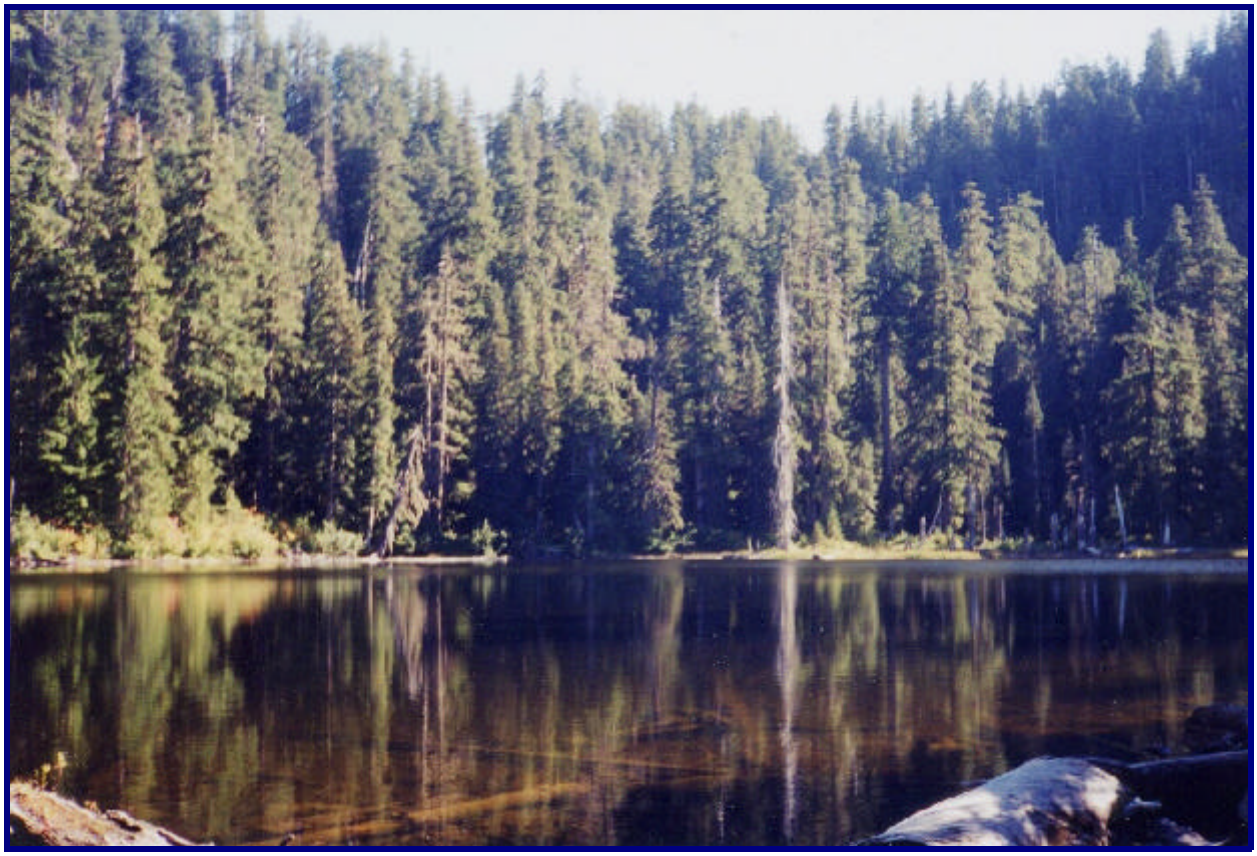
Crabtree Watershed Analysis

July 2001



Crabtree Lake

Bureau of Land Management
Salem District
Cascades Resource Area
1717 Fabry Road SE
Salem, Oregon 97306

Crabtree Watershed Analysis

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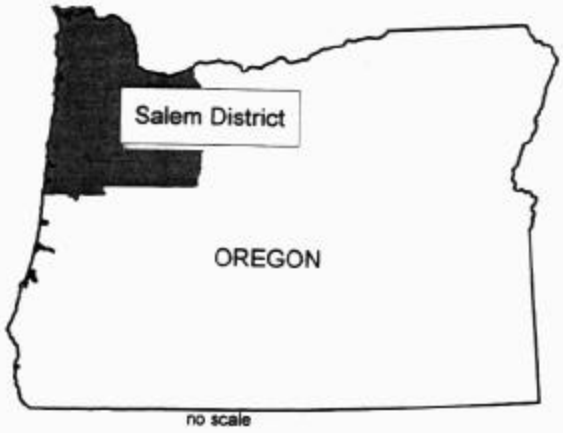
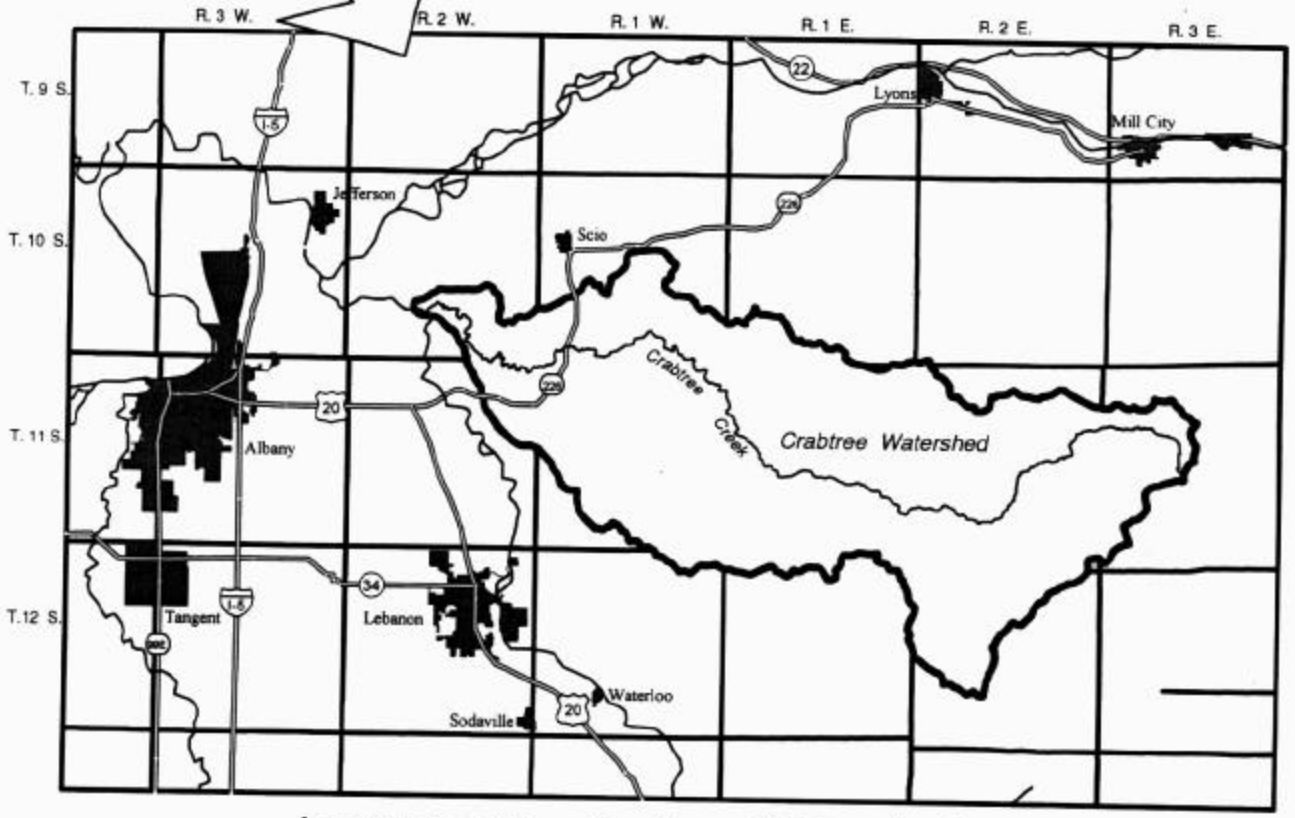


Salem District



Location of the Crabtree Watershed

5 0 5 10 Miles

June 2001

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Executive Summary

This executive summary provides an overview of the Crabtree Watershed Analysis. It summarizes major elements contained within the document, including a brief description of the analysis area, watershed analysis purpose and process, issues and key questions, and findings and recommendations of the analysis.

Watershed Analysis Area

The Crabtree Watershed is located in northwest Oregon in Linn County. The watershed is 100,022 acres in size and extends from the confluence of Crabtree Creek with the South Santaim River, five miles east of the city of Albany, to about 30 miles east into the Cascades Mountains. The Crabtree Watershed includes the communities of Crabtree and LaComb. The watershed is located within the Willamette Valley and Western Oregon Cascades Physiographic Provinces.

The watershed was stratified into six sub-watershed basins (SWBs). The Beaver Creek and Richardson Gap SWBs are primarily in the Willamette Valley Physiographic Province. The Church Creek, Roaring River, and the North and South Forks of Crabtree SWBs are in the Western Oregon Cascades Physiographic Province.

The Crabtree Watershed includes 80,263 acres of private lands, 18,008 acres of BLM lands, and 1,751 acres of state lands. The majority of the watershed is owned by private landowners, about half of which are industrial timber companies. Eighteen percent of the watershed is in federal ownership which is managed by the Bureau of Land Management.

Federal lands in the watershed are managed according to the standards and guidelines of the *Salem District Resource Management Plan* (RMP) and the *Northwest Forest Plan* (NFP). Industrial and non-industrial private lands managed for timber production are managed in compliance with the Oregon Forest Practices Act (OFPA), primarily on economic rotation lengths of 40 to 70 years. The lower end of the watershed is predominately rural residential and agricultural lands.

Watershed Analysis Purpose and Process

The purpose of a watershed analysis is to provide federal agencies a comprehensive and systematic analysis to guide planning and management of federal lands within the watershed. It is intended to guide planning and land management activities to successfully meet the intent of the *Northwest Forest Plan* (NFP) as it applies to the watershed.

Watershed analysis develops and documents a scientifically based understanding of the ecological structures, functions, processes, and interactions within a watershed. This analysis process identifies current conditions, trends, findings, recommendations and data/inventory gaps. The information contained in this document will help in making sound resource management decisions for federal lands contained within the watershed. The watershed analysis will serve as the framework for developing site-specific proposals, monitoring and restoration needs. 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 landowners 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. 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 watershed analysis process begins by identifying significant resource issues which focus on a basic analysis of ecological conditions, processes, and interactions in the watershed. These issues are addressed by asking basic and fundamental key questions. Key questions focus the analysis on cause-and-effect relationships and on conditions as they relate to the ecological processes occurring in the watershed. The key questions have been grouped into three resource categories: Terrestrial, Aquatic and Social. While there are considerable overlap and interaction between the various ecosystem components and processes in a natural system, these broad categories serve as an organizational aid to facilitate analysis of complex systems. This organization is carried through the entire document for ease of reading and organization.

Issues and Key Questions

The watershed analysis process begins by identifying significant resource issues which focus on a basic analysis of ecological conditions, processes, and interactions at work in the watershed. These issues are addressed by asking basic and fundamental key questions. Key questions focus the analysis on cause-and-effect relationships and on conditions as they relate to the ecological processes occurring in the watershed. The interdisciplinary team (IDT), with comment from the public, identified and distilled basic issues and key questions on which to focus the analysis. The following describes the primary issues and key questions that directed the analysis process.

Terrestrial Resources

Terrestrial resources include vegetation, plant communities, forest health, wildlife habitat and Special Status/Special Attention plant and animal species. Land management activities have altered the watershed, resulting in changes in distribution and patterns of occurrence of habitat and species. Terrestrial resources are also affected by natural processes such as natural succession and disturbance processes.

Issue: What management opportunities exist for protecting, maintaining, and/or improving terrestrial resources in the Crabtree Watershed? How can NFP and RMP objectives associated with managing terrestrial resources best be met in this watershed?

Key Questions:

* What is the current condition of the terrestrial resources in the watershed?

* What are the dominant natural processes and how do they affect terrestrial resources?

* How have private and public land use practices influenced terrestrial resources and how will they in the future?

Aquatic Resources

Aquatic resources include water quality and quantity, flood control, private and municipal water rights, fish species and instream habitat. Aquatic resources are affected by both physical conditions and natural processes such as hydrology, riparian condition, soils, erosion, and slope stability. Land management activities have altered the watershed resulting in declining fish runs, water quality and aquatic habitat degradation. Of specific concern is Crabtree Creek, which is listed by DEQ as water quality limited for summer stream temperature. Demands for aquatic resources are increasing and so are conflicts with other resource uses.

Issue: What management opportunities exist for protecting, maintaining, or improving aquatic resources in the Crabtree Watershed? How can NFP and RMP objectives associated with managing aquatic resources best be met in this watershed?

Key Questions:

* What is the current condition of aquatic resources in this watershed?

* What are the dominant physical conditions and natural processes affecting aquatic resources?

* How have private and public land use practices influenced aquatic resources and how will they in the future?

Social

Social resources consider human uses including forest products, transportation, and recreation. The demands on watersheds to provide for a variety of human uses and products is increasing. This analysis will focus on the role that BLM-administered land, in this watershed play in meeting the overall demand for uses and products that were identified in the RMP. Meeting other resource protection and enhancement objectives must also be considered.

Issue: What developments or other management opportunities exist to meet the demand for recreational and natural resource commodities in this watershed, while still providing resource protection consistent with the RMP?

Key Questions:

* What are the major or human uses and where do they occur?

* What are the current and future trends related to human uses?

* What are the potential social or resource conflicts related to human uses?

Findings and Recommendations

Terrestrial

Terrestrial Finding #1- Late seral or late successional (mature and old-growth) Forest Habitat: The amount and quality of late seral forest habitat is limited in the Crabtree Watershed. The analysis of current conditions shows 11 percent late seral forest across all ownerships. Less than five percent is in old-growth over 200 years of age. For BLM lands, the amount of late seral is considerably higher at 35 percent. About 21 percent of BLM lands is in old-growth forests. Sixty percent of the late seral forest in Crabtree Watershed is on BLM lands.

The amount and quality of late seral forest was further analyzed by sub-watershed basin (SWB). North Fork Crabtree SWB and Church Creek SWB have the most late seral with 27 percent and

17 percent, respectively. Seventy percent of the remaining late seral in the watershed is found in these two SWBs. Late seral forest is most scarce in Richardson Gap SWB (<2%), Beaver Creek SWB (3%), Roaring River SWB (8%), and South Fork Crabtree SWB (10%).

With the development of Riparian Reserves and Late Successional Reserves (LSRs) on federal lands and Oregon Forest Practices Act (OFPA) buffers on non-federal lands, the entire watershed (all ownerships) has the potential to support 14 to 16 percent late seral forest habitat within 80 years under current management. Due to the small total percentage of federal lands in the Crabtree Watershed (less than 20 percent), there are limits to how much federal lands can contribute to late seral forest habitat over time.

Terrestrial Finding #2 - Standing Dead/Down Coarse Woody Debris (CWD): There is a scarcity of standing dead/down CWD habitat, especially larger material in the early stages of decay. Estimates show that the amount of standing dead/down CWD are below NFP and RMP standards. Over the long term, the amount of standing dead material on federal lands is expected to approach 60 percent of potential cavity dwelling wildlife populations as late seral forest develops in LSRs and Riparian Reserves and green tree retention guidelines are implemented. There would be an increase of standing dead/down CWD on private/state lands as relatively new OFPA requirements continue to be implemented.

Terrestrial Finding #3 - LSR Boundaries: LSR boundaries in the vicinity of Harry Mountain Ridge and the Snow Peak area delineated by the Salem District RMP follow interior section lines rather than topographic features and/or known Special Status/Special Attention Species occurrence. Managing along legal boundaries irrespective of ecological features and species occurrence would be inconsistent with the management of these LSRs as ecosystems and protection of known Special Status/Special Attention Species.

Terrestrial Finding #4 - Special Habitats: On BLM lands, the Snow Peak Ecosystem and Carolyn's Crown/Shafer Creek/Crabtree ACEC are priority special habitat complexes in the Crabtree Watershed. Buzzard Butte and White Rock Fen ACEC are unique special habitat features that are also important.

Terrestrial Finding #5 - Willamette Valley Habitats: A fairly large portion of the Crabtree Watershed is within the Willamette Valley Physiographic Province. A number of bird species that are considered to be Willamette Valley habitat specialists are known or are suspected to occur on non-federal lands in the watershed. The Richardson Gap area has been identified as a Grassland Bird Conservation Area (BCA), according to the *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (American Bird Conservancy, March, 2000). Under the Conservation Strategy, non-federal landowners can pursue cooperative agreements and funding to maintain, improve, restore and/or protect native Willamette Valley habitats, especially in the Richardson Gap Grassland BCA. Cooperative programs and funding opportunities are described in the Implementation Section, Chapter 9, of that document. A number of voluntary programs are available to private landowners which provide financial and technical assistance. Programs include those administered by the U.S. Department of Agriculture under the 1996 Farm Bill, the Wildlife Habitat Conservation and Management Program administered by Oregon Department of Fish and Wildlife, and matching funds provided by private foundations such as the National Fish and Wildlife Foundation.

Terrestrial Finding #6 - Road Densities: There are approximately 603 miles of road on all ownerships within the watershed. Currently, the average total road density across all ownerships is estimated at about 4 miles per section. Of the 603 total road miles in the watershed, 130 miles are on federal lands (22 %). Average total road density on federal lands is estimated at about five miles per section, which is high. Road densities on federal lands are highest in the South Fork Crabtree, Richardson Gap, and Church Creek SWBs (over five miles per section). North Fork Crabtree Creek and Roaring River SWBs have road densities between four and five miles per section. Road densities on federal lands are lowest in Beaver Creek SWB.

Terrestrial Finding #7 - Special Status/Special Attention Plant Species: There are four known populations of BLM special status plant species populations and numerous known survey and manage species sites in the watershed. These species include tall bugbane, *Cimicifuga elata,* fir clubmoss, *Huperzia occidentalis*, meadow sidalcea, *Sidalcea campestris*, and noble fir polypore fungus, *Bridgeoporus nobilissimus*.

Terrestrial Finding #8 - Noxious Weeds: New invader and established infestation noxious weed species are present along many roadsides in the watershed. These noxious weeds are present and will continue to invade native plant habitats if no action is taken. Noxious and invasive weeds will continue to be a concern over time because of the increased human use of the watershed, especially at lower elevations and in travel corridors.

Terrestrial Finding #9 - Special Status/Special Attention Animal Species: There are three Survey and Manage mollusk species that are documented to occur in the Crabtree Watershed. The Oregon megomphix *(Megomphix hemphilli)*, and two tail-dropper slugs, the blue-gray tail dropper *(Prophysaon coeruleum)* and the papillose tail dropper *(Prophysaon dubium)*. The red tree vole, a Survey and Manage species, has been documented to occur in the Church Creek SWB, and is highly likely to occur elsewhere in the watershed. Four bat species identified in the NFP as species in need of additional protection are highly likely to occur in the Crabtree Watershed. In addition, eight Bureau Sensitive species have been documented or are highly likely to occur in the watershed. These include the harlequin duck, peregrine falcon, goshawk, common nighthawk, Lewis' woodpecker, purple martin, yellow-breasted chat and western meadowlark

Terrestrial Finding #10 - Bald Eagles: There is one known bald eagle nest site near the lower end of the Crabtree Watershed. The nest tree itself is just outside the watershed, however, the bald eagles are known to utilize Crabtree Creek in the lower end upstream as far as Church Creek and Roaring River SWBs. There are no bald eagle concentrations or winter roosts in the Crabtree Watershed. Wintering birds are thought to be the local birds that nest in the vicinity. There is suitable bald eagle nesting habitat on BLM lands in the vicinity of Crabtree Creek in the Church Creek SWB.

Terrestrial Finding #11 - Nesting Spotted Owls/Habitat: The only portion of the Crabtree Watershed that was found to be viable for nesting spotted owls was the upper portion of North Fork Crabtree SWB on BLM lands in the LSR. The North Fork Crabtree SWB as a whole as well as the Church Creek SWB were found to be marginal to limiting for nesting spotted owls. The Beaver Creek, Richardson Gap, Roaring River, and South Fork Crabtree SWBs were found to be non-viable for nesting spotted owls.

Of the seven known spotted owl sites (KOSs) with site centers in the watershed, four were found to be viable. Three sites of these sites are located in the North Fork Crabtree SWB on BLM lands in the LSR. One located in the Church Creek SWB is limiting, but occupancy and reproduction appears to be stable. The other three sites are considered to be non-viable.

Terrestrial Finding #12 - Connectivity/Dispersal Habitat: The Cascades portion of the watershed is viable for dispersal of spotted owls. The Crabtree Watershed provides for dispersal to/from the Quartzville Watershed to the east. Spotted owl dispersal out of the Crabtree Watershed is limited by the scattered federal ownership and the North Santiam River Corridor to the north, the South Santiam River Corridor to the south and the Willamette Valley on the west. The most significant lands in the watershed for spotted owl movement are the BLM lands in the North Fork Crabtree SWB. These lands are directly connected to the large LSR/wilderness network to the east of the watershed where the majority of dispersal in the Cascades Range takes place.

Recommendations:

Terrestrial Recommendation #1 - Density Management/Thinnings (Findings 1, 2, 11 and 12): Timber harvest should emphasize enhancement and restoration opportunities that target stands in Riparian Reserves, LSR, Connectivity lands (CONN) and General Forest Management Area (GFMA) lands in Critical Habitat that have been managed primarily for timber in the past. Density Management would be prescribed primarily in mid-seral stands in the stem exclusion stage to encourage the development of late seral conditions. Implement density management prescriptions in Riparian Reserves and LSR to develop and maintain late seral forest stand characteristics. Desirable stand characteristics include larger trees for a large green tree component and recruitment of large standing dead/down CWD in future stands, multi-layered stands with well developed understories, and multiple species that include hardwoods and other minor species.

Terrestrial Recommendation #2 - Standing Dead/Down CWD (Findings 1 and 2): Implement NFP and RMP standards and guidelines for green tree retention for the recruitment and development of standing dead/down CWD and to contribute to the development of late seral forest stand characteristics. Protect existing material and leave additional green trees in future harvest units to make up for deficiencies in current conditions.

In the Matrix, leave trees should be over 12 inches dbh and represent the current range of conifer species, size and diameters. Leave additional green trees in areas where standing dead/down CWD does not meet *Northwest Forest Plan* (NFP) and *Salem District Resource Management Plan* (RMP) standards. Typically, up to four additional trees per acre are left in areas where standing dead/down CWD is lacking. Create enough large, hard standing material to meet the 40 percent level of potential cavity dwelling wildlife populations. It is anticipated that natural decay/falldown and blowdown of green tree retention will meet or exceed NFP requirements for down CWD.

In Riparian Reserves and LSR, standing dead/down CWD requirements should approximate those cited in the Late Successional Reserve Assessment (LSRA) for the area. Treatment objectives in these allocations would be for individual tree growth and/or stand structure enhancement for the purposes of accelerating late seral forest development in younger age classes. Landscape level considerations include connectivity for species, past management and natural disturbances such as fire, insects, and disease. Leaving trees to grow and become snags later is appropriate in early to mid seral stands.

Terrestrial Recommendation #3 - Special Habitats/Species/LSR Boundaries (Findings 3 and 4): Adjust boundaries of LSRs to better protect special habitats and Special Status/Special Attention Species in the Snow Peak and Harry Mountain Ridge areas. Use more ecologically meaningful features to define LSR boundaries such as watershed boundaries, topographic features, roads, forest type breaks, and Special Status/Special Attention Species buffers and management areas rather than interior section lines.

Terrestrial Recommendation #4 - Special Habitats (Finding #4): Consider amending the RMP to protect habitat adjacent to the Buzzard Butte area and encourage the further development of late seral forest habitat in the vicinity.

Terrestrial Recommendation #5 - Noxious Weeds (Finding #7): Use the principles of integrated weed management to eradicate, control, and prevent the spread of established and new invader noxious weed infestations. Integrated weed management means using all suitable methods (cultural, physical, biological, chemical) in a compatible manner to reduce weed populations.

Control established infestations primarily by biological control agents and by revegetating disturbed ground with desirable species. Make biological control releases in the Crabtree Watershed as new agents become available.

Encourage washing of ground disturbing equipment from off site to limit the spread of all exotic and noxious weed species.

Terrestrial Recommendation #6 - Nesting Spotted Owls/Habitat (Finding #11): Coordinate management and protection around KOSs with adjacent private landowners and the state. Highest priority sites are those in Church Creek, South Fork and North Fork Crabtree SWBs.

Land Tenure

The highest priority lands in the Crabtree Watershed for retention in BLM ownership include lands with high ecological values. These lands include all LSR, Critical Habitat for the northern spotted owl, and Matrix lands in the vicinity of Buzzard Butte and Snow Peak. These lands are mapped as Zone 1 according to definitions under Land Tenure on page 53 of the Salem District RMP, with the exception of the LSR and Matrix lands in the vicinity of Snow Peak and Buzzard Butte, which are mapped as Zone 2. Consider amending the RMP to designate these lands as Zone 1, high priority for retention. The remaining lands in the watershed are in Zone 2 according to the RMP. There are no federal lands in the watershed that meet the definition of Zone 3, high priority to exchange out of federal ownership.

Aquatic

Aquatic Finding #1 - Riparian Condition: Riparian surveys on BLM lands indicate that current riparian vegetation is composed largely of varied age classes which are heavily skewed toward stands less than 80 years old, resulting in a lack of mature to late successional dominated riparian vegetation. Stream adjacent vegetation along many sections of Crabtree Creek have been removed by high flows, and movement of sediment, large cobbles and boulders down the channel. Riparian areas with young conifer stands are common in all of the SWBs, but are most prevalent in the Roaring River and South Fork Crabtree SWBs. The North Fork Crabtree and Church Creek SWBs have the most late successional forest in riparian areas on the average.

Aquatic Finding #2 - Large Woody Debris (LWD): The combination of a lack of large woody structure in streams and several torrential flow events in the early 1970s and 1996, resulted in some channelization of the streams in the watershed, and a further reduction of LWD in the system. Generally, LWD is severely lacking in the watershed, particularly in the lower portions of the larger streams where anadromous fish are present. The high percentage of riparian acreage with low potential is mainly due to the large amount of agricultural lands in the lower watershed and young conifer stands in the mid- and upper portions of the watershed. Some of the headwater reaches have good quantities of LWD that may eventually be flushed down into lower reaches of the watershed. In the Crabtree Watershed, only 15.5 percent of the riparian areas (within 30 meters of stream channels) have high potential for LWD recruitment to streams (dominant age-class >130 years) and only 2.4 percent have moderate potential (conifer dominated or mixed forest, 80-130 years). The remaining 82 percent have low potential (conifers <80, hardwoods and non-forest). The North Fork Crabtree and Church Creek SWBs have the highest potential for LWD recruitment.

Aquatic Finding #3 - Stream flows: July and August have the greatest potential for conflict between consumptive uses and instream water needs with 52 and 61 percent of water allocated to consumptive uses respectively, at an 80 percent exceedence flow.

Aquatic Finding #4 - Water Quality: In the Oregon Department of Environmental Quality (ODEQ) publication, *1988 Oregon Assessment of Non-point Sources of Water Pollution* (ODEQ 1988), also known as the *319 Report*, Crabtree Creek water quality is listed as being moderately impacted, supported by data in the upper reaches, and by observation in the lower sections. Problems identified include: turbidity, erosion, sediment, low dissolved oxygen, and low flows. The probable causes were listed as erosion, road runoff, vegetation removal, and water withdrawals. Impacted values were identified as fisheries, aquatic life, water recreation, irrigation, wildlife, aesthetics, and livestock. Since the report, additional data has been collected in the sub-watershed by the South Santiam Watershed Council. The data indicate dissolved oxygen and pH are probably not of concern in Crabtree Creek. Roaring River SWB is listed as having greater than 20 percent steam channel expansion due to roads, which is considered high.

Aquatic Finding #5 - ODEQ 303(d) listing: In the *Oregon Department of Environmental Quality's 303(d) List Of Water Quality Limited Waterbodies*, also known as the *303(d) report*, Crabtree Creek is listed as water quality limited for summer stream temperature, from the mouth upstream to White Rock Creek. Summer temperatures have been found to be above the 64 degrees F. threshold for fish rearing for notable periods of time.

Aquatic Finding #6 - Stream Temperatures: Summer water temperatures in Crabtree Creek at river mile 30 were below the basin standard of 64 degrees F., but all other Crabtree stations were above the standard for extended periods of time. Because the data represent a seven day running average, it is apparent that water temperatures are high for extended periods of time during the summer. In early summer, water temperatures increase in a downstream direction which is expected. However, beginning mid July temperatures decrease in a downstream direction with temperatures at river mile 14 significantly cooler than found at river mile 28. This phenomenon indicates one or several sources of cooling water exist between the two stations in the warmest part of the year.

Aquatic Finding #7 - Slope Stability and High Water Flows: Analysis of aerial photographs indicate an increase in landslide activity and the loss of riparian cover occurred between 1993 and 1998. The flood of February 1996 affected much of northwest Oregon, and may have triggered the observed changes. 1998 photos of Crabtree Creek in the vicinity of river miles 28 and 30 display an open riparian canopy, and the creek appears to have suffered high flows and large sediment loads. Sediment has been deposited on the flood plain, removing vegetation and allowing direct solar input. A few large landslides in the area added considerable sediment to the creek, and most appear to have initiated at roads. BLM road 11-2E-14.1 suffered a few large slides that appears to have added sediment to the creek. Several tributaries entering the section of Crabtree Creek between river mile 28 and 30 appear to have delivered heavy sediment loads in the recent past. Several shallow ponds are obvious on the photographs and may also be contributing to warmer water temperatures in the upper sections of Crabtree Creek.

Aquatic Finding #8 - Off Highway Vehicle (OHV) Use: OHV and motorcycle use in the Hunter/Church Creek area has created accelerated erosion affecting water quality. The area is under temporary closure until September 1st, 2001.

Aquatic Finding #9 - Non-point Pollution: Tetra Tech (1993) estimated non-point pollution annual loads of nitrogen, phosphorous, and total suspended solids for watersheds in the Willamette River basin. Results suggest the non-point pollution levels are 5 to 20 percent higher in the Santiam sub-basin than the Willamette Basin average, however sources have not been identified.

Aquatic Finding #10 - Age Class Distribution: The SWBs with the greatest percent of forested land in the young age class (0 to 30 years old) are Richardson Gap and Beaver Creek. Lands in these SWBs are owned and managed by non-industrial private parties with small landholdings, and BLM land which is managed as General Forest Management Area (GFMA). By contrast, Church Creek and Roaring River SWBs currently have the lowest percentage of forest lands in the younger age class. These SWBs are managed to a greater degree by industrial forest companies and BLM.

The sub-watershed with the largest amount of late seral is North Fork Crabtree Creek SWB. Most of the late seral stands in this sub-watershed are located on BLM lands in the upper reaches managed as LSR. South Fork Crabtree Creek, Church Creek, and Roaring River SWBs have the highest percentages of private land at an age where harvest is likely within the next decade.

Aquatic Finding #11 - Soils: Several major geologic hazards exist in the Crabtree Watershed which affect streams and water quality. Earth flows and slumps occur in large scattered areas of the watershed, and result in the delivery of soil material to streams through streambank erosion of the toe of the failure. Slope failures occur in steeply sloping, rocky mountainous terrain and include rock slides, debris avalanches and earth flows. Stream erosion and deposition are common within portions of the watershed resulting in higher turbidity, siltation of salmon spawning gravels, and a decrease in channel stability. Church, and North Fork Crabtree SWBs appear to have the greatest acreage of upland in an unstable condition. The SWB with the most extensive BLM ownership classified as unstable is North Fork Crabtree sub-watershed.

Aquatic Finding #12 - Fisheries: Reaches 1-3 of the upper mainstem and reach 1 of South Fork Crabtree Creek are the primary reaches within the watershed that support, or have the potential to support anadromous fish. All of these reaches appear to have low habitat complexity and are the reaches in which instream restoration (placement of LWD) would probably result in the most benefit to anadromous fish production. These stream reaches are almost entirely in private ownership.

Aquatic Finding #13 - Water Quality and Fisheries: The lower mainstem of Crabtree Creek (from the mouth to Larwood) has high percentages of actively eroding streambank on private lands, primarily used for agriculture.

Recommendations:

Aquatic Recommendation #1 - Riparian Condition and LWD (Findings #1 and 2) on federal lands: Actively manage Riparian Reserves to achieve Aquatic Conservation Strategy Objectives on BLM lands. Plan and implement riparian silvicultural projects designed to accelerate growth of riparian conifers to improve potential for LWD recruitment on BLM lands. Improve and restore riparian habitat through planting and seeding with native vegetation. Activities could include planting, density management, thinning, road decommissioning, and erosion control in Riparian Reserves.

Aquatic Recommendation #2 - Riparian Condition and LWD (Findings #1 and 2) on non-federal lands: Improve riparian conditions, and promote large conifer development in riparian areas through density management and thinnings. Work with other landowners in the watershed to improve riparian condition and overstory by implementing projects designed to accelerate growth of riparian conifers to improve potential for LWD recruitment. Bringing in and anchoring large logs and rootwads in channels may work in some areas to improve fish habitat and stream structure.

Aquatic Recommendation #3 - Stream Flows (Finding #3): Cooperate with ODFW to ensure instream flows are protected in summer and fall during extremely low flow years.

Aquatic Recommendation #4 - Water Quality (Terrestrial Finding #6, Aquatic Findings #4 and 7): Reduce roaded miles that contribute flow or sediment to streams. Reclaim/decommission roads to reduce road densities in the watershed. Where roads cannot be decommissioned, close and storm proof unnecessary roads. Pursue road reconstruction and improvement projects on permanent access roads to reduce sediment to streams or prevent future water quality problems. Highest priorities for reducing roaded miles would be in North Fork and South Fork Crabtree SWBs, Roaring River SWB and Church Creek SWB. Permanently close Hunter/Church Creek areas to protect water quality, low elevation late seral forest habitat and reduce disturbance to wildlife species, including the KOS in the Church Creek SWB.

Aquatic Recommendation #5 - Water Quality (Findings #4, 7 and 11): Cooperate with state and private landowners to improve water quality. Improve drainage from existing roads and replace culverts that do not meet 100- year flood standards, to reduce loss of roads during large storms and addition of sediments and rock materials to streams. Divert runoff from unstable slopes and stabilize slide areas.

Aquatic Recommendation #6 - ODEQ 303(d) listing (Findings #4 and 5): ODEQ is scheduled to set the Total Maximum Daily Load for temperature in Crabtree Creek during 2002. After ODEQ sets the maximum load, BLM will be expected to produce a Water Quality Restoration Plan (WQRP) for BLM managed lands within the watershed. The plan must include detailed restoration activities and time lines.

Aquatic Recommendation #7 - Stream Temperatures (Findings #4 and 6): Develop projects to improve stream shade on BLM lands. Work with other landowners and the South Santiam Watershed Council to increase effective stream shade, expand the temperature monitoring network and locate sources of high water temperatures. Expanded temperature monitoring would provide data for development of the WQRP discussed above.

Aquatic Recommendation #8 - Soils, Slope Stability and High Water Flows (Findings #4, 7 and 11): Conduct an assessment of landslides and erosion problems in the watershed. The pending WQRP for the Crabtree Watershed should address erosion problems and restoration actions. Stabilize slides where possible, by seeding, diverting water from unstable slopes, installation of erosion matting, and unweighting slides at the top. Improve road drainage, and replace culverts where needed. Improve riparian cover where possible. Restore vegetative cover on bare slopes. Work on joint projects with other landowners to improve upland conditions on lands in all ownerships.

Aquatic Recommendation #9 - OHV Use (Finding #8): Permanently close the Hunter/Church Creek area to off- road vehicle and motorcycle use and rehabilitate trails affecting water quality.

Aquatic Recommendation #10 - Non-point Pollution (Finding #9): Support the South Santiam Watershed Counsel, and ODEQ efforts to quantify non-point sources of pollution.

Aquatic Recommendation #11 - Age Class Distribution (Finding #10): Conduct a cumulative effects analysis when a project is proposed by BLM. Redesign or defer projects where necessary, and consider restoration activities to reduce cumulative impacts where practical. Schedule BLM timber sales and other projects so as to reduce their contribution to cumulative effects.

Aquatic Recommendation #12 - Fisheries (Finding #12): Cooperate with private landowners to implement instream restoration projects and retain riparian overstory vegetation on the mainstem of Crabtree Creek and South Fork Crabtree Creek. Design and implement cooperative restoration projects on the mainstem of Crabtree Creek involving BLM, state and local governments and private landowners.

Aquatic Recommendation #13 - Water Quality and Fisheries (Finding #13): Work with the South Santiam Watershed Council to encourage private landowners in Lower Crabtree Creek (from the mouth to Larwood) to implement bank stabilization measures on agricultural lands, including exclosure of livestock from the stream channel where appropriate.

Social

Social Finding #1 - General: Public lands in the Crabtree Watershed are an important resource to people in the mid-Willamette Valley for a variety of commodity and non-commodity values. Finding a balance between providing commodity based products such as timber with other values such as water quality, fish, wildlife, recreation, and visual resources will be an ongoing challenge that will only increase as rural and urban communities in the mid-Willamette continue to grow. These issues are further complicated by the intermixed ownership pattern of private land BLM-administered lands. The BLM's ability to develop partnerships with interested groups and adjacent landowners on a variety of issues and projects will be a key component of successful public land management in this watershed.

Social Finding #2 - Timber Management: Under the Salem District RMP, timber harvest activities will continue to occur at various levels relative to the land use allocations in the Crabtree Watershed. Timber harvest activities will include regeneration harvest, thinnings, density management and salvage operations conducted according to the NFP.

Social Finding #3 - Rural Interface: Approximately 1,613 acres of the BLM-administered in the Crabtree Watershed are located within Rural Interface Areas (RIAs). These RIAs have a low to moderate level of sensitivity, that varies by RIA. Most of the residential landowner concerns in RIAs are associated with timber management and recreational/public use. Timber management concerns are associated with potential negative impacts to water quality, scenic quality, recreational values and short term disturbance during logging operations (i.e. noise, dust, log truck traffic). Recreational/public use concerns are related to problems such as littering, vandalism, theft, fire use, shooting, and other noise on public lands adjacent to or near residential lands. Problems with trespass associated with public use of BLM-administered lands near private property is also a concern.

Social Finding #4 - Public Access: Motorized access to public and private lands in the Crabtree Watershed will likely decrease in the long term. Both private landowners and the BLM have restricted vehicle access in areas because of problems with garbage dumping, erosion, damage to vegetation, vandalism, theft, long term occupancy, and reckless fire and firearm use. The restriction of vehicle access to private and public forest lands is a growing trend in many of the watersheds in western Oregon that are near rural and urban areas. These restrictions are becoming an increasing concern recreational activities which require motorized access. Without the funding to provide adequate enforcement and development of self-policing partnerships with user groups, limiting vehicle access is currently the only cost effective way of addressing these problems. Because of the intermixed ownership pattern of private and public lands in the Crabtree Watershed, any long term solution would have to be a collaborate effort between private and public land managers.

Social Finding #5 - Off-Highway Vehicle Use: Unmanaged off-road use by motorized vehicles may not be compatible with other resource management objectives for BLM-administered lands, due to concerns associated with erosion, vegetation damage, water quality, fisheries and wildlife disturbance. Due to the intermixed ownership pattern in the watershed, any area designated for off-road use by motorized vehicles would need to include private and public lands. Currently, private landowner support for such a project is low.

Social Finding #6 - Recreation: The recreational settings in the greatest demand for SCORP Region 8 are semi-primitive and primitive. The Crabtree Watershed will likely never have a roadless area of significant size to meet the criteria for a primitive setting. The east half of the Crabtree Watershed and extending into the western portion of the Quartzville Watershed offers potential for providing a semi- primitive setting for both motorized and non-motorized recreational activities. Motorized use would be limited to those roads designated as open, but main routes on BLM-administered lands will likely remain open. There may be potential for developing a trail system for non-motorized use such as hiking, mountain biking, and horseback riding utilizing existing roads and trails and developing additional trails. This would include the development of a trail leading from Crabtree Lake to Green Peter Peninsula. Public lands in the west half of the Crabtree Watershed will continue to provide recreational opportunities such as hunting, fishing, target shooting in both rural and roaded modified settings. Private lands in the west half of the watershed would continue to provide similar activities to the extent that they remain open for public use.

Social Finding #7 - Crabtree Lake: Crabtree Lake Outstanding Natural Area (ONA) is one of the more significant features in the Crabtree Watershed. It receives recreational use and use for educational and research purposes. The condition of Crabtree Lake ONA has improved significantly since vehicle access was blocked approximately 1/4 mile from the lake in the early 1990s. Visitor use is relatively low and no new campsites have been established around the lake since the campsite inventory in 1993. Currently no visitor facilities such as restrooms or signage are provided on site. Past efforts at signing the area have been subject to frequent vandalism. The last mile of the road accessing Crabtree Lake has greatly deteriorated in the last ten years to the point that it may be difficult for passenger vehicles to use.

Social Finding #8 - Visual Resources: There are 1,249 acres of BLM-administered land in the Crabtree Watershed with a Class I rating, requiring the highest level of protection under the Visual Resource Management (VRM) system. These lands include the Carolyn's Crown, Shafer Creek, and Crabtree Lake ACEC's. There are no BLM-administered lands in the watershed with a Class II rating. Timber management activities will continue to be evident on private lands and on BLM administered lands with a Class III or IV rating. Of BLM-administered lands with a Class III or IV rating, the Snow Peak and Buzzard Butte areas were identified as having greater visual sensitivity. BLM-administered lands within RIAs would also be potentially more sensitive.

Social Finding #9 - Prohibited Uses: The occurrence of prohibited uses such as illegal dumping, vehicle abandonment, long-term occupancy, equipment and sign vandalism, wildlife poaching, unauthorized removal of forest products and the growing or manufacturing of illegal drugs is increasing on public and private land in the Crabtree Watershed. Cooperative law enforcement efforts between public and private landowners, such as the Linn County Protective Association, can help discourage these prohibited uses. However, current funding is not adequate to address this problem on BLM administered lands. If the closure of private lands to motorized public access continues, the incidence of these prohibited uses on public lands that remain open may increase.

Recommendations

Social Recommendation #1 - Rural Interface Areas and Visual Resource Management (Findings #1, 2, 3 and 8): Many of the same mitigating management practices can be used to reduce the potential impacts to visual resources and rural interface areas, resulting from timber harvest activities. Of BLM-administered lands with a Class III or IV rating, the Snow Peak and Buzzard Butte areas were identified as having greater visual sensitivity. In addition, special consideration should be given to those BLM-administered lands which have both Rural Interface and Visual Resource concerns. Below is a list of mitigating management practices that could be taken depending on the proposed action and site specific characteristics.

* Get adjacent landowner input early in the planning process for areas with a potential for high sensitivity to better determine areas of concern.

* Early in project planning, consider reducing visual or other disturbance factors in designing the size, shape, and location of the timber harvest units or project. Consider small patch cuts, thinning, or uneven aged management to better maintain forest cover.

* Where possible, utilize green retention trees and riparian reserves to buffer the visual impacts from view. Consider leaving additional trees for added buffering where needed.

* Where possible, consider using alternative reforestation site preparation prescriptions to broadcast burning.

Social Recommendation #2 - Public Access and Road Use (Findings #4 and 9): Look for opportunities to work with private landowners, local and federal law enforcement and other user groups to keep public and private forest land roads open for public use and to discourage prohibited uses.

Social Recommendation #3 - Off-Highway Vehicle Use (Finding #5): Evaluate any proposals for providing off-road motorized use, including roads and trails. Private landowner support and mitigation measures for resource protection should be important criteria for consideration. Due to the current lack of private landowner support and resource concerns associated with water, fish and wildlife, BLM- administered lands in the Crabtree Watershed may be less suited to meeting the demand for motorized off-road use.

Social Recommendation #4 - Recreation (Finding #6): Evaluate the potential of establishing multi-use non-motorized trails in the Snow Peak and Crabtree Lake areas. Also consider possible connections to Green Peter Peninsula and other BLM-administered lands in the Quartzville Watershed.

Social Recommendation #5 - Crabtree Lake (Finding #7): Continue to monitor the condition of Crabtree ONA on an annual basis. Convene an interdisciplinary team to prepare a management plan for Crabtree ONA that addresses issues associated with the appropriate level of public access, facility development and other resource concerns.

Social Recommendation #6 - Prohibited Uses (Finding #9): Continue to work with private, local, state and federal partners to reduce prohibited uses and to clean up areas where dumping is occurring.

Data Gaps, Inventory and Monitoring Needs

Terrestrial

Special Status /Special Attention vertebrate and invertebrate species occurrence in the Crabtree Watershed, such as the Oregon giant earthworm, harlequin duck, peregrine falcon, goshawk, Western pond turtle, red tree vole, and bat species. **Recommendation:** Survey for priority wildlife species in the watershed. Continue cooperative efforts with adjacent non-federal landowners and the State to survey and manage known spotted owl sites in the lower portion of the watershed.

Presence and abundance of nonvascular plants and fungi, particularly *Bridgeoporus nobilissimus,* to determine appropriate management areas. **Current Status:** Surveys for this species are in progress and are recommended for BLM lands east of Snow Peak and in the Harry Mountain Ridge vicinity along the divide between Crabtree, Quartzville, and Thomas Creek watersheds. Surveys for *Bridgeoporus nobilissimus* in the Snow Peak area will be complete by the end of 2001.

Density Management or thinning opportunities across all LUAs, particularly Riparian Reserves, LSR, CONN, and Critical Habitat in GFMA and CONN. **Recommendation:** Conduct stand exams, including CWD and standing dead components, across all LUAs to identify restoration/enhancement treatment opportunities in stands previously managed for commercial forest products, especially in appropriate Riparian Reserves and LSRs. Preliminary screening has been completed and identification of potential projects is in progress.

Noxious weed sites in the watershed on federal and non-federal lands. **Recommendation:** Develop a comprehensive inventory of noxious weed sites in the watershed and coordination with other public and private parties for the development of weed control plans. Continue surveying and monitoring of noxious and invasive weeds. Develop partnerships and actively pursue funding for weed control projects.

Swiss needle cast infection levels and trends in the watershed. **Recommendation:** Establish monitoring plots to measure current levels of defoliation due to Swiss needle cast and determine trends in the watershed over time.

Aquatic

Stand ages and seral stages on non-federal lands for the purpose of estimating cumulative effects associated with future projects. **Recommendation:** Inventory of stand ages and seral stages on non-federal lands to create an accurate GIS layer for the purpose of estimating cumulative effects associated with future projects.

Adequate water temperature and stream modeling data to determine where temperature enrichment to streams may be occurring. **Recommendation:** Increase water temperature data collection to help determine where temperature enrichment to streams is occurring. Model streams in the watershed using either the *Heet Source* model or *Shadow* model to help determine where temperature enrichment is occurring.

Sediment sources and potential failures associated with roads needed to identify road decommissioning and storm proofing opportunities. **Recommendation:** Inventory roads on all ownerships to determine which are contributing sediment, have the highest risk of failure, and which could be decommissioned or storm proofed.

Riparian treatment opportunities in the watershed to enhance stream shade, such as conifer planting in riparian areas. **Recommendation:** Conduct stand exams, including photographic interpretation, in appropriate Riparian Reserves to identify projects that could enhance stream shade.

Fragile soils on non-federal lands and landslide activity and erosion potential across the entire watershed. **Recommendation:** Inventory fragile soils on non-federal lands and develop a detailed landslide and erosion inventory across the entire watershed.

The upstream limits of resident fish distribution on federal lands are not known on many streams within the watershed. Currently, where no field data are available, resident fish are assumed to be present in streams that are 3rd order and larger. **Recommendation:** Inventory streams on federal lands to determine the upstream limits of resident fish. Much of this inventory work will occur for site specific analysis of future projects proposed in the watershed.

The upstream limit of anadromous fish distribution is not known in Church Creek, but is suspected to occur on BLM land. **Recommendation:** Inventory Church Creek to determine the upstream limit of anadromous fish distribution.

Habitat inventories have been conducted on many streams within the watershed, but inventories on several more streams (primarily on private lands) would provide a more complete picture of aquatic habitat conditions in the watershed. **Recommendation:** Support cooperative efforts to survey habitat and fish distribution across all ownerships in the watershed.

Social

Visitation levels and recreational activities in the watershed. **Recommendation:** As time and funding allow, collect additional field data.

Dispersed campsites, shooting areas, and OHV trails in the watershed. **Recommendation:** As time and funding allow, inventory dispersed campsites, shooting areas, and OHV trails in the watershed.

Special Forest Products in the watershed on federal and non-federal lands. **Recommendation:** Conduct a Special Forest Products inventory and develop a strategy to increase the marketability of these products, both on private and public forest lands.

Chapter 1 Introduction

Watershed Analysis

The purpose of a watershed analysis is to provide federal agencies a comprehensive and systematic analysis to guide planning and management of federal lands within the watershed. It is intended to guide planning and land management activities to successfully meet the intent of the *Northwest Forest Plan* (NFP) as it applies to the 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. By developing and documenting a scientifically based understanding of the processes and interactions occurring within a watershed, a common framework for evaluating and managing the federal land within the landscape can be established. The watershed analysis will serve as a framework for developing site-specific proposals, monitoring and restoration needs. The analysis will also be used in making sound resource management decisions for federal lands contained within the watershed.

This analysis process identifies current and historical conditions, trends, findings, recommendations and data/inventory gaps, and will show how to move landscape units from existing to desired conditions, identify commodity outputs, identify recreation and other social management recommendations, and other ecological considerations. Adjustment of Riparian Reserve widths was not addressed in this document.

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 landowners 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. 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 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.

Document Organization

The watershed analysis process begins by identifying significant resource issues which focus on a basic analysis of ecological conditions, processes, and interactions in the watershed. These issues are addressed by asking basic and fundamental key questions. Key questions focus the analysis on cause-and-effect relationships and on conditions as they relate to the ecological processes occurring in the watershed. The key questions have been grouped into three resource categories: Terrestrial, Aquatic and Social. Terrestrial resources include vegetation, plant communities, forest health, wildlife habitat and Special Status/Special Attention plant and animal species. Aquatic resources include water quality and quantity, flood control, private and municipal water rights, fish species and instream habitat. Social resources consider human uses including forest products, transportation, and recreation. While there are considerable overlap and interaction between the various ecosystem components and processes in a natural system, these broad categories serve as an organizational aid to facilitate analysis of complex systems. This organization was carried through the entire document for ease of reading and organization.

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, and is as follows:

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. Establishes the issues and key questions to be considered during the 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 - Future 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.

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, lists, tables, charts, and maps that are not specific to the issues but 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. Primary team members were staff from within the Bureau of Land Management (BLM) Cascades Resource Area. The second phase involved sending letters of interest and questionnaires to watershed landowners, other local, county, and state agencies, and other interested individuals and organizations. These individuals, groups, and organizations were encouraged to complete our questionnaire and return it to our office. In addition, notification regarding ongoing watershed analyses was published in the Salem District Project Update, with contact email addresses and phone numbers. 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 Crabtree Watershed.

Management Direction - Federal Land Use Allocations

The Crabtree Watershed is 100,022 acres in size and includes 80,263 acres of private lands, 18,008 acres of federal lands, and 1,751 acres of state lands. All of the federal lands within the Crabtree Watershed are managed by the Salem District BLM. The BLM manages 18 percent of the watershed and is considered to be a relatively minor landowner. The majority of the watershed is owned by private landowners, about half of which are industrial timber companies. See Figure 2-1, Ownership Acreage and Percentages in Crabtree Watershed.

Land use is allocated according to the NFP and the Salem District Resource Management Plan (RMP). See Figure 2-2, BLM Land Use Allocation Acres and Percentages in the Crabtree Watershed, and Table 2-1, Land Use Allocations for BLM Lands in the Crabtree Watershed. 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). Matrix lands are managed for a combination of values, including planned timber harvest, and the LSRs are managed for older forest habitat development and preservation.

Riparian Reserves overlay the Matrix and LSR. They have been identified as a buffer, based on site potential tree height, along all standing and flowing water, intermittent stream channels, ephemeral ponds, and wetlands. Riparian Reserves are to be managed to maintain and enhance riparian and older forest (late seral) conditions to contribute to the attainment of the Aquatic Conservation Strategy Objectives in the NFP. A more detailed description of management objectives and direction for these LUAs are given in Chapter Six, Future Conditions and Trends; and the standards and guidelines are discussed in detail in the NFP and RMP.

Chapter 2 - Characterization

This chapter describes the dominant physical and biological processes and features, and human influences in the Crabtree Watershed that affect ecosystem functions or conditions. This narrative is intended to give the reader a quick overview of the watershed. More detailed analysis is contained in other chapters of this document, particularly in Chapter 5, Current Conditions.

Location and Setting

The Crabtree Watershed is located in northwest Oregon in Linn County. The watershed is 100,022 acres in size and extends from the confluence of Crabtree Creek with the South Santiam River, five miles east of the city of Albany, to about 30 miles east into the Cascades Mountains. Elevations range from 240 feet in the Willamette Valley, to Crabtree Mountain (4436 feet) and Yellowstone Mountain (4316 feet), the highest peaks, located on the east end of the watershed (See Map 1, Location Map). The watershed is bordered by Franklin Butte, Rogers Mountain and Snow Peak on the north; Crabtree Mountain and Yellowstone Mountain on the east; and Bald Peter, Keel Mountain, Green Mountain and Round Mountain on the south side of the watershed. The Crabtree Watershed includes the communities of Crabtree and LaComb. The watershed is located within the Willamette Valley and Western Oregon Cascades Physiographic Provinces. Approximately 40 percent of the watershed is located in the Willamette Valley Physiographic Province and the remaining 60 percent is in the Western Oregon Cascades Physiographic Province (See Map 9, Spotted Owl Habitat Map).

Immediately to the east of the Crabtree Watershed is the Quartzville Watershed, which is part of the predominant north-south Late-Successional Reserve (LSR)/wilderness network of the Cascades Mountain Range, managed primarily by the U.S. Forest Service. The BLM lands in the eastern portion of Crabtree Watershed are contiguous with this LSR/wilderness network to the east. The crest of the Cascades is approximately 32 miles east of the Crabtree Watershed.

North of the Crabtree Watershed is the Thomas Creek Watershed, which is primarily private lands. To the north of Thomas Creek are the North Santiam River Corridor, and the cities of Lyons, Mill City, and Gates. To the north, about 10 miles across the North Santiam River Corridor, is the Little North Santiam Watershed.

South of the Crabtree Watershed is Hamilton Creek, a low elevation watershed comprised mostly of private lands in the foothills of the Cascades. To the south of Hamilton Creek and Crabtree Watershed are the communities of Lebanon and Sweet Home and the South Santiam River Corridor.

The western portion of the Crabtree Watershed and immediately to the west is the Willamette Valley floor. The Crabtree Watershed exhibits ecological characteristics of the Cascades Mountain Range as well as remnant habitats characteristic of the Willamette Valley. The majority of the native Willamette Valley habitats have been altered and currently consist of agricultural, rural and residential areas. Fragments of native Willamette Valley habitats consisting of grasslands, Oregon white oak savannahs, wetlands and hardwood types are still intact on non-federal lands.

Terrestrial

The array and landscape pattern of plant communities and their seral stages are a result of natural processes and human-caused disturbances. Fire has been the major short-term natural process. Human-caused disturbances are most commonly logging, fire, agriculture, mining, recreation facilities, and residential development.

The upper reaches of the Crabtree Watershed are managed as forest land, with agriculture dominating the lower elevation terraces and flood plains. Much of the forested areas within the watershed have been previously logged, and are in young to moderate aged stands of trees. The most extensive stands of mature forests in the watershed are located in the northeast portions of North Fork Crabtree sub-watershed on BLM lands.

Approximately 55 percent of the Crabtree Watershed are conifer types consisting mostly of Douglas-fir and western hemlock. Above 3000 feet, the cooler Pacific silver fir zone is composed of Pacific silver fir, noble fir, Douglas-fir, and western hemlock. About 34 percent consists of rural, residential, and agricultural lands, mostly in the Willamette Valley portion of the watershed. About 10 percent of the watershed are hardwood and mixed types consisting of red alder, bigleaf maple, hemlock and fir, with minor components of Oregon white oak and Oregon ash that occur in the lower portion, especially along the riparian areas.

The remaining one percent are non-forest types and natural openings in the forest environment, including special habitats such as meadows, wetlands, rock outcrops, cliffs, and talus slopes. The Crabtree Watershed is relatively rich in special habitats. Two significant special habitat complexes are located in the Crabtree Watershed. They are the Carolyn's Crown/Shafer Creek/Crabtree ACEC and the Snow Peak Habitat Complex. Many other special habitat features are found scattered throughout the Crabtree watershed. Among them are Buzzard Butte, White Rock Fen ACEC, and the Richardson Gap area.

Plant and animal species that occur in the Crabtree Watershed are fairly typical of those found in the Western Oregon Cascades and Willamette Valley Physiographic Provinces. Lists of plant and animal species including special status/special attention species that are known or highly likely to occur in the watershed are included in the appendices.

Aquatic

Hydrology and Water Quality

Crabtree Creek flows into the South Santiam River which, in turn, flows into the Santiam River, four miles west near the town of Jefferson. The Santiam River flows into the Willamette River north of Albany. The Willamette River Basin (WRB) is the largest river basin in Oregon, and drains 11,100 square miles, and is part of the Columbia River subregion. A large percentage of the state's population and major cities are located in the WRB, including Portland, Salem, Corvallis and Eugene. The United States Geologic Survey (USGS) has divided the WRB into hydrologic units and assigned each a Hydrologic unit code. The Crabtree Creek Watershed is located within the southeast section of the WRB, and is synonymous with the USGS fifth field unit 1709000602.

Although recent improvements in water quality have been achieved, the Oregon Department of Environmental Quality publication, *1988 Oregon Assessment of Non-point Sources of Water Pollution* (ODEQ), also known as the 319 report, recently identified the protection and enhancement of water quality in the WRB as one of the most critical long-range resource management issues currently facing the State of Oregon (Tetra Tech 1992). According to the ODEQ, water quality in upper Crabtree Creek is listed as being moderately impacted by turbidity, erosion, sediment, low dissolved oxygen, and low flows. The affected beneficial uses are fisheries, aquatic life, water recreation, irrigation, wildlife, aesthetics, and livestock.

The Crabtree Watershed includes Crabtree Creek and its tributaries which include (but are not limited to) Bald Peter Creek, Beaver Creek, Bonnie Creek, Camp Creek, Carter Creek, Church Creek, Green Mountain Creek, Hunter Creek, North Fork Crabtree Creek, Roaring River, Rock Creek, Shafer Creek, South Fork Crabtree Creek, and White Rock Creek. For the purposes of this analysis, the Crabtree Watershed was stratified into six sub-watershed basins (SWB), which will be used for future cumulative effects analyses. See Map 5, Sub-Watershed Basins Map. SWBs include Beaver Creek and Richardson Gap, which are primarily in the Willamette Valley Physiographic Province; Church Creek, Roaring River, and the North and South Forks of Crabtree Creek which are in the Western Oregon Cascades Province.

The climate in the upper elevations of the Crabtree Watershed is characterized by cool temperatures and heavy winter snowfall, while 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 62 inches in the mountains to 43 inches on the valley floor, with the greatest precipitation occurring November through January, and the least occurring June through September (Taylor 1992). Snow pack plays a minor role in overwinter storage of precipitation in the Crabtree Watershed.

Riparian and stream adjacent vegetation along many sections of Crabtree Creek have been removed by high flows and movement of sediment, large cobbles and boulders down the channel. Overstory vegetation along the upper reaches of Crabtree Creek are dominated by dense younger conifer stands, with some mature mixed stands. The lower reaches of Crabtree Creek are dominated by grasses and shrubs. The current riparian vegetation is heavily skewed toward younger stands, resulting in a lack of mature to late successional dominated riparian vegetation, and a lack of larger material available for recruitment as large woody debris. Large conifers are necessary for long-term stream structure, and are limited in the Crabtree Creek Watershed. The combination of a lack of woody structure and several torrential flow events in the early 1970s and 1996 resulted in some channelization of the streams in the watershed, and a further reduction of woody debris in the system. Channelized streams generally have higher high flows and greater velocity, lower low flows, few meanders, incised banks, uniform streambeds, and a shorter overall stream length.

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) and include series such as Chehalis and McBee silty clay loams. The Soil Conservation Service (SCS) publication *Soil Survey of Linn County Area, Oregon* (Langridge, 1987) described these series as poorly to well drained soils on flood plains and stream terraces. Upland soils in the higher elevations include series such as Keel gravelly silt loam, and Henline very stony sandy loam. These soil series are described as shallow to deep, well drained, cold soils of the western part of the Cascade Range. Lower elevation soil series include Klickitat stony loam, Kinney cobbly loam, Nekia silty clay loam, Philomath cobbly silty clay, and Dayton silt loams . These soils are moderately deep to deep well drained soils on the foothills of the Cascades (Langridge, 1987).

Slope stability and mass movement hazards exist in the Crabtree Watershed which have affected streams and water quality. See Map 15, Precipitation Zones/Slope Stability Hazard. Slope stability was based on slope hazard and stand age. Less than two percent of the forested acres in the watershed is considered to be unstable or potentially unstable (see Table 5-21). Earth flows and slumps occur in scattered areas of the watershed, and result in the delivery of soil material to streams through streambank erosion and slope failures. Slope failures occur on steep rocky mountainous terrain and include rockslides, debris avalanches and earth flows. These failures are capable of delivering large quantities of unconsolidated materials to major drainages in a short period of time, and are often associated with roads. Slope erosion occurs on exposed slopes, producing increased sediment loads and higher turbidities. Stream erosion and deposition are common within portions of the watershed resulting in higher turbidity, siltation of salmon spawning gravels, and a decrease in channel stability.

Fisheries

Winter steelhead trout (*Oncorhynchus mykiss*) and spring chinook salmon (*O. tshawytscha*) are the only anadromous salmonids native to the Crabtree Creek Watershed. Stocks of both species are in serious decline, and the native spring chinook are probably extinct. Planting of hatchery stocks of both species (including summer steelhead) has been extensive in the South Santiam Basin, including Crabtree Creek. Planting of non-native stocks has probably been detrimental to the native stocks due to hybridization and competition. The Oregon Department of Fish and Wildlife (ODFW) is trying to reestablish a run of spring chinook in Crabtree Creek by planting smolts and surplus adults from the South Santiam Hatchery.

The Roaring River Fish Hatchery is located in the Crabtree Watershed, and is involved with raising rainbow trout for the Catchable Trout Program. Stocking of nonnative resident fish in flowing waters statewide was discontinued in 1998 to comply with ODFW's Wild Fish Management Policy, which discourages release of catchable trout in anadromous waters. Hatchery rainbow trout are released in lakes and streams in Oregon that do not have anadromous fisheries, including Crabtree Lake. The Roaring River Fish Hatchery is also used for rearing summer steelhead from the South Santiam Fish Hatchery.

Stream habitat in the watershed is generally in a degraded condition from decades of land management practices such as timber harvest, road building, stream cleaning and conversion of forest lands to agricultural uses. Streams are lacking large woody debris which serves to create and maintain habitat complexity, increases the retention of spawning gravel and nutrients, reduces the velocity of high flows, provides instream and overhead cover for aquatic organisms, and provides a nutrient base and/or preferred substrate for many taxa of aquatic invertebrates.

Social

The Willamette Valley has a long history of human habitation. Evidence suggests the Willamette Valley may have had human inhabitants as early as 10,000 years ago. Sites dating to about 8,000 years ago occur along the South Santiam River with artifacts indicative of hunting. At the time of Euro-American exploration and settlement, the Kalapuya Indian groups lived in the Willamette Valley along the Santiam and Molalla Rivers, and on the slopes of the western Cascades. The Kalapuya were known to have burned in the Willamette Valley to maintain habitat for favored plant and game animal species.

Today, a variety of human uses occur in the Crabtree Watershed. The predominant uses include industrial timber production, agricultural and livestock raising, residential and recreational use.

The east half of the Crabtree Watershed is dominated by private industrial forest land and BLM administered forest lands. Much of the agricultural and residential use occurs in the western portion of the watershed, in the Willamette Valley. Approximately 1,600 acres of BLM-administered lands are intermixed with agricultural and residential use in the foothills of the Cascade Range. These lands have been identified as having higher public sensitivity associated with timber and other resource management activities.

The Crabtree Watershed also offers a variety of recreational opportunities. Most of these opportunities occur in a setting that is characterized by a forested environment that has been significantly modified in many areas by timber harvest activities and high road densities. Recreational activities are primarily dispersed in nature, including camping, target shooting, hunting, and off-highway vehicle use. Problems with dumping, vandalism, and resource damage have resulted in the gating and blocking of several private and BLM roads in the watershed. Larwood County Park is the only developed recreation site in the watershed.

The majority of the roads in the watershed are surfaced by rock and passable by the average vehicle. There are also several lesser maintained roads and spur roads that offer more challenging driving experiences. Public vehicle access to public and private industrial landowners is limited by gates.

Respondents to a scoping questionnaire indicate that recreation opportunities, water resources, and forest health are important values. The comments reflected the need for balanced multiple use resource management, including sound forestry practices and preserving older forests.

Ownership

The Crabtree Watershed is 100,022 acres in size and includes 80,263 acres of private lands, 18,008 acres of Bureau of Land Management lands, and 1,751 acres of state lands. See Map 2, Ownership; and Figure 2-1, Ownership Acreages and Percentages in the Crabtree Watershed. Federal ownership in this watershed is considered to be relatively minor, with about 18 percent of the watershed managed by the BLM. The majority of the watershed is owned by private landowners, about half of which are industrial timber companies.

All of the 18,008 acres of federal lands in the Crabtree Watershed are managed by the Salem District BLM. These lands are managed according to the standards and guidelines of the *Salem District Resource Management Plan* (RMP) and the *Northwest Forest Plan* (NFP). There are

several Land Use Allocations (LUAs) within the Crabtree Watershed. The majority of BLM lands in the Crabtree Watershed (11,270 acres) are Matrix lands consisting of General Forest Management Area (GFMA) and Connectivity (CONN). There are 6,738 acres of Late-Successional Reserves (LSR), located mostly in the upper end of the watershed. Riparian Reserves overlay the Matrix and LSR. They have been identified as a buffer, based on site potential tree height, along all standing and flowing water, intermittent stream channels, ephemeral ponds, and wetlands. See Map 3, Land Use Allocations; and Figure 2-2, BLM Land Use Allocation Acres and Percentages in the Crabtree Watershed.

OWNER	ACRES	PERCENT
BLM	18,008	18
STATE	1,751	2
PRIVATE INDUSTRIAL	37,763	38
PRIVATE NON-INDUSTRIAL	42,501	42
TOTAL	100,022	100

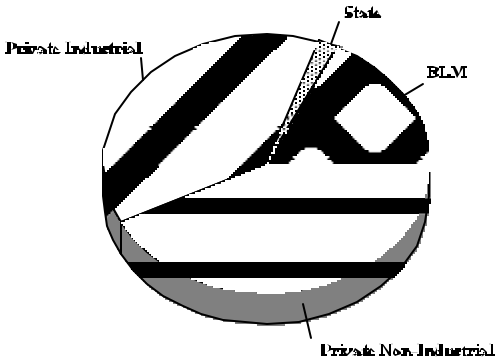

Figure 2-1. Ownership Acreage and Percentages in Crabtree Watershed.

LUA	ACRES	PERCENT
GFMA	7,209	40
CONN	4,061	23
LSR	6,738	37
TOTAL	18,008	100

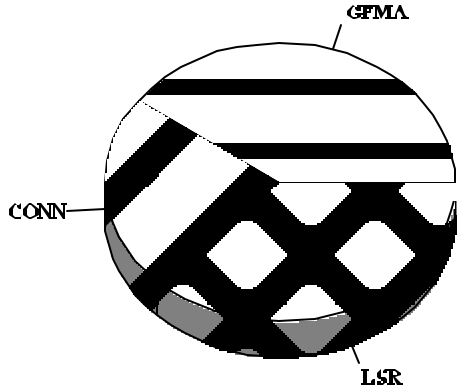

Figure 2-2. BLM Land Use Allocation (LUA) Acres and Percentages in Crabtree Watershed.

Table 2-1 Land Use Allocations for BLM Lands in the Crabtree Watershed.

Land Use Allocation	Outside Riparian Reserves		Inside Riparian Reserves		Total	
	% of All BLM	Acres	% of All BLM	Acres	% of All BLM	Acres
GFMA	23%	4,154	17%	3,053	40%	7,209
CONN	13%	2,281	10%	1,782	23%	4,061
LSR	20%	3,670	17%	3,068	37%	6,738
Total	**56%**	**10,105**	**44%**	**7,903**	**100%**	**18,008**

Chapter 3 Issues and Key Questions

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

- **Terrestrial**
- **Aquatic**
- **Social**

This first step in the process should answer the question *What is the condition of the watershed and how did it get this way?* The key questions for each resource category focus on a basic analysis of ecological conditions, processes and interactions at work in the watershed. An attempt to answer key questions is accomplished by gathering the current resource data available or by identifying data gaps. Current and reference conditions/trends and causal relationships are examined to the extent practicable for each of the resource categories. Answering the key questions provides the basis for recommendations which address the issues identified.

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.

Considerable overlap and interaction occur among the various ecosystem components within the three resource categories. For instance soil erosion affects both upland productivity and water quality. Riparian ecosystems are an interface between aquatic and terrestrial resource categories that affect both. There are upland terrestrial and aquatic wildlife and plant species. The grouping into resource categories was used purely as an organizational aid for easing analysis and promoting easier reading.

A scoping questionnaire seeking public input for the Crabtree Watershed analysis was sent out to landowners, residents, and interested parties during the spring of 2000. In addition, notification regarding ongoing watershed analyses was published in the Salem District Project Update, with contact email addresses and phone numbers. Respondents indicated that recreation opportunities, water resources, and forest health are important issues. The comments reflected the need for balanced multiple use resource management, including sound forestry practices and preserving older forests. This information was considered during the watershed analysis process and the formulation of the issues and key questions that follow.

Terrestrial Resources

Issue: What management opportunities exist for protecting, maintaining, and/or improving terrestrial resources in the Crabtree Watershed?

Discussion: Terrestrial resources include vegetation, plant communities, forest health, wildlife habitat and Special Status/Special Attention plant and animal species. Land management activities have altered the watershed, resulting in changes in distribution and patterns of occurrence of habitat and species. Terrestrial resources are also affected by natural processes such as natural succession and disturbance processes. How can NFP and RMP objectives associated with managing terrestrial resources best be met in this watershed?

Key Questions:

* What is the current condition of the terrestrial resources in the watershed?

* What are the dominant natural processes and how do they affect terrestrial resources?

* How have private and public land use practices influenced terrestrial resources and how will they in the future?

Aquatic Resources

Issue: What management opportunities exist for protecting, maintaining, or improving aquatic resources in the Crabtree Watershed?

Discussion: Aquatic resources include water quality and quantity, flood control, private and municipal water rights, fish species and instream habitat. Aquatic resources are affected by both physical conditions and natural processes such as hydrology, riparian condition, soils, erosion, and slope stability. Land management activities have altered the watershed resulting in declining fish runs, water quality and aquatic habitat degradation. Of specific concern is Crabtree Creek, which is listed by DEQ as water quality limited for summer stream temperature. Demands for aquatic resources are increasing and so are conflicts with other resource uses. How can NFP and RMP objectives associated with managing aquatic resources best be met in this watershed?

Key Questions:

* What is the current condition of aquatic resources in this watershed?

* What are the dominant physical conditions and natural processes affecting aquatic resources?

* How have private and public land use practices influenced aquatic resources and how will they in the future?

Social

Issue: What developments or other management opportunities exist to meet the demand for recreational and natural resource commodities in this watershed, while still providing resource protection consistent with the RMP?

Discussion: Social resources consider human uses including forest products, transportation, and recreation. The demands on watersheds to provide for a variety of human uses and products is increasing. This analysis will focus on the role that BLM-administered land, in this watershed play in meeting the overall demand for uses and products that were identified in the RMP. Meeting other resource protection and enhancement objectives must also be considered.

Key Questions:

* What are the major or human uses and where do they occur?

* What are the current and future trends related to human uses?

* What are the potential social or resource conflicts related to human uses?

Chapter 4 Historical Conditions

Introduction

Ecosystems are not static, but vary over time and space. This dynamic nature of ecosystems exemplifies the need to consider ranges of conditions over time, rather than single points in time.

The following narrative explains how ecological conditions have changed over time due to natural disturbances and human influences. This information is used to explain existing conditions and predict potential trends.

Geologic History

Creation of the Cascade Mountains began 40 million years ago during the Eocene era when the oceanic Farallan plate began under thrusting the North American continental plate at a shallow angle and at a rapid rate (3 inches/year). 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. 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 mid-Miocene periods (22.5 to five 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. As recently as seven million years ago, the volcanic belt had narrowed to a band as wide as the present day High Cascades Range.

Located within the western Cascades and Willamette Valley Physiographic Provinces, the Crabtree Watershed is mainly composed of basalt, andecite, and pyroclastic deposits in the headwater reaches of the watershed, and nonmarine terrace and alluvial deposits in the lower elevation western reaches.

Terrestrial

Disturbance Regimes and Ecological Effects

There are many disturbance factors that operate within the Crabtree Watershed. These factors include wind, fire, floods, insects, disease and humans. Today, humans are the agents of greatest disturbance in the landscape. In the past when human population levels were low, fire was the primary disturbance factor.

Fire Ecology

Fire is the primary natural disturbance factor over the landscape that causes the greatest ecological effects over space and time. Understanding basic fire ecology terminology is helpful in understanding fire effects on the ecosystem 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 over a given area. 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.

The source of fire ignitions comes from two primary sources, lightning and humans. Lightning is the primary source of wildfire ignitions in the Pacific Northwest and humans the secondary cause.
Occurrence or patterns of lightning fires are determined by regional climate, land forms, elevation, aspect, and fuel type. Human caused fires can be a result of 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 Crabtree Watershed, lightning starts occur more frequently in the east portion of the watershed at higher elevations. On the west side of the watershed human caused ignitions at the lower elevations are the primary source of fires.

Willamette Valley Province

The Crabtree Watershed is located within the Willamette Valley and western Oregon Cascades Physiographic Provinces. There has been a greater departure from historic conditions in the Willamette Valley portion of the watershed. Historically, native habitats in the Willamette Valley consisted of grasslands, Oregon white oak savannahs, and wetlands. Mixed hardwood/conifer forest types were more predominate in the past. These forest types consisted of a diversity of tree species such as Oregon white oak, Oregon ash, bigleaf maple, red alder, black cottonwood, Douglas-fir, western hemlock, and ponderosa pine. The majority of native Willamette Valley habitats have been altered and currently consist of agricultural, rural and residential areas. Decline of native ponderosa pine and Oregon white oak has mostly been due to harvest and habitat conversion. Fragments of native Willamette Valley habitats are still intact on non-federal lands.

The oak savannah/prairie ecosystem in the Willamette Valley portion of the watershed was influenced by Native American burning. 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 prior to Euro-settlement. Native Americans used fire to manipulate the ecosystem to provide safety from warring tribes, better game forage for game management, to maintain traditional food sources and ease of travel. This use of fire extended up major river drainages such as the Santiam and Mckenzie rivers and extended into the foothills of the Cascades and Coast Range (Boyd 1986). This influenced the ecology of the foothill forests and valley floor. At the same time fire occurred naturally, primarily from lightning.

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 prior to Euro-settlement. This use of fire to manipulate their environment extended up major river drainages such as the Santiam and Mckenzie rivers and extended into the foothills of the Cascades and Coast Range (Boyd 1986).

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 due to fire suppression. 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, prairies and undisturbed low elevation wetlands are among the rarest habitats in this watershed.

In the past, the Native American use of fire maintained prairie and oak-savannah habitats. Today, most of these native Willamette Valley habitats have been converted to agricultural/rural areas. Due to fire suppression, the remaining oak savannah began changing to a conifer ecosystem, especially in the foothills of the Cascades and Coast Range. The habitat for native vegetation in the Willamette Valley began to degrade. Trees encroached on native habitats and hydrological processes were altered through road construction and wetland conversion to agriculture. Human disturbance has created seed beds for exotic species through soil disturbance and roads have provided travel corridors for exotic plant species. As a result, human disturbance has provided excellent opportunities for invasive plant species to become established in the ecosystem, thus competing with native vegetation.

Western Oregon Cascades Province

Much of the information on disturbance processes for the Western Oregon Cascades Province comes from the Mid-Willamette Late-Successional Reserve Assessment (LSRA, 1998). In that assessment, there are two major plant association groupings in the Cascades portion of the Crabtree Watershed; the warm/moist western hemlock/Pacific silver fir, and dry western hemlock/Pacific silver fir plant associations. There is a specific fire regime for each of the two plant associations. The fire regimes are based on the physical factors of: elevation, aspect, topography, climate and weather patterns. These factors have significant effects on fire behavior, which affects fire regime, and therefore fire history (Teensma 1987, Morrison and Swanson 1990, Garza 1995, Weisberg 1997).

The fire regime associated with the **warm/moist western hemlock/Pacific silver fir plant association** is characterized by average low frequency (>200 years) stand replacing fires; moderate frequency (80-200 years) partial burns. The dominant early seral species regenerating after a stand replacement disturbance in this regime is Douglas-fir. Western hemlock and western red cedar may be components in developing stands in the western hemlock type. Pacific silver fir and noble fir may be components of developing stands in the Pacific silver fir type. One or two intermediate disturbances may occur over the life of the stand. These disturbances can kill the fire intolerant western hemlock and Pacific silver fir while only slightly affecting the tolerant Douglas-fir. Post-fir seedbeds will vary, with western hemlock and Pacific silver fir able to regenerate under more shady conditions than Douglas-fir. These intermediate disturbances serve to increase the within as well as between, stand heterogeneity. Most stands in this regime reach classic old-growth conditions of multiple layers, large snags and downed wood. The fire pattern for this fire regime is one of stand replacement fires that occur over large areas (greater than 1000 acres) of the landscape infrequently, creating large, early seral patches. Partial burns and under burns occur in a more variable pattern, creating gaps and heterogeneity across the landscape.

The fire regime associated with the **dry western hemlock/Pacific silver fir plant association** is characterized by average moderate frequency (80-200 years) stand replacing fires; average moderate frequency (80-200 years) partial burns. The dominant early seral species regenerating after a stand replacing disturbance is Douglas-fir. Western hemlock and western red cedar may be components of developing stands. Some stands in this regime reach classic old-growth conditions of multiple layers, large snags and downed wood. Some stands may not develop multilayered canopies before experiencing another stand replacing event. One or two events may occur over the life of the stand. These disturbances can kill the fire intolerant western hemlock and western red cedar, while only slightly affecting the fire tolerant Douglas-fir, leaving remnants of various densities. Post fire seedbeds will vary, with western hemlock able to regenerate under more shady situations than Douglas-fir. These intermediate disturbances serve to increase the within as well as between, stand heterogeneity. Pacific silver fir, noble fir and Douglas-fir commonly regenerate after a stand replacing fire in the Pacific silver fir type. Intermediate disturbances have a variety of effects in this zone. Pacific silver fir, having thin bark and shallow roots, is very susceptible to mortality. Noble fir is moderately susceptible (especially when young), and Douglas-fir is quite fire tolerant. Partial stand replacing fires are

quite variable, leaving patches of live stands interspersed with areas of high mortality. Stand replacement fires occur over large areas (greater than 1000 acres) of the landscape at moderate frequencies (80-200 years) creating large, early seral patches. Partial burns and under burns occur in a more variable pattern, creating gaps and heterogeneity across the landscape.

Historically, large blocks of older forest dominated the Cascades portion of the watershed. The watershed was unroaded until relatively recent times, and direct influences from human disturbance was minimal. Fragmentation was less and connectivity of habitats was higher, resulting in better wildlife dispersal capabilities across the landscape.

Fire left a mosaic of forest types, seral stages and a legacy of structural diversity across the landscape. The result was multilayered canopies, high numbers of standing dead trees, downed logs and coarse woody debris (CWD), and a prolonged stand 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 much of the structural diversity components. Where fire gave diversity and complexity yielding stability, timber harvest gave the forest simplicity and instability. Timber harvest has changed the forest to a less complex system. Fire has been virtually eliminated from the ecosystem.

With the harvest of trees, the amount of older forest, standing dead and down CWD components of wildlife habitat have decreased. As a result, within stand diversity has decreased and between stand diversity has increased. Timber harvest and road construction has increased the amount of high contrast edge and isolation of remaining patches in the watershed. Harvest patterns along property boundaries have disrupted travel corridors and decreased connectivity of habitats resulting in poorer wildlife dispersal capabilities. As a result of commercial forestry, the regeneration period has been shortened resulting in a proportionately higher amount of mid seral stages across most of the watershed (see Map 8, Seral Stages).

Wind Events

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. 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.

Blowdown is sometimes associated with timber harvest activities which cause fragmentation across the landscape. Blowdown as a result of past timber harvest has occurred in the Crabtree

Watershed, however, based on wind patterns, topography and past events, blowdown in the Crabtree Watershed has not proven to be a serious problem.

Insects and Pathogens

Insects and pathogens are important components of western Oregon's forested ecosystems. Insects function in forest dynamics as defoliators, decomposers, pollinators, and prey or hosts to other species such as birds, amphibians, and other insects. The diversity and community composition of insects and pathogens influences processes such as nutrient cycling, plant population dynamics, and predator-prey interactions. From the silvicultural perspective, insects and pathogens can affect tree growth rates, stand structure, fire hazard, recruitment and decomposition of CWD. Insects and pathogens can profoundly affect and on occasion actual become disturbance processes in the forest environment.

Insects

Much of our current understanding about insects comes from studies conducted on the H.J. Andrews Experimental Forest (HJA), located on the Blue River Ranger District of the Willamette National Forest. Over 3,400 insects have been documented from the HJA, and this may represent only half of the total species actually present (Parsons et al. 1991). Of these 3,400 species, 523 moth species (order *Lepidoptera*) have been recognized. *Lepidoptera* are vital components of food webs by serving as the primary food resource for bats and passerine birds.

Studies on the HJA also show that insect diversity and functional diversity are much higher in canopies of old-growth trees compared with those of young trees (Schowalter 1989, 1995). In addition to being more diverse, mature and old-growth stands are less susceptible to insect outbreaks, and therefore typically suffer less defoliation than young stands (Schowalter 1989). Forests management activities such as selective logging, fire suppression, and seedling planting have proven vulnerable to mountain pine beetle *(Dendroctonus ponderosa*e), western spruce budworm *(Choristoneura occidentali*s), and Douglas-fir tussock moth *(Orgyia pseudotsugat*a).

Although several thousand insect species inhabit our forests, it is only a few species, primarily specific bark beetles *(Coleoptera)* and defoliating caterpillars *(Lepidoptera)*, that significantly affect growth and survival of conifers and thus receive the most attention.

Douglas-fir beetle *(Dendroctonus pseudotsugae)* is present and widespread throughout our forests. Its populations are maintained at low levels in root disease pockets or on scattered dead or down trees. Endemic populations (i.e., low, relatively static numbers, which cause relatively insignificant amounts of damage) can build up to epidemic levels (i.e., high numbers that cause

readily noticed or significant damage) following windstorms with significant blowdown. Data from 50 years of aerial surveys, conducted to detect insect-caused mortality, indicate notable increases in Douglas-fir beetle caused mortality every eight to twelve years, usually two years after stormy winters. Impacts range from scattered mortality (one tree killed per four acres) over large areas to concentrations of 5 to 20 trees killed per acre in areas 1 to 50 acres in size.

An outbreak of mountain pine beetle *(Dendroctonus ponderosae)* in western white pine occurred in the Cascades during the late 1960s. As a result, western white pine populations have dropped significantly below historic levels.

Balsam wooly aphid *(Adelges piceae)* is an exotic insect, introduced into the Pacific Northwest during the 1920s on true firs in the Willamette Valley, which gradually spread to the Cascades. During the 1960s, it caused extensive areas of Pacific silver fir mortality at high elevations to the east of the Crabtree Watershed. While this insect has had little influence recently, it had a profound influence on the structure of high elevation stands closer to the crest of the Cascades Mountains.

Pathogens

Similar to insects, there are relatively few fungi species that are considered to be a problem in the forest environment. Of the more than 100,000 species of fungi, only a small fraction (< 200 species) can cause serious damage.

Laminated root rot *(Phellinus weirii)*, a native disease that affects many conifer species, is a very widespread disease of Douglas-fir in the western Cascades. Various surveys show that laminated root rot is patchily distributed and occurs at endemic levels in Douglas-fir forests. Trees killed by the disease provide snags and down logs, which benefit many wildlife species. Management of forests on short rotations and replanting with susceptible species such as Douglas-fir tends to favor the disease. Current management emphasizes planting or retaining resistant or immune species such as western white pine, western red cedar and red alder.

White pine blister rust *(Cronortium ribicola)* can infect nearly all the 5-needle pines including western white pine. Western white pine is a minor component in the Crabtree Watershed. As a result of white pine blister rust and an outbreak of mountain pine beetles *(Dendroctonus ponderosae)*, western white pine populations in the Cascades have dropped significantly below historic levels. Current management emphasizes planting genetically developed blister rust resistant pines in harvest areas.

Swiss needle cast *(Phaeocryptopus gaeumannii)* is a native fungal pathogen that occurs only on Douglas-fir. Until the 1980s, this defoliator was considered a problem only in Christmas tree plantations. Since then, it is estimated that Swiss needle cast has reduced the total growth of Douglas-fir by 25 percent in coastal Oregon. While this pathogen rarely kills, it has the capacity

to severely retard Douglas-fir growth, enabling insects and diseases to kill weakened trees. Symptoms caused by Swiss needle cast are common in low elevation plantations in the Crabtree Watershed. Currently, these symptoms can be described as low to moderate with isolated pockets where severe symptoms are evident. The problem is not as severe in the Cascades as it is in the Coast Range of Oregon. Plots to monitor the disease are being established in the Oregon Cascades.

Other pathogens would include Annosus (*Fomes annosus*), which is widespread in hemlocks and true firs with bark damage. Dwarf mistletoes (*arcuethobium spp*.), cause reduced growth and deformities in western hemlock, and to a lesser extent true firs and Douglas-fir. Armillaria (*Armillaria spp*.) is a root rot most significant in young Douglas-fir. Brown cubical rot (*phaeolus schweintzii*) and red ring rot (*Fomes pini*) are problems in older Douglas-fir stands. Black stain root disease (*Ceratocystis wagnerii*) and Rhabdocline needle cast (*Rhabdocline pseudotsugae*) are problems in young Douglas-fir stands.

Wildlife Habitat

The departure from historic disturbance regimes addressed in the previous section has affected the abundance and distribution of wildlife species throughout the Crabtree Watershed. Species that find their optimum habitat in components of older forest (late seral) have been adversely affected through harvest or degradation of preferred habitat and fragmentation. 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 changes in disturbance regimes.
Some species present during historic times have been greatly reduced in numbers or extent, or no longer occur in the watershed due to direct human impacts. Species such as the fisher, gray wolf, and the western rattlesnake no longer occur, or their populations are greatly reduced. Nonnative species such as the bullfrog, starling, house sparrow, opossum, Norway rat, eastern cottontail and nutria have displaced some native species. These species are often associated with human altered environments such as agricultural, rural and urban areas. Impacts from nonnative species are especially acute in the Willamette Valley province where these altered environments occur.

Aquatic

Hydrology / Water Quality

Stream channel morphology reflects a channel systems ability to transport or store inputs of water, sediment, and wood. Differences in channel slope, flow, depth, sediment supply, and

large woody debris affect a channels sensitivity to changes in inputs (Washington Forest Practices Board, 1993).

Limited stream gauging data exists for the Crabtree Watershed. However, significant flood events are known to have occurred in the South Santiam sub-basin as long as records have been kept. The most recent major floods recorded in the watershed were in December 1964, and February 1996. Floods are often a result of warm storms, heavy rain and snow pack at lower elevations, resulting in the generation of large volumes of runoff in a short period of time. The amount of snow pack, and the time required for runoff to reach a stream are affected by the number and size of openings in the natural forest canopy, and the miles of road in the vicinity of stream channels. Openings in the forest canopy allow for a heavier snow pack to accumulate, when compared with a closed forest canopy.

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 much more quickly. The combination of harvesting and roads in small watersheds have been shown to increase peak flows, produce higher storm volumes, and produce earlier rises in stream flow response to storms (Jones et. al. 1996).

Historically, disturbance in the watershed prior to European influence is thought to be due mostly to fire. The Native Americans used fire to manipulate the lower reaches of the watershed, and maintain a prairie ecosystem. The upper reaches of the watershed were characterized by natural moderate frequency partial burns and low frequency stand replacement fires. These disturbances would have affected stream channels, flows, and water quality, and provided woody debris and gravels to streams. The natural disturbance cycle was long enough to allow recovery of the stream system in-between fire events. This type of disturbance is different from the disturbance cycle seen in the watershed currently. Harvesting is almost constant, forming a patchwork of stands of varying ages. Roads provide continual disturbance, change the hydrologic response to storms, and the input of sediment to streams. The historic low to moderate frequency of disturbance in the forested reaches of the watershed have been replaced by chronic, constant disturbances, and has affected the character and morphology of streams.

Soils

Slope Stability

The relationship between pyroclastic rock and slope stability was studied by the USFS on the H.J. Andrews Experimental Forest by Dyrness (1967). In this study, 94 percent of mass soil movement events occurred on the 37 percent of the area made up of pyroclastic material, and 6 percent of the area made up of green tuff and breccias.

Comparative rates of soil movement from various land uses have been inventoried over a 25-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, 2.45 cubic meters per hectare per year for clearcuts , and 26.19 cubic meters per hectare per year associated with roads. 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.

Fisheries

Historically, winter steelhead trout (*Oncorhynchus mykiss*) and spring chinook salmon (*O. tschawytscha*) were the only anadromous salmonids that could migrate over Willamette Falls into Crabtree Creek. Both species used Crabtree Creek for spawning and rearing. Spring chinook would enter the Santiam sub-basin in May and hold in large, deep mainstem pools until they spawn in the early fall. Winter steelhead would enter the sub-basin from March through May, and spawn immediately upon reaching their spawning grounds. Adults that survived the spawning process would return downstream to the ocean. Pacific lamprey (*Lampetra tridentata*) also were capable of ascending the falls and entering the upper Willamette River tributaries, but little is known about their historic distribution or abundance.

The Santiam sub-basin provided the majority of the winter steelhead production and about one-third of the spring chinook salmon production in the Willamette Basin (Wevers, et al. 1992). Up to two-thirds of the Santiam sub-basin steelhead production occurred in the upper portions of the North and South Santiam rivers. The remaining production occurred in the lower foothill tributaries including Crabtree Creek. Little information is available regarding historic abundance of steelhead and chinook in Crabtree Creek, however, they are believed to have been plentiful. Historically (and currently) upstream migration of chinook in mainstem Crabtree Creek has been blocked by a barrier waterfall at approximate river mile (RM) 33. Chinook are not suspected to have historically utilized any Crabtree Creek tributaries. However, in a summary report for a stream survey conducted on Crabtree Creek by the U.S. Fish and Wildlife Service (USFWS) in 1940 the author wrote "...salmon get way up into the upper portions of Crabtree, Bald Peter and South Fork Creeks and a few are even said to ascend Rock Creek" (McIntosh et al. 1994). Whether the word "salmon" was used generically to include steelhead is unclear.

Steelhead are suspected to have had access up to another waterfall at approximate RM 34.5. Tributaries known to have been accessible to steelhead are Beaver Creek, Roaring River, Rock Creek, South Fork Crabtree Creek and Bald Peter Creek. Other tributaries that may have been accessible to steelhead are Church Creek, Hunter Creek, Green Mountain Creek and White Rock Creek. No information is available regarding historic or current anadromous fish use of Beaver Creek. Roaring River, which enters Crabtree Creek at approximate RM 15, is said to have produced fair numbers of steelhead historically (Willis et al. 1960). In South Fork Crabtree

Creek, which enters Crabtree Creek at approximate RM 27, historic steelhead distribution is suspected to have extended to a barrier waterfall at approximate RM 2.2, as well as to approximate RM 2.5 in Bald Peter Creek, a tributary that enters South Fork Crabtree Creek at approximate RM 0.25.

In the1940 USFWS stream survey, the surveyors reported seeing coarse scaled suckers, shiners, chubs, sculpins and trout at varying levels of abundance (McIntosh et al. 1994). Resident rainbow trout have been stocked in Crabtree Creek since the 1920s, although the numbers of fish are unknown. Stocking of nonnative resident fish in flowing waters statewide was discontinued in 1998 in order to comply with Oregon Department of Fish and Wildlife's Wild Fish Management Policy. Rainbow trout have also been stocked over the years in Crabtree Lake.

Much of the most productive habitat in the Santiam sub-basin has been blocked by dams on the North, South and Middle Santiam rivers. Detroit Dam and the downstream Big Cliff Dam, constructed in 1953 on the North Santiam, and Foster and Green Peter dams, constructed in 1968 on the South and Middle Santiam rivers, have blocked anadromous fish passage to historic upstream spawning and rearing areas. As a result of these dams, wild anadromous fish production is restricted to lower mainstem and tributary streams, such as Crabtree Creek.

Hatchery production of spring chinook was increased as mitigation for the dams in the Santiam Basin. Hatchery stocks are derived primarily from native Willamette stock. In 1983 and '84, 150,000 and 196,000 spring chinook fry were released in Crabtree Creek. Spring chinook smolts were released in1984-87 (avg. 4,300/year), and in 1994-97 (avg. 20,000/year). In 1998, 40 surplus adult spring chinook from S. Santiam Hatchery were also released in Crabtree Creek. In 1975 and '76, 3.2 million fall chinook smolts were released in Crabtree Creek. Big Creek stock winter steelhead were released throughout the Willamette Basin in the 1960s through the 1980s. Roaring River was stocked with 12,000 Big Creek stock fingerlings in 1979, and Crabtree Creek received 61,000 in 1983 and 8,500 in 1985. Skamania stock summer steelhead were also widely released throughout the Willamette Basin during the 1970s and '80s, with Roaring River receiving an average of 5,600 fingerlings and smolts per year from 1977-80.

Fish Habitat

Crabtree Creek and many of its tributaries were surveyed in 1940 and 1950 by USFWS personnel. Personnel of the Oregon Fish Commission surveyed the mainstem from the mouth of Roaring River upstream six miles in 1951, the lower two miles of the South Fork in 1954 and 34.5 miles of the mainstem in 1959 (McIntosh et al. 1994; Willis et al. 1960). Most of the information contained in the survey reports is in narrative form, and is mainly focused on investigation of the potential for increasing the range of anadromous fish, looking for potential

impoundment and hatchery sites as well as barriers to fish passage and water diversions.

Anadromous and resident fish existed in streams that would have had an abundance of large persistent wood. Log jams were likely common, particularly in the low gradient (<2%) sections. Woody debris provided instream cover and helped 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 more complex, with water flowing around boulders and large pieces of wood. Side channel and off channel habitats were common in low gradient areas.

Riparian areas in the lower portion of the watershed were likely composed of mixed hardwoods and conifers. Above the point where the valley begins to constrict (approx. RM 21), riparian areas would have been dominated by older coniferous forests, with some alder and maple along the stream corridor.

Stream temperatures were likely cool in the summer, supporting strong populations of spring chinook that would enter the Santiam sub-basin in May and hold in large mainstem pools until they spawned in the fall, requiring deep, cold water pools for holding during summer months. Periodic fires, often followed by landslides, would have had a negative effect on salmonids due to increased sedimentation and increases in water temperature. However, due to the biotic diversity brought about by fire in the landscape, there were likely places where some fish could escape the impacts of these events.

A diversion canal, supplying the community of LaComb with irrigation water is located at RM 23.5. In the 1940 and 1959 surveys the diversion was not screened, and probably resulted in the loss of considerable numbers of fish. In the 1959 survey report the author wrote " . . . adult steelhead, as well as fingerlings, have been reported in the irrigation ditches" (Willis et al. 1960). In the 1940 survey, several other diversions (all unscreened) for irrigation and mill ponds were noted.

Log driving is known to have occurred on Crabtree Creek at least as early as 1892 and continued until at least 1906, probably later (Farnell 1979). Log drives and the associated splash dams that probably would have been necessary to drive logs on a stream the size of Crabtree Creek would have had serious adverse effects on instream habitat conditions for fish.

Social

Prehistoric Human Activities

Within the boundaries of the Crabtree Watershed area, 29 archeological sites and seven archeological isolates (areas with single or few artifacts) have been recorded on BLM-

administered lands. Two of these sites appear to date to the Middle Archaic Period, a long period that started about 6000 years ago and ended about 2000 years ago with the advent of bow and arrow technologies. Four sites and two isolates appear to date to the Late Archaic Period which runs from 2000 years ago to approximately 200 years ago. The majority of the other sites have not been dated and may be undatable with current methods. Prehistoric activities appear to have been particularly focused toward Snow Peak and its immediate vicinity and around Crabtree Mountain and the surrounding area. All of the recorded sites have been disturbed by timber harvest and road building activities to some extent.

Excavated sites from the South Santiam area indicate that people have used that portion of the Cascade Range for at least the past 8000 years and scanty Clovis Period finds in the Willamette Valley indicate that there may have been a human population in the valley by 10,000 years ago. Early Archaic sites (8000 to 6000 years ago) are well documented in the valley and by the Middle Archaic, a large number of sites are known.

The sites in the Crabtree Watershed consist of lithic scatters most often with no tools recorded on sites. Those sites with recorded tools typically have scrapers, knives, projectile points, choppers, core tools, and utilized flakes. Stone material utilized include jasper, chert and less commonly, obsidian. These lithic scatters appear to be small camp sites with the majority of tools being associated with hunting activities. Jasper and chert are local to the Crabtree Watershed while obsidian had to be obtained by trade or travel to eastern Oregon. Some of the sites appear to run along ridgelines where later settler trails developed suggesting that the settler trail was aboriginal in origin and that the sites are aboriginal campsites on an established east-west travel route. Overall, prehistoric sites in the Crabtree Watershed likely represent the upland activities of people whose main bases were in the Willamette Valley. Such tools as are visible on the sites are typical to hunting, which during ethnographic times was a Fall activity, and travel for trade purposes. Ethnographic information also includes descriptions of the area being used for huckleberry picking.

Historic Native American Use

The Crabtree Watershed falls within the historically recorded territories of the Santiam Kalapuya and the Molalla Indians. This information was collected by anthropologists early in the 1900s and describes the Santiam Kalapuya and Molalla Indian's way-of-life, prior to contact with settlers.

The Kalapuya maintained permanent villages in the Willamette Valley and lower reaches of Willamette tributaries. Their subsistence activities were closely tied to various plants available in the Willamette Valley, particularly camas and tarweed, and family groups moved to temporary camps from March to November to harvest various plant resources. During their seasonal round however, from late summer into early fall, some small groups embarked on hunting, fishing and berry picking expeditions into the Cascade and Coast Ranges while others remained near plant resources in the valley. The Kalapuya are known to have deliberately set fire to the dry prairie of the Willamette Valley for a number of resource management purposes, including manipulating habitat for hunting, promoting favored plant species, and preparing tarweed for harvest. However, deliberate firing of lands outside the Willamette Valley themselves were not observed or recorded. Such fires may have been set in some areas to encourage huckleberry growth, most notably land now within Table Rock Wilderness Area, but this doesn't appear to have been widely practiced in the Cascades. Naturally occurring fires and escaped Indian campfires or runaway valley fires may have been adequate to maintain Cascade huckleberry habitat.

The Molalla Indians occupied the eastern and western slopes of the Cascades. Apparently always few in number but well established in the mountains, the Molalla wintered in small villages along the lower reaches of rivers in the Cascades and spent the summer at higher elevations hunting deer and elk and collecting roots and berries. The Molalla traded with the Klamath and other Indians on the east side of the mountains and intermarried with the Kalapuya. They may have served as a trade link between people east of the Cascades and west of the mountains. The time depth of the Molalla occupying the west side of the Cascades is in dispute. It is possible that they migrated west sometime during the 1810's as a result of a war between the Molalla and the Cayuse Indians. Whether the Molalla were residing or using the west side of the Cascades prior to that time has not been clearly determined.

Historic Human Use

Homesteading and Settlers

The first homestead claim filed in the watershed dates to the 1866 however, homesteading became more common in the late 1870s. In 1878, the Cyrus family homesteaded along Crabtree Creek. They raised sheep and milk cows and grazed their livestock along the creek and meadows. Nail built a cabin in 1878 in T. 12 S., R. 1 E, and later built a sawmill. Bante built a cabin in 1878 and homesteaded near Nail. By 1879, a few more cabins were being recorded on Government Land Office (GLO) survey maps and a number of settler's trails ran into and through the watershed.

The Camp Hamilton Trail was mapped in 1878 in T. 12 S. R. 1 E. Several homestead claims were made in 1883 and 1889 and accessed from the trail. Many of the earliest claims failed however and additional claims were made for the same parcel.

Fawn Heaven camp shown on 1879 GLO maps was in use seasonally by settlers. This camp did not show up on later maps. It probably was used by hunters and berry pickers.

The trail to Snow Peak, mapped by GLO surveyors in 1897, was one of the earliest trails in the Snow Peak area. The trail may have been aboriginal in origin. Indians and early settlers used Snow Peak for hunting and huckleberry picking.

Homesteading activities continued in the watershed through the 1920s and into the 1930s. Homesteads often included construction of a cabin, clearing of a small number of acres for cultivation, planting of fruit trees and raising of some livestock. Although many of these claims were ultimately abandoned, evidence of them sometimes still exists in the form of fruit trees, cabin ruins, trash dumps, and small grassy clearings.

A few grazing leases were let on the BLM-managed lands in the watershed. These occurred in T. 11 S., R. 1 E. between 1941 and 1950 and T. 12 S., R. 1 E. between 1941 and 1947.

Historic Fire Protection Activities and CCC Work

Systematic and widespread fire protection started in the watershed in 1911 with the activities of the Linn County Fire Protection Association (LCFPA). Lookouts were built on Snow Peak (1911), Green Peter (1912), Yellowstone Mountain (1921) and Bald Peter (1937). Trails in use by area settlers were improved and extended to construct and supply the lookouts and to staff and supply fire camps at Crabtree Guard Station, Snow Peak camp, Cougar Camp, Halfway Cabin and Four Corners on Thomas Creek. Camps were usually staffed from April through fire season. The LCFPA built trail shelters along trails for work and supply crews. Telephone lines were hooked up from Snow Peak Lookout, the first in the District, and connected to the LCFPA office in Mill City. In 1913, telephone lines were built along Green Peter Trail and ran by way of Crabtree Mountain, Yellowstone Mountain, Bald Peter and Foster to the LCFPA main station in Lebanon. Cabins or trail shelters for work crews occurred at 12-mile intervals along this trail. The trail ran to Cougar Camp via Crabtree Lake. Some residents in the area served as fire wardens for the LCFPA while other fire wardens were hired seasonally and stationed at camps.

The Civilian Conservation Corps (CCC) had a camp at Crabtree (later became Crabtree Guard Station) and Buzzard Butte in the 1930s. The camp at Crabtree was the CCC headquarters for the area. CCC crews improved fire lookouts and the system of trails used to supply lookouts and fire camps. As trails were upgraded into roads by the CCC workers, many of the earlier trails fell out of use and by 1941, access into the LCFPA facilities was by vehicle. The CCC crews also built cabins at Cougar Camp for fire crews.

Major trails of the LCFPA in the watershed include Roaring Creek Trail (Converted to a road by the CCC's in 1938), Snow Peak Trail (probably aboriginal in origin and improved by the CCC's in the 1930s until it was replaced by an easier route in 1941), Willamette Valley Mainline Trail, LaComb to Green Mountain Trail (put out of use by CCC construction of a new route), Bald Peter Trail (improved by CCC's), Green Peter Trail, New Mill City to Snow Peak Trail, and Monument Peak to Snow Peak Trail.

Historic Timber and Logging Activities

Portions of the watershed that were granted to railroads as part of the O&C railroad grant were eventually returned to federal ownership and became managed by the BLM. By township, logging activities commenced on BLM-managed lands in the Crabtree Watershed in the following years:

T. 10 S., R. 1 E., Lulay Brothers, 1929
T. 11 S., R. 1 E., H.C. Pyle, 1928
T. 11 S., R. 2 E., Willamette Valley Lumber Company, 1946
T. 11 S., R. 3 E., Willamette Valley Lumber Company, 1951
T. 12 S., R. 1 E., Ford Lumber Company, 1939
T. 12 S., R. 2 E., Hammond Lumber Company, 1940

The earliest mills in the watershed were probably Clark's Mill in Sec. 20, T. 11 S., R. 1 E. This mill was operating in 1878. In 1927, the Lulay Brothers railroad logged in the area out of their logging camp (Lulay Camp.) They began operating a saw mill there in the 1930s. Between 1928 and 1941, Henry Pyle operated a sawmill on his homestead and logged nearby government timber. Also operating a mill in the watershed was the Ford Lumber Company (1937-1943).

Chapter 5 Current Conditions

Introduction

The Crabtree Watershed is 100,022 acres in size and is located within the Willamette Valley and Western Oregon Cascades Physiographic Provinces. Elevations range from 240 feet at the confluence of Crabtree Creek with the South Santiam River in the Willamette Valley, to Crabtree Mountain (4,436 feet) and Yellowstone Mountain (4,316 feet), the highest peaks, located on the east end of the watershed. The watershed is bordered by Franklin Butte, Rogers Mountain and Snow Peak on the north; Crabtree Mountain and Yellowstone Mountain on the east; and Bald Peter, Keel Mountain, Green Mountain and Round Mountain on the south side of the watershed. The Crabtree Watershed includes the communities of Crabtree and LaComb.

The Crabtree Watershed was stratified into six sub-watershed basins (SWBs) which are delineated on Map 5, Sub-Watershed Basins. The Beaver Creek and Richardson Gap SWBs are primarily in the Willamette Valley Physiographic Province. The Church Creek, Roaring River, and the North and South Forks of Crabtree SWBs are in the Western Oregon Cascades Physiographic Province. Approximately 40 percent of the Crabtree Watershed is located in the Willamette Valley Physiographic Province. The remaining 60 percent is in the Western Oregon Cascades Physiographic Province. Federal lands in the watershed are managed by the Bureau of Land Management (BLM). The area of each SWB and percentages of the total watershed are displayed in Table 5-1, below.

Table 5-1 Sub-Watershed Basins of the Crabtree Watershed by Ownership Acres and Percent.

SWB	Federal Acres (% of SWB)	Non-Federal Acres (% of SWB)	Total Acres (% of WA)
Beaver Creek	1,988 (8%)	22,921 (92%)	**24,909(25%)**
Church Creek	3,826 (24%)	12,397 (76%)	**16,223(16%)**
North Fork Crabtree	8,435 (51%)	7,928 (49%)	**16,363(16%)**
Richardson Gap	742 (3%)	22,419 (97%)	**23,162(23%)**
Roaring River	2,322 (26%)	6,658 (74%)	**8,980 (9%)**
South Fork Crabtree	695 (7%)	9,689 (93%)	**10,385(10%)**
TOTALS	**18,008 (18%)**	**82,012 (82%)**	**100,022 (100%)**

Terrestrial

Vegetation Patterns

Information on vegetative conditions was derived from a variety of sources. BLM Forest Operations Inventory (FOI) records were used to depict vegetative conditions on BLM lands. Estimates of vegetative cover and stand conditions on BLM lands are expressed as existing in the summer of 1999. Vegetative condition on private lands was determined from aerial photograph interpretation using the Western Oregon Digital Imagery Project (WODIP). Estimates of vegetative cover and stand conditions on non-federal lands are expressed as existing in the summer of 1997. This information was developed for the evaluation of seral stage distribution and habitat conditions across the watershed. Harvest and other management activities conducted since then were not evaluated in this analysis.

Approximately 55 percent of the Crabtree Watershed are conifer types consisting mostly of Douglas-fir and western hemlock. About 34 percent consist of urban/rural residential, agricultural lands and roads, in the Willamette Valley (western) portion of the watershed. In the lower elevations of the watershed and along the riparian areas are hardwood and mixed types consisting of red alder, bigleaf maple, hemlock and fir, with minor components of Ponderosa pine, Oregon white oak and Oregon ash that comprise about 10 percent of the watershed. The remaining one percent consists of non-forest types such as barren, water, meadows, rock cliff/talus, and other natural openings in the forest environment. Map 6, Vegetation Cover Type, shows the locations of cover types in the watershed.

The forested portion of the watershed can be stratified into three plant association groups: Douglas-fir, western hemlock and Pacific silver fir series. Plant associations describe the potential dominant plant community (a combination of tree and shrub and/or herb layers) that would inhabit a site over time without any disturbance (Hemstrom and Logan 1986). A plant association defines a biological environment in terms of species' composition, productivity, and response to management. Knowledge of the presence and distribution of indicator understory species further refines the biological environment, allowing us to more accurately assess site potential.

Plant associations with similar attributes have been aggregated into groups. These plant associations groups have been arranged into "sub-series" based on the broad environmental conditions in which they are found. This is a key stratification in identifying the range of structural and compositional characteristics that can be expected under natural conditions on a given site. Table 5-2 characterizes the relationship between series, environment or sub-series environments, and plant associations found in the watershed.

The joint FS/BLM plant association modeling project does not extend all the way through the Willamette Valley. As a result, 28 percent of the watershed has no plant associations data coverage. This unmodelled lower portion of the watershed is 86 percent agricultural/non-forest and 14 percent forested lands. This forested portion has plant associations of Douglas-fir grading into western hemlock as elevation increases.

Table 5-2 Crabtree Watershed Plant Association Series, Sub-Series, & Indicator Species.

Series	Sub-Series or Environment	Understory Indicator Species Groups in Plant Associations
Douglas-fir	Low to mid-elevation on the driest environments supporting forest; these stands can grade into woodlands of Douglas-fir, Oregon white oak and pines.	vine maple; ninebark-dwarf Oregon grape; dwarf Oregon grape-swordfern-ninebark; ninebark-whipple vine; ninebark- grass; snowberry
Western Hemlock	Warm & Moist - More moisture than the Douglas-fir or Grand-fir zones. This area is warm, moist, productive; near riparian areas, toe slopes and up to mid slopes at low elevations.	dwarf Oregon grape/oxalis; Oregon oxalis; swordfern; twinflower; salmonberry-swordfern; foamflower; salmonberry-oxalis
Western Hemlock	Well-drained, dry - Mid to upper slopes in low elevations.	dwarf Oregon grape; dwarf Oregon grape-salal; rhododendron-dwarf Oregon grape; rhododendron-salal; rhododendron/twinflower; vanilla leaf; dwarf Oregon grape/vanilla leaf; twinflower; rhododendron-Alaska huckleberry/dogwood bunchberry; rhododendron/beargrass
Pacific Silver Fir	Mid to upper elevations where cooler temperatures and persistent snow packs shorten the growing season.	vine maple/coolwort foamflower; Oregon oxalis; coolwort foamflower; rhododendron-Alaska huckleberry/dogwood bunchberry; Alaska huckleberry/dogwood bunchberry; big huckleberry/beadlily; rhododendron-dwarf Oregon grape; big huckleberry/beargrass; rhododendron/beargrass

For the remainder of the watershed which is covered by the plant association modeling project,

western hemlock is the most dominant series present, occurring on 83 percent of the watershed. It occurs from low to mid elevation and up the major riparian areas. The western hemlock series can be further differentiated with 70 percent of the series being in the warm, moist sub-series and the other 30 percent in the drier, well-drained sub-series. The remaining 17 percent of the watershed which is covered by the plant association modeling project, is in the Douglas-fir series (5 percent), the silver fir series (11 percent), or non-forest types (2 percent). The Douglas-fir series occurs primarily on the lower elevation southern aspects while in the higher elevation 11 percent is in the silver fir series (over about 3000 feet), where noble fir is a component. The Late Successional Reserve (LSR) Land Use Allocation (LUA) is primarily within the silver fir series due to its higher elevation. Noble fir stands are most frequent in the vicinity of Snow Peak.

In addition, mixed hardwood stands consisting mostly of big leaf maple, red alder with some Oregon white oak, Oregon ash and black cottonwood comprise a minor component at low elevations and in riparian zones of larger order streams such as Crabtree Creek.

Seral Stages

Seral stage is an important component in describing the overall structure of the vegetation and patterns across the watershed. On federal lands, age class distribution has been categorized into age class bands corresponding to vegetative seral stage development. On non-federal lands, the WOODIP data yielded size classes which were correlated to seral stages. See Table 5-3, Seral Stage Definitions for Crabtree Watershed; Map 8, Seral Stages, and Figures 5-1, 5-2, & 5-3, Seral Stage Amounts by Ownership.

Table 5-3 Seral Stage Definitions for Crabtree Watershed.

Seral Stage	Age Class (Federal lands)	Size Class	Size Class
Open/Grass/Forb	**0 to 10 years**	**0**	**0**
Open sapling/brush	**10 to 40 years**	**1**	**less than 10 inches DBH**
Closed Sapling	**40 to 80 years**	**2**	**11 to 20 inches DBH**
Mature	**80 to 200 years**	**3**	**21 to 30 inches DBH**
Old-growth	**greater than 200 years**	**4**	**greater than 30 inches DBH**

Seral Stage	Acres
Old-growth	3,821
Mature	2,588
Closed Sapling	3,078
Open Sapling/Brush	7,641
Early-Grass/Forb	288
Nonforest	591

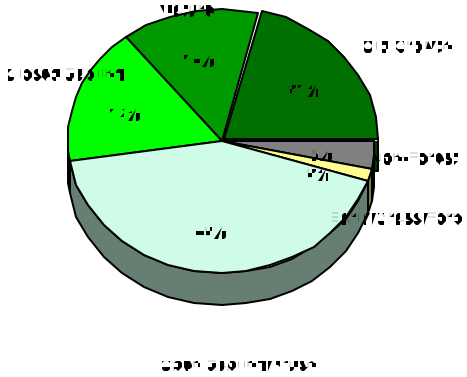

Figure 5-1. Seral Stage for BLM Ownership.

Seral Stage	Acres
Old-growth	3
Mature	4,269
Closed Sapling	22,762
Open Sapling/Brush	10,756
Early-Grass/Forb	9,839
Nonforest	34,376

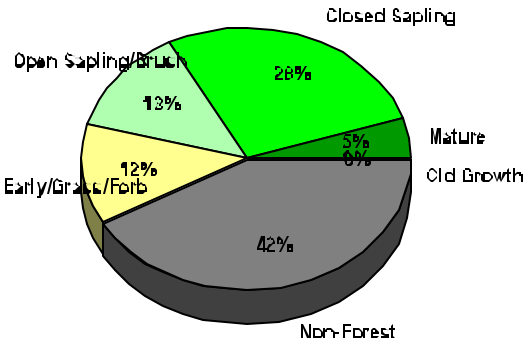

Figure 5-2 Seral Stage for Non-Federal Ownership.

Seral Stage	Acres
Old-growth	3,819
Mature	6,852
Closed Sapling	25,844
Open Sapling/Brush	18,395
Early-Grass/Forb	10,122
Non-Forest	34,990

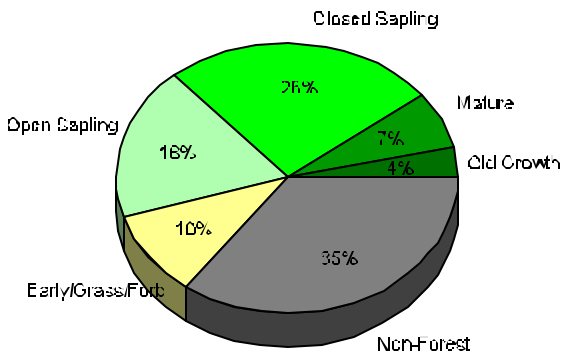

Figure 5-3 Seral Stages for All Lands.

Mature and old-growth forest are considered to be late successional (late seral) habitat. Late seral comprises about 11 percent of the watershed. Acres of late seral forest in the Crabtree Watershed were further broken down by ownership and SWB. Seventy percent of the late seral forest is in the North Fork Crabtree and Church Creek SWBs. Sixty percent of the late seral forest in the Crabtree Watershed is on BLM lands.

Seral stage amounts and distribution were further analyzed on federal lands and categorized by LUA. See Table 5-4, Seral Stage Acreage on Federal Lands by LUA. Late seral forests comprise 35 percent of the federal ownership in the watershed. Most of the late seral forest is located in LSR. Fifty-four percent of the LSR is in late seral forest conditions compared with 34 percent in Connectivity (CONN), and 19 percent in General Forest management Area (GFMA). Approximately 21 percent of the federal ownership in the watershed is in old-growth forests more than 200 years of age.

Table 5-4 Seral Stage Acreage on Federal Lands by LUA in the Crabtree Watershed.

Seral Stage		GFMA	%	CONN	%	LSR	%
Early/grass/forb		146	2%	57	1%	85	1%
Open Sapling/brush		3,205	44%	2,127	53%	2,309	35%
Closed Sapling		2,412	34%	460	11%	206	3%
Mature	Late Seral	939	13%	367	9%	1,282	19%
Old-Growth		440	6%	1,018	25%	2,363	35%
Non-forest		66	1%	31	1%	494	7%
Totals		7,209		4,061		6,738	

Late Seral Habitat Quality

Late seral forest within each SWBs was calculated and further analyzed for edge effects and fragmentation. Harvest patterns and natural disturbance in the past have created a mosaic of seral stages across the watershed. Where a late seral patch is surrounded by younger age classes, the edges of the patch exhibit environmental conditions that are different from the interior of the patch. As the amount of open area and edge increases, habitat quality declines for species associated with late seral forests and improves for species that are associated with edge and open areas. The amount of interior late seral forest in relation to the amount of total late seral forest gives some indication of the quality of existing late seral forest habitat and the influence of edge effects.

Edge on existing late seral forest was modeled to determine the amount of interior late seral forest and the influence of the edge effects. As a result of this analysis, it was found that 21 percent of the late seral forests in the watershed are interior forests. The majority of remaining interior late seral forest, about 1,135 acres, is found in the upper half of the watershed on BLM lands in the North Fork Crabtree SWB. The largest patches of interior late seral forest in the lower half of the watershed are found in Church Creek SWB in the Church Creek, Hunter Creek, and Hammond Camp areas. There are 860 acres of interior late seral forest in the Church Creek SWB. The remaining 140 acres of interior late seral forest habitat are scattered among the other four SWBs. Road locations were mapped to estimate the effect of roads on existing interior late seral forest. This analysis indicates that the late seral forest in the Crabtree Watershed is further fragmented due to edge effects created by existing roads, especially in the Church Creek, North Fork and South Fork Crabtree SWBs.

Overall, the quality of late seral forest habitat in the Crabtree Watershed is impaired by fragmentation caused by past harvest activity, especially in the Roaring River, Richardson Gap, Beaver Creek, and South Fork Crabtree SWBs. The highest quality late seral forests are located on BLM lands in the North Fork Crabtree SWB in LSR and Church Creek SWB in CONN; however, they are further fragmented by roads.

Landscape Structure

The structure and pattern of vegetation or habitats within an ecosystem such as a watershed, can be characterized in terms of patches, corridors, and a background matrix. The patterning of patches, matrix, and corridors across the watershed strongly influences the ecological characteristics, processes, and energy flows (Diaz and Apostol 1992).

The term 'matrix' in landscape ecology is defined as the most connected portion of the landscape, the vegetation type that exerts the most control over landscape function (Diaz and Apostol 1992). Patches are definable vegetative types that differ in their habitat characteristics from their surroundings. Patches vary in size, shape, type, heterogeneity, and the vegetative types that surround them.

In the Richardson Gap and Beaver Creek SWBs which comprise the lower portion of the watershed in the Willamette Valley, the matrix is non-forest, agricultural types with patches of forests in all seral stages, predominately in the upper elevations of both SWBs. In the Roaring River, Church Creek and South Fork Crabtree SWBs, the predominate matrix is closed sapling stands averaging 50 years of age. There is a significant secondary matrix of open sapling stands in these SWBs.

Patches of early seral stage and some mature comprise the rest of the South Fork Crabtree and Roaring River. Within the Church Creek SWB, there are patches of mature and old-growth forests within the CONN block. The North Fork Crabtree SWB has a matrix that is a combination of early open sapling stands, 20 years average age, in the northern portion and closed sapling, 50 years average age, in the southern portion. In the upper end, mature and old-growth forests comprise the predominate matrix surrounding Carolyn's Crown Area of Critical Environmental Concern (ACEC). The seral stage distribution in the watershed follows a general harvest pattern from lower to upper elevations in the watershed over time.

Mature and old-growth forests comprise about 11 percent of all ownerships in the watershed. Approximately 35 percent of the federal ownership in the watershed is in mature and old-growth (late seral) habitat. The majority is located in the upper end of the watershed in the North Fork Crabtree SWB in LSR. There is a significant block of mature and old-growth forest in the Church Creek SWB in the Church Creek, Hunter Creek and Hammond Camp areas in CONN. See Map 8, Seral Stages.

The drainages and their associated riparian/streamside vegetation provide corridors for wildlife movement. They flow from the eastern higher elevations through the watershed to the Willamette Valley Province to the west. The higher elevation ridge top areas connecting the peaks of the watershed also serve as flow corridors. The flow of the more mobile species of wildlife is from higher elevation to lower elevation in the fall/winter and to higher elevation in the spring. This corresponds to a poorly defined east/west flow across the watershed, presumably along drainages and ridge tops. Vegetation in natural corridors has been altered over time due to fire, past harvest patterns, and roads.

The Mid-Willamette LSR Assessment (LSRA) discussed connectivity in a larger scale than this watershed analysis. Connectivity can be described as the ability of a landscape to provide for species movement between refugia. Between LSR connectivity analysis showed that the Crabtree Watershed is an important link between the Quartzville LSR to the east and the Thomas Creek LSR to the north and west. However, connectivity of federal lands between the Quartzville and Thomas Creek is disrupted by the scattered ownership pattern. To the north of Thomas Creek are the North Santiam River Corridor, and the cities of Lyons, Mill City, and Gates.

The LSR lands in the eastern portion of the Crabtree Watershed connect with the contiguous LSR/wilderness network to the east, which includes the Quartzville Watershed. The Quartzville Watershed, immediately to the east of Crabtree, is part of the predominant north-south LSR/wilderness network which comprises the backbone of the Cascades Mountain Range. The Cascade Crest is approximately 32 miles to the east of the Crabtree Watershed.

To the south of the Crabtree Watershed is Hamilton Creek, a low elevation watershed comprised mostly of private lands in the foothills of the Cascades. To the south of Hamilton Creek and Crabtree Watershed are the communities of Lebanon and Sweet Home and the South Santiam River Corridor.

The western portion of the Crabtree Watershed and immediately to the west is the Willamette Valley floor. Connectivity is effectively cut off and the Willamette Valley acts as an effective barrier for many wildlife species. The Crabtree Watershed exhibits ecological characteristics of the Cascades Mountain Range as well as remnant habitats characteristic of the Willamette Valley, such as white oak savannah and grasslands.

Special Habitats

Special habitats are usually non-forest types such as meadows, wetlands, rock outcrops, cliffs, and talus slopes. They greatly contribute to the overall biodiversity across the landscape and are important for plants and wildlife. The Crabtree Watershed is relatively rich in special habitats. Two significant special habitat complexes are located in the Crabtree Watershed. They are the Carolyn's Crown/Shafer Creek/Crabtree ACEC and the Snow Peak Habitat Complex.

Many other special habitat features are found scattered throughout the Crabtree watershed. Among them are Buzzard Butte, White Rock Fen ACEC, and the Richardson Gap area. See Maps 19 and 23, Special Management Areas.

The Carolyn's Crown/Shafer Creek/Crabtree ACEC is a 1,222-acre biologically diverse habitat complex with a rich cultural and geological history. The area consists of a glaciated valley with streams, a lake, a vernal pond, and several forest communities. Within the glaciated valley is Carolyn's Crown, a cirque with steep, rocky sidewalls carved by glaciers. The basin has provided protection from wildfires for centuries, so that the area now contains one of the oldest communities of Douglas-fir, western hemlock and western red cedar that is estimated to be 400 to 600 years old. Many diverse habitats are present within this area. The near climax, multi species forest has an abundance of the classic old-growth components, such as large trees, large CWD and snags in various stages of decomposition, and a multilayered canopy with good vertical stand structure. There are both lentic and lotic aquatic habitats including a deep lake, shallow lake/wetland with springs, seeps, perennial and intermittent streams and associated habitats. Natural forest openings such as wet meadows, dry meadows, dry grass hillsides, Sitka alder/brush patches, cliffs, crevices and talus slopes are all present. There are alpine type meadows in the vicinity of Crabtree Mountain on the divide with the Quartzville Watershed. The presence of very old forests and the diversity of habitats present in close proximity at an elevation of 3000 to 4000 feet is unusual. The entire Carolyn's Crown/Shafer Creek/Crabtree ACEC is located in the North Fork Crabtree SWB within LSR.

The Snow Peak Habitat Complex is located on the northern edge of the Crabtree Watershed. The complex includes Snow Peak and the Anthus, Thomas Carin and Waldo Peak. In the immediate vicinity of the peaks are numerous dry meadows, rock outcrops, cliffs and talus slopes. At the base of the peaks are topographic bowls within which are wetlands, wet meadows, brush patches and a lake. The divide between Thomas Creek and Crabtree Creek watersheds bisects this ecosystem. Much of the Snow Peak Habitat Complex is within the Thomas Creek Watershed, including the head of Neal Creek, Ella Creek, Indian Prairie and Eleanor Lake. There has been more harvest activity on the north side in the past, and most of the complex in Thomas Creek is in early seral stages. The majority of the late seral forest is in the Crabtree Watershed to the south of Snow Peak on BLM lands. There are significant special habitats on the South side of Snow Peak, including wetlands, numerous rock outcrops and Snow Peak Meadows. Snow Peak Meadows is a series of natural openings and wetlands in topographic bowls at the base of Snow Peak. Portions of the Snow Peak Habitat Complex are in LSR, and portions are in GFMA and CONN, including Snow Peak itself.

Buzzard Butte is located in the Church Creek SWB, mostly on BLM lands. This peak rises to an elevation of 1320 feet and is known as a turkey vulture soaring and gathering area immediately adjacent to the Willamette Valley floor. Within the habitat complex are dry hillside meadows fringed with old-growth Douglas-fir and a hardwood component consisting of bigleaf maple and Oregon white oak. Buzzard Butte is primarily in GFMA, with minor portions on adjacent non-federal lands that have been recently harvested.

The Richardson Gap area is located in the lower end of the watershed in the vicinity of Richardson Gap, Franklin Butte and Rogers Mountain, mostly on private lands. Contained within these areas are remnant Willamette Valley vegetation types, including grasslands and oak-shrub types. Some native Willamette Valley bird species are known to occur here. The area has been identified as a Grassland Bird Conservation Area (BCA), according to the *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (American Bird Conservancy, March 2000). The purpose of the BCA concept is to focus conservation efforts on priority habitats and focal land bird species.

The White Rock Fen ACEC is located in the minor drainages at the upper end of White Rock Creek in the North Fork Crabtree SWB. The area is unique for its four sphagnum bogs which were created from ancient mass-wasting. Hydrologically, there is no similar configuration found on the Salem district. Sphagnum ecosystems are uncommon and provide very specialized habitat for uncommon plant and animal species. In addition, there are a number of wetlands, rock outcrops, cliffs, and talus habitats in the surrounding White Rock area.

Standing Dead and Coarse Woody Debris (CWD)

Standing dead and down CWD provide essential structure and functional habitat conditions for plant and animals in each seral stage. CWD is an important pool of energy, carbon, and nutrients in ecosystems and has an impact on site productivity. Data from inventory plots and stand exams were used to estimate the amount and condition of standing dead and down CWD across the watershed. The inventory and stand exam data for the watershed show that there are very few snags in 75 percent of the open or closed sapling stands. The other 25 percent of these stands have at least two snags per acre. Mature stands average almost eight snags per acre with 20 percent having no snags. Old-growth stands average 10 snags per acre and all plots had snags. Most of the mature and old-growth (late seral) stands are in the LSR in the upper end of the watershed. This indicates that there is a shortage of standing dead material in the remainder of the watershed, especially in younger stands. In the lower portions of the watershed, standing dead material is scarce.

Estimates of the amount and condition of down CWD were compared to the *Northwest Forest Plan* (NFP) standard of 240 lineal feet per acre of hard material more than 20 inches in diameter. The amount and condition of down CWD follow a similar pattern to standing dead material, with the good quality material in the upper end and a lack of high quality material in the lower portions of the watershed. Most of the open sapling stands have down CWD left from previous logging in the more advanced stages of decay, much of which is smaller diameter material. Twenty-six percent of the plots had no down CWD. In the closed sapling stands, 75 percent meet the NFP standard.

Another method of measuring down CWD is to measure percent of the ground covered by down wood. The standard of 240 lineal feet translates to approximately 0.8 percent. For the late seral stands in the watershed, the percent cover is between 2.3 and 2.6 percent. The recommendation in the LSRA translates to 10-15 percent ground cover of all diameters and species in the LSR. Since most of the late seral stands are in the LSR, they would fall below this recommendation, as would be the younger and mid-seral stands in LSR.

Overall, there is not enough large, harder material as either snags or down CWD that will persist in the long term, especially in the lower end of the watershed and in younger stands. Late seral stands in the LSR will no longer be mortality salvaged and closed forest stands will not be thinned without leaving a CWD component that meets the guidelines established in the LSRA. The LSRA guidelines will also be applied to treatments within Riparian Reserves. This material will be important for nutrient capital and future habitat for cavity and CWD dwelling wildlife species.

Roads and Transportation

The existence of roads have obvious physical effects on the ecosystem. The land area taken up in roads does not contribute to forested habitats. Run off from roads causes changes in water quality that effect aquatic and semi-aquatic vegetation and wildlife. The existence of roads causes edge effects and microclimate changes that affect plant communities and wildlife. In addition, open roads and road maintenance activities cause disturbance effects resulting from increased traffic and human intrusion. Roads also facilitate the spread of noxious weeds and exotic species. Roads in the watershed were mapped and are shown on Map 10, Transportation. Total miles of road and road densities across the Crabtree Watershed were calculated by SWB and ownership. See Table 5-5, Road Densities by SWB and Ownership in the Crabtree Watershed.

Table 5-5 Road Densities (miles/square mile) by SWB and Ownership in Crabtree Watershed.

SWB	Federal (BLM)	Non-Federal	Totals
Beaver Creek	3.40	2.41	**2.48**
Church Creek	5.12	4.74	**4.83**
North Fork Crabtree	4.39	6.09	**5.22**
Richardson Gap	5.22	2.63	**2.72**
Roaring River	4.87	4.17	**4.36**
South Fork Crabtree	7.04	5.52	**5.62**
Totals	**4.68**	**3.68**	**3.86**

There are approximately 603 miles of road on all ownerships within the watershed, and the average total road density is estimated at about four miles per square mile. The highest road densities are more than five miles per square mile and occur in the South Fork and North Fork Crabtree SWBs. Church Creek and Roaring River SWBs have moderately high road densities of between four and five miles per square mile.

Of the 603 road miles in the watershed, 130 miles are on federal lands (22%). Road densities on federal lands are estimated to be about five miles per square mile, which is high. Road densities on federal lands are highest in the South Fork Crabtree, Richardson Gap, and Church Creek SWBs (more than 5 miles per square mile). North Fork Crabtree Creek and Roaring River SWBs have road densities between four and five miles per square mile. Road densities on federal lands are lowest in Beaver Creek SWB.

Special Status/Special Attention Species

Plants

There are four known populations of BLM special status plant species populations and numerous known survey and manage species sites in the Crabtree Watershed. Based on a literature review of the habitat requirements of the Special Status Species (SSS) known to occur in the province, a list of potential species has been identified for the Crabtree Watershed and its special habitats (Appendix B-1). This list includes Federal Endangered, Federal Threatened, Federal Proposed Threatened, and Bureau Sensitive species. Included in Appendix B-2 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.*

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. Two populations of *Cimicifuga elata* are known to occur in the Crabtree Watershed, one growing within a Riparian Reserve and the other near a road.

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 two documented sites of *Huperzia occidentalis* in the Crabtree Watershed, one is in the LSR, and both are in riparian areas.

Sidalcea campestris, meadow sidalcea, is a tracking species. It was once a very common native grassland wildflower found in the Willamette Valley that is now limited to fence-rows, roadsides, and ditches. This plant is very susceptible to roadside spraying. There is one documented site of *Sidalcea campestris* in the lower Crabtree Watershed along a road.

Bridgeoporus (=Oxyporous) nobilissimus, the noble fir polypore fungus, is a Bureau Sensitive Species and an SEIS Special Attention Species. It has been found in over nine other locations in the region ranging from the Olympic Peninsula south to the Crabtree Watershed. This long lived butt rot fungus grows on the roots and bases of old-growth noble fir and Pacific silver fir trees, snags and stumps. Little else is known about the habitat requirements and life history of this species. A management area of 600 acres of BLM land has been defined around the population in the Thomas Creek Watershed to the north of Crabtree Watershed. One site is along the ridge between Thomas Creek and Crabtree and another recent site in the Crabtree Watershed was found during a survey of a potential timber sale. The sale has been dropped to allow time for further surveys in the area and management recommendations for the site.

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 Crabtree Watershed. There are a few known meadow knapweed and spotted knapweed sites and a Japanese knotweed site in the watershed. All three 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 Crabtree 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.

Animals

As part of the analysis, the occurrence of wildlife species in the Crabtree Watershed was analyzed. A list of vertebrate wildlife species was compiled using BLM wildlife databases, the Oregon Natural Heritage Program (ONHP) Database, and various wildlife field guides and texts along with knowledge of the habitats present gained through air photo interpretation, GIS information, and field reconnaissance. The resulting list is included in Appendix C-1. The resulting list of wildlife species was then cross referenced with *Rare, Threatened and Endangered Species of Oregon* (ONHP, March, 1998) and Salem District's sensitive species list to determine federal, state, and Bureau status of each species with status. The resulting list of special status species which are known or highly likely to occur in the Crabtree Watershed and their habitat preferences is included in Appendix C-3. This list includes 2 federally threatened, 10 Bureau Sensitive species, 3 Bureau Assessment species, and 22 Bureau Tracking species. In addition, there are three Survey and Manage mollusk species, four Survey and Manage/Protection Buffer bat species and the red tree vole that are documented or highly likely to occur in the Crabtree Watershed.

Little is known about the occurrence of special status invertebrate species in the Crabtree Watershed. A list of suspected or possible special status invertebrate species that could occur in the watershed is included in Appendix C-2. One species, the Oregon giant earthworm, is a Bureau Sensitive species. It is associated with uncultivated soils at low elevations in the Willamette Valley. It is not known if the species is found in the Crabtree Watershed.

There are three Survey and Manage Strategy one and two mollusk species that are documented to occur in the Crabtree Watershed. The Oregon megomphix *(Megomphix hemphilli)*, a Survey and Manage Bureau Sensitive species, is found in moist conifer/hardwood forests with bigleaf maple in association with duff and leaf litter at low to mid elevations. Surveys that have been conducted for this species indicate that the Oregon Megomphix is common along the interface between the Willamette Valley and the Western Oregon Cascades. Much of the Crabtree Watershed is located in this transition zone between the two physiographic provinces. The Oregon Megomphix has been found in the Church Creek SWB.

There are two tail-dropper slugs which are Survey and Manage Strategy species that are documented to occur in the Crabtree Watershed. The blue-gray tail dropper *(Prophysaon coeruleum)* and the papillose tail dropper *(Prophysaon dubium),* occur in conifer/hardwood forests in association with ferns, mosses, duff and litter at low to mid elevations. Preliminary surveys indicate that papillose tail droppers are locally common to abundant in watersheds south of the Little North Santiam. The blue-gray tail dropper is more common in the watersheds to the north of the North Santiam River.

The harlequin duck, a Bureau Sensitive species, has been observed on Crabtree Creek in the past, but breeding status is unknown. It is found on swift flowing mountain rivers and larger streams where it breeds and in rocky coastal areas during the winter. Breeding populations occur in the Quartzville Watershed immediately to the east, and the North Santiam to the Northeast of the Crabtree Watershed.

The goshawk, a Bureau Sensitive species, has been observed in the Crabtree Watershed, but breeding status is unknown. The goshawk prefers late seral forests generally at higher elevations, such as the higher elevation LSR in North Fork Crabtree.

The golden eagle is known to occur in the Crabtree Watershed, but breeding status is unknown. They are known to occur in the vicinity of Snow Peak during the nesting season. The closest known nest site is to the north of Harry Mountain in the Thomas Creek Watershed.

The peregrine falcon, a former endangered species, is considered to be a Bureau Sensitive species. The peregrine falcon is highly likely to occur as a migrant and winter visitor and could occur as a nesting species in the Crabtree Watershed (Pagel, pers. comm.). Suitable cliff habitat for nesting is present in the North Fork Crabtree SWB on BLM lands in LSR, especially in the vicinity of Crabtree Mountain. The closest known nest site is five miles to the southeast in the Quartzville Watershed. There are no large bodies of water in the watershed, however, prey is available in the form of avian species such as the band-tailed pigeon and passerine birds.

A fairly large portion of the Crabtree Watershed is within the Willamette Valley Physiograhic Province. A number of bird species that are considered to be Willamette Valley habitat specialists are known or are suspected to occur in the watershed. These species include the yellow-breasted Chat, grasshopper sparrow, vesper sparrow, and western meadowlark. They prefer native Willamette Valley habitats such as grasslands and riparian areas along larger streams and rivers. According to the *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (American Bird Conservancy, March 2000), a Bird Conservation Area (BCA) has been identified in the lower Crabtree Watershed in the vicinity of Richardson Gap to target these species for conservation efforts.

The common nighthawk is known to occur from the valley floor to higher elevation clearcuts. Breeding populations in the Willamette Valley are of concern, however, this species has been known to breed in the Cascades at rather high elevations in early seral and open areas.

The purple martin, Lewis' woodpecker, and the western bluebird are species native to the Willamette Valley which need cavities and standing dead/cull material for nesting. Due to the scarcity of this type of material and competition with nonnative starlings and house sparrows, these species are rare. The Lewis' woodpecker, which was formerly a summer resident, is known only as a winter visitor and transient today. The purple martin and western bluebird do utilize artificial nest boxes. The western bluebird also occurs at higher elevations in the Cascades as a breeding species.

The red tree vole, a Survey and Manage strategy one and two species, has been documented to occur in the Church Creek SWB, and is highly likely to occur elsewhere in the Crabtree Watershed. This arboreal vole is found in mid to late seral forests with closed canopies. The red tree vole is considered to be a late seral associate and there is suitable habitat present in all SWBs, primarily below 3500 feet elevation. Red tree vole habitat in the Crabtree Watershed was analyzed according to seral stage, stand conditions and elevation. The Crabtree Watershed is 18 percent federal ownership, of which 52 percent is suitable habitat for the red tree vole. The majority of red tree vole habitat occurs in the Church Creek and North Fork Crabtree SWBs.

The long-eared myotis, long-legged myotis, silver haired bat, and Townsend's big-eared bat are Survey and Manage/buffer species that are suspected to occur in the watershed. They are species which have been identified as in need of additional protection in the NFP. They are associated with cliff/crevice and cave habitats and some are known to utilize standing dead/cull components in forest stands. In addition, the Townsend's big-eared bat is known to use buildings and abandoned mines. They forage in a variety of habitats, especially riparian areas.

Threatened and Endangered Species

Threatened and endangered species habitat was analyzed separately in the watershed analysis process. There are no endangered species known or suspected to occur in the Crabtree Watershed. There are two federally threatened species which have been documented to occur in the watershed. The bald eagle has been documented in the lower end of the watershed. The northern spotted owl has been documented to occur in the mid to upper end of the watershed.

The Canadian lynx was recently listed as a threatened species. The Canadian lynx is not likely to occur in the Crabtree Watershed. Habitat for lynx in the Salem District was recently analyzed based on criteria set forth by the Lynx Scientific Team. As a result of this analysis, the Crabtree Watershed does not have potential or existing suitable habitat for lynx. The Crabtree Watershed was found to be 17 miles west of the nearest Lynx Habitat Units (LHU) on adjacent Forest Service lands to the east.

Bald Eagle

There is one known bald eagle nest site near the lower end of the Crabtree Watershed. The nest tree itself is just outside the watershed, however, the bald eagles are known to utilize Crabtree Creek in the lower end upstream as far as Church Creek and Roaring River SWBs.
Bald eagles have large home ranges and are known to move long distances. They are present as

migrants in the Crabtree Watershed as well (Isaacs, pers. comm.). There are no bald eagle concentrations or winter roosts in the Crabtree Watershed. Wintering birds are thought to be the local birds that nest in the vicinity. There is suitable bald eagle nesting habitat on BLM lands in the vicinity of Crabtree Creek in the Church Creek SWB. In addition, bald eagles have been observed roosting on Round Mountain, on the southeast edge of the watershed. It is unknown if these birds are the Crabtree birds, or the birds that nest on Foster/Green Peter reservoirs to the southeast.

Northern Spotted Owl

The overall habitat conditions for northern spotted owls was analyzed across the entire watershed. Age classes and forest types were classified as suitable for nesting, foraging, dispersal or non-suitable habitat for the spotted owl. Non-suitable habitat was further classified as either capable or non-capable of becoming suitable habitat over time. The Willamette Valley portion of the watershed was analyzed separately and found to be non-viable for the spotted owl due to a high percentage of non-capable habitat (80%). The Willamette Valley Physiographic Province is not considered to be within the normal range of the spotted owl. Habitat acres in the Willamette Valley portion of the watershed were removed from the totals, and the remaining portion of the watershed that is within the Western Oregon Cascades Physiographic Province was analyzed separately. The results are displayed in Table 5-6, Spotted Owl Habitat by Ownership in the Cascades Province of the Crabtree Watershed; and on Map 9, Spotted Owl Habitat.

Table 5-6 Spotted Owl Habitat by Ownership in the Cascades Physiographic Province of the Crabtree Watershed

Spotted Owl Habitat Class		Federal		Non-Federal		TOTAL	
		Acres	%	Acres	%	Acres	%
Nesting	**Suitable Habitat**	4,430	25%	6	0%	4,436	7.2%
Foraging		1,927	11%	3,867	9%	5,794	9.4%
Dispersal		3,079	17%	21,126	48%	24,205	39.4%
Capable		7,628	43%	15,371	35%	22,999	37.4%
Non-capable		668	4%	3,361	8%	4,029	6.6%
TOTALS		**17,732**	**100%**	**43,731**	**100%**	**61,463**	**100%**

Approximately