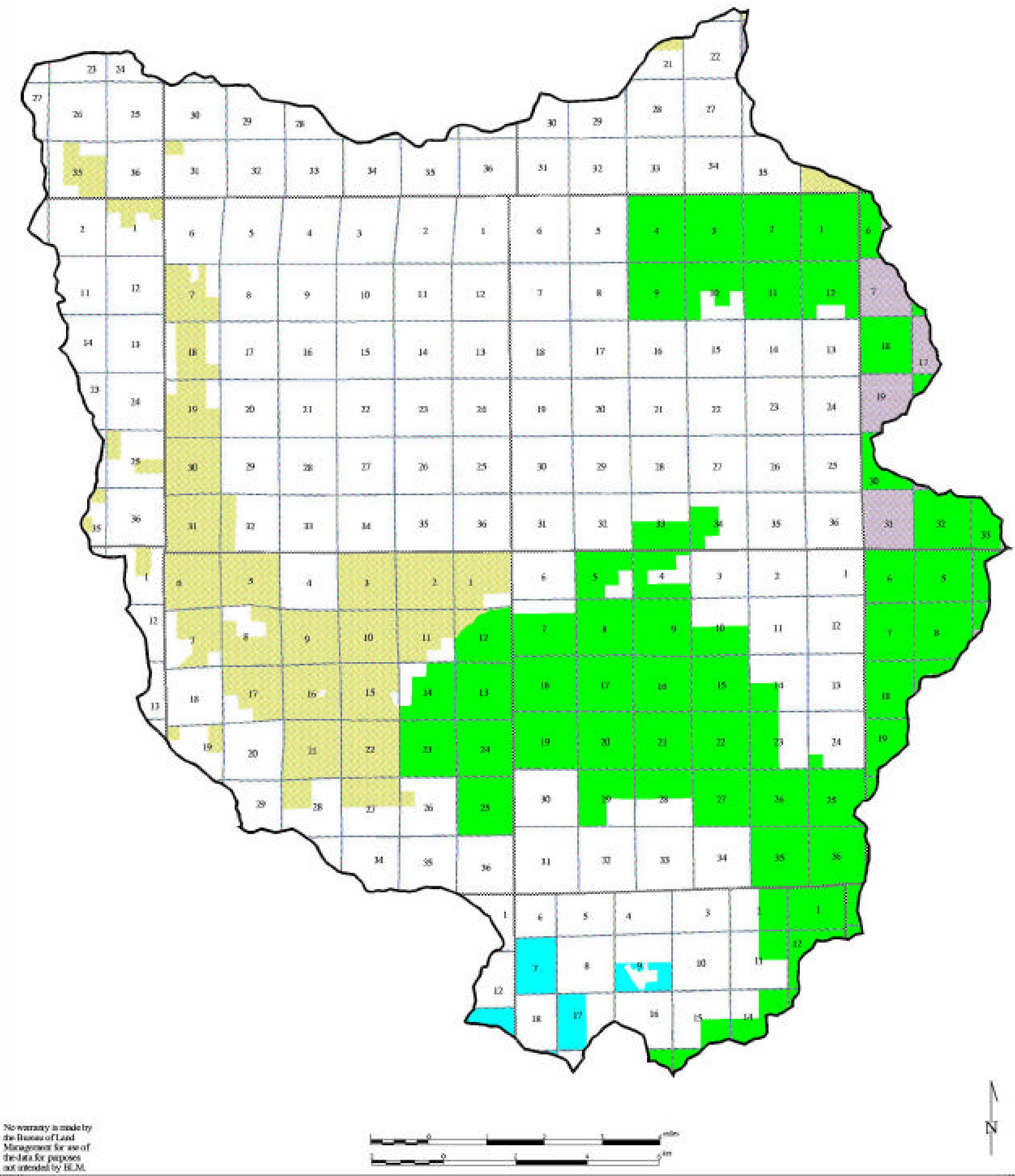
- Non-Forest
- Early/Grass/Forb
- Open Sapling
- Closed Sapling
- Young Hardwood
- Mature Hardwood
- Mature Conifer
- Old Growth

Map #: F

SERAL STAGE

Molalla River Watershed

LAND USE ALLOCATION



No warranty is made by the Bureau of Land Management for use of the data for purposes not intended by BLM.

Map #: G

LAND USE ALLOCATION

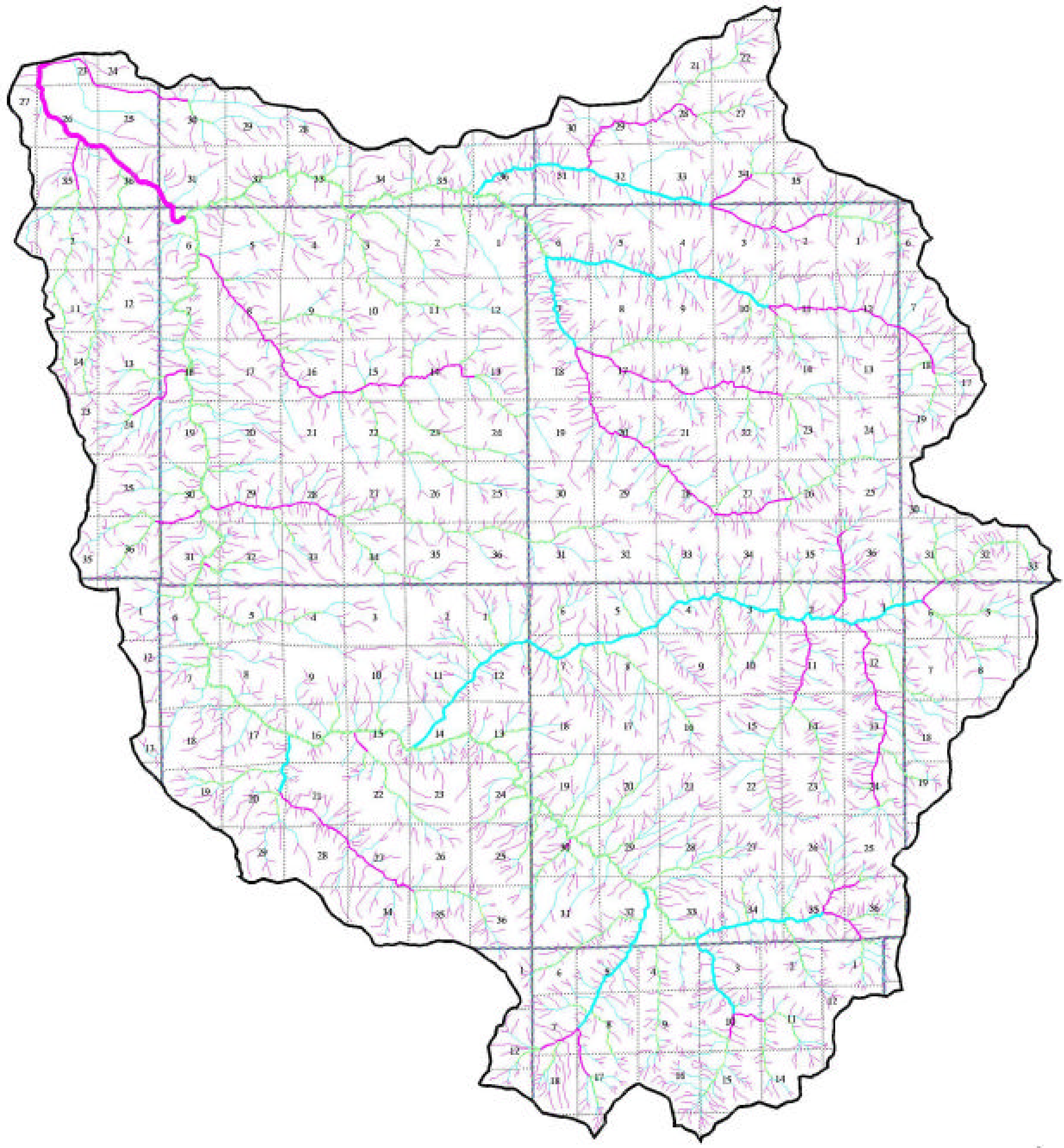
LEGEND

- Matrix (BLM) – Connectivity/ Diversity Block
- Matrix (BLM) – General Forest Management Area
- Late Successional Reserve
- Matrix (USFS)

Map Created: 03/24/99 10:17 AM

Molalla River Watershed

STREAM ORDER



No warranty is made by the Bureau of Land Management for use of the data for purposes not intended by BLM.

LEGEND

- 1st Order
- 2nd Order
- 3rd Order
- 4th Order
- 5th Order
- 6th Order
- 7th Order

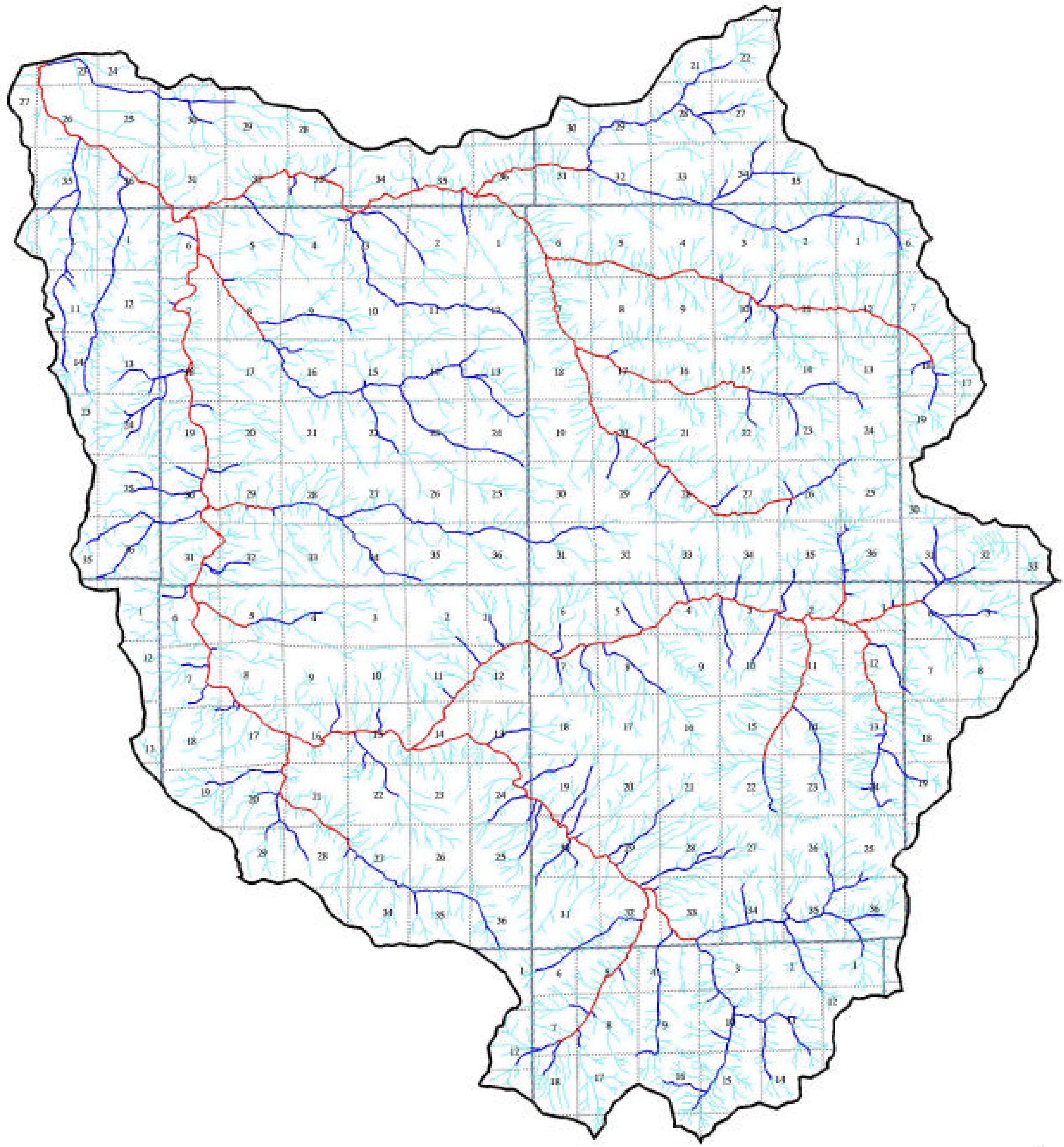
Map #: H

STREAM ORDER

Map Created: 03/24/99 10:19 AM

Molalla River Watershed

FISH DISTRIBUTION



No warranty is made by the Bureau of Land Management for use of the data for purposes not intended by BLM.

N

LEGEND

Resident

Resident and Anadromous

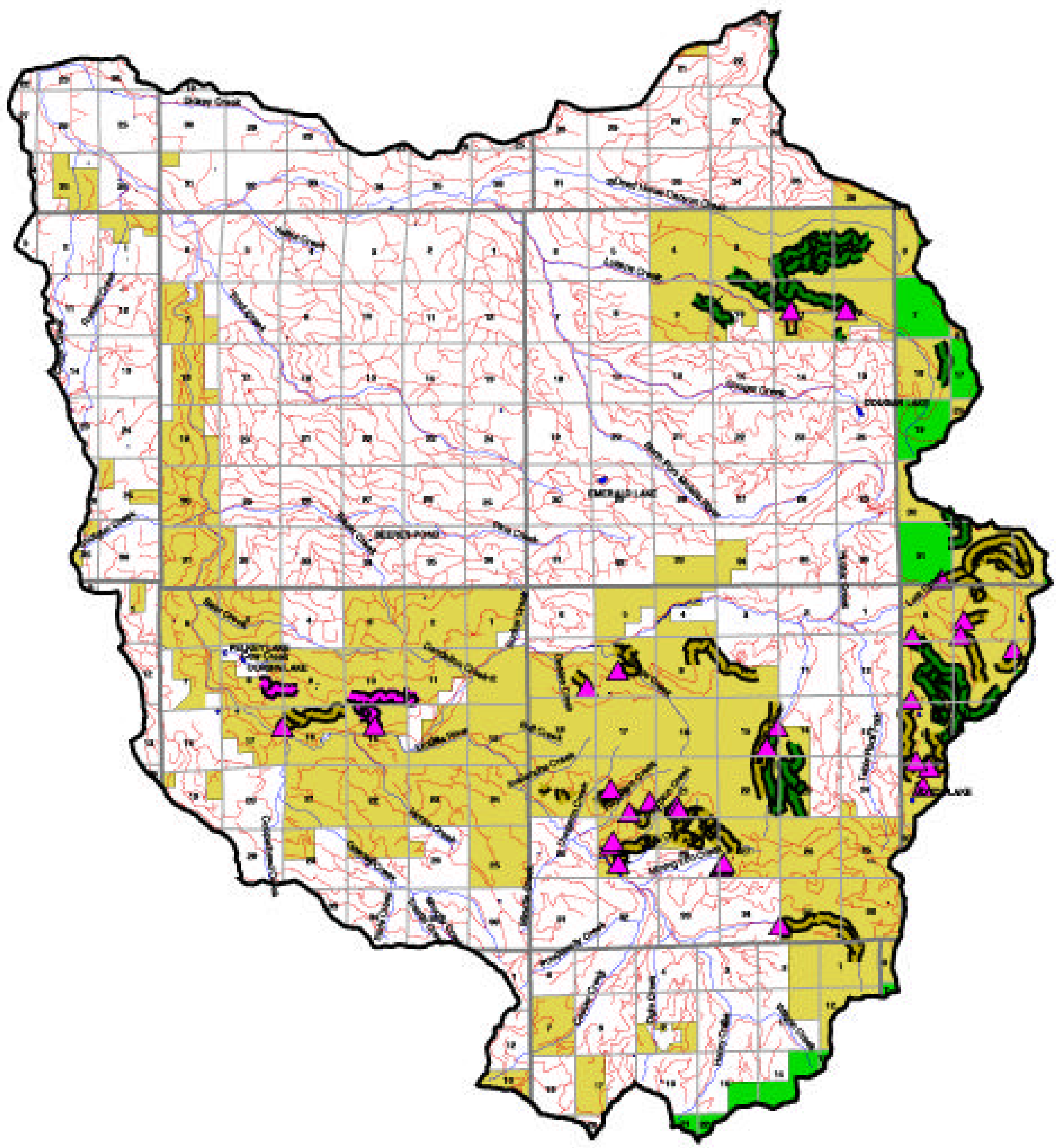
Map #: 1

FISH DISTRIBUTION

Map Created: 03/24/99 10:21 AM

Molalla River Watershed

POTENTIAL ROAD RESTORATION AREAS



No warranty is made by the Bureau of Land Management for use of the data for purposes not intended by BLM.

1 0 1 2 Miles

2 0 2 4 Kilometers

N

LEGEND

Roads

Streams & Lakes

BLM

U.S. Forest Service

Tank Trap Locations

Roads to be closed by Timber Sales

Roads to be decommissioned

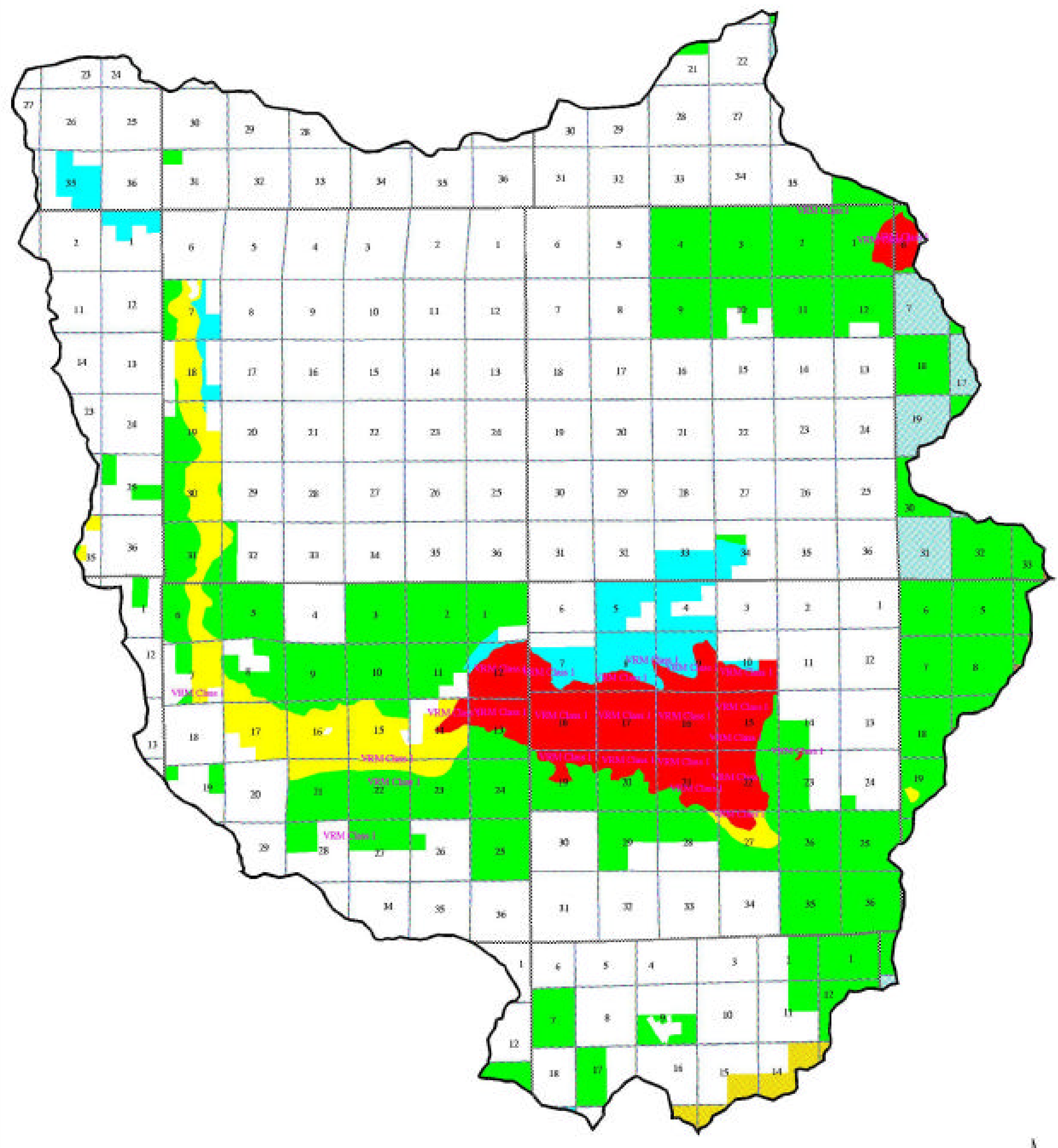
Roads to be Stormproofed

Map #: J

POTENTIAL ROAD RESTORATION AREAS

Molalla River Watershed

VISUAL RESOURCE CLASSIFICATION



No warranty is made by the Bureau of Land Management for use of the data for purposes not intended by BLM.

LEGEND

Modification (USFS)

Preservation (USFS)

VRM Class 2 (BLM)

VRM Class 4 (BLM)

Partial Retention (USFS)

VRM Class 1 (BLM)

VRM Class 3 (BLM)

LEGEND (Acreage)

VQO Modification:	1883.2 acres
VQO Partial Retention:	29.7 acres
VQO Preservation:	596 acres
VRM Class 1:	6224.2 acres
VRM Class 2:	4487.6 acres
VRM Class 3:	3338.8 acres
VRM Class 4:	29018.5 acres

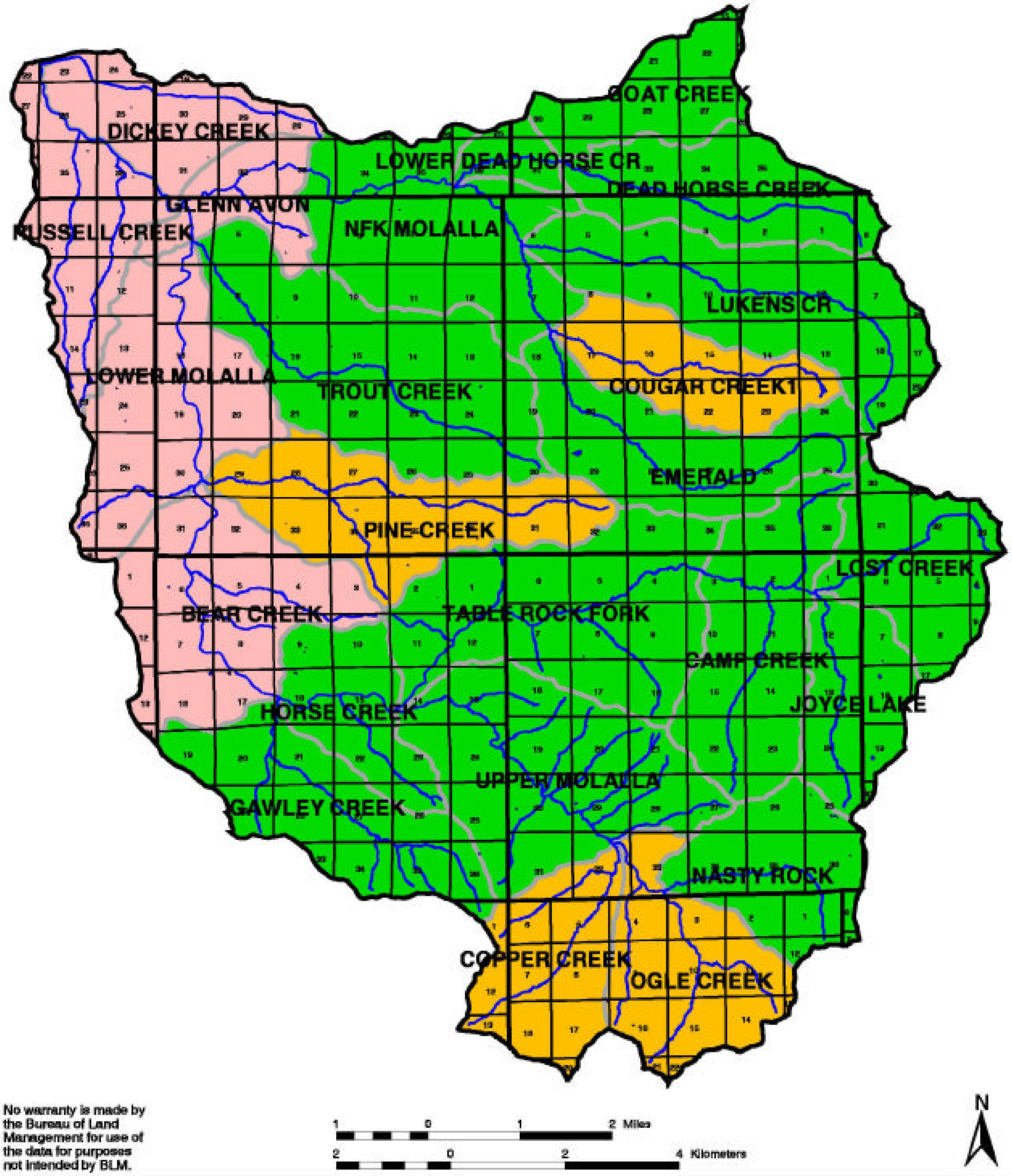
Map #: K

VRC CLASSIFICATION

Map Created: 03/24/99 10:23 AM

Molalla River Watershed

WATER AVAILABLE FOR RUNOFF (WAR)



No warranty is made by the Bureau of Land Management for use of the data for purposes not intended by BLM.

Map #: L

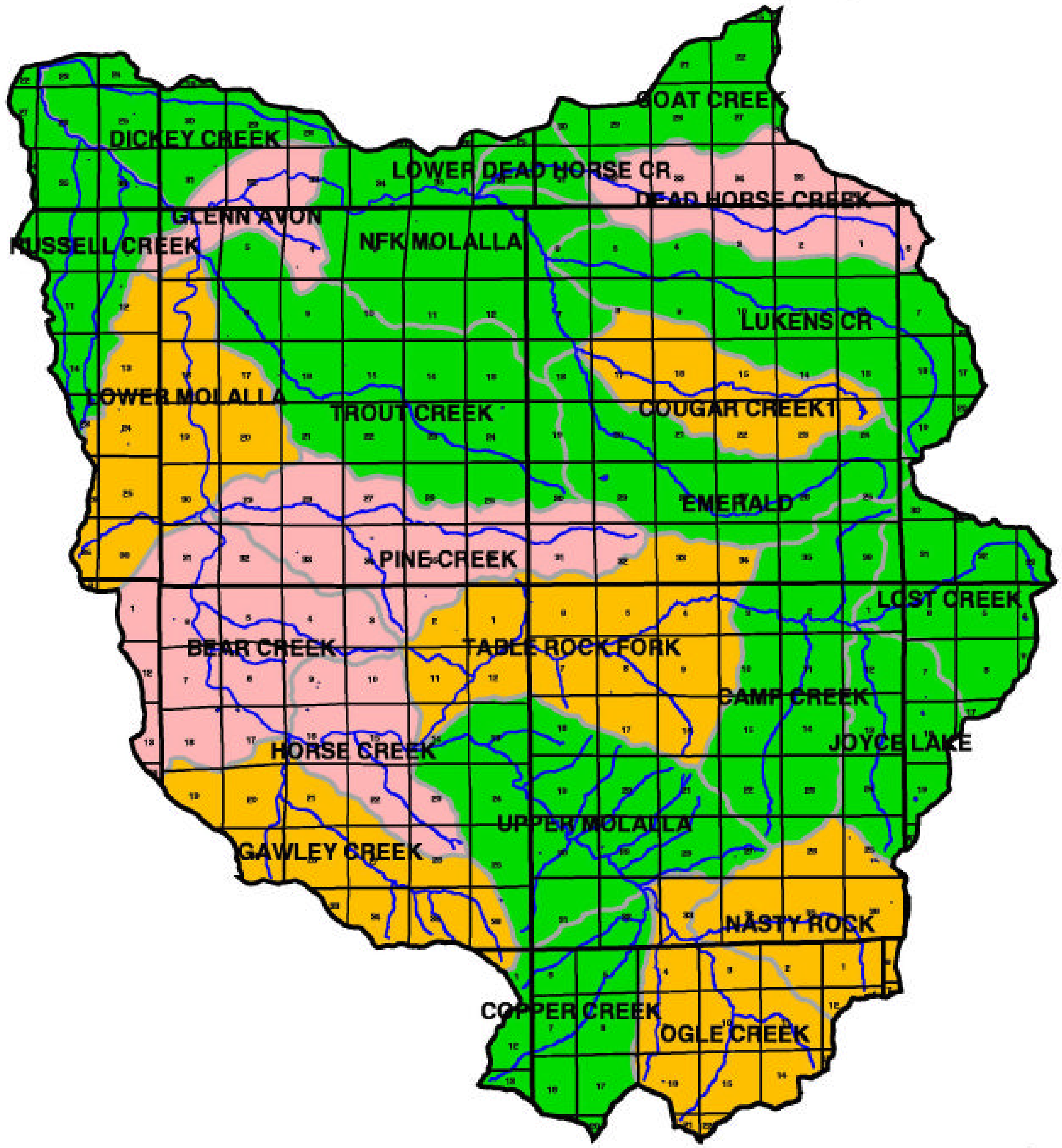
LEGEND

Township	**WAR Values**
Section	High
Molswb	Moderate
Streams & Lakes	Low

WATER AVAILABLE FOR RUNOFF

Molalla River Watershed

EQUIVALENT CLEARCUT ACREAGE (ECA)



No warranty is made by the Bureau of Land Management for use of the data for purposes not intended by BLM.

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 7 Kilometers

N

Map #: M

EQUIVALENT CLEARCUT ACREAGE

LEGEND

Township	**ECA Values**
Section	High
Molswb	Moderate
Streams & Lakes	Low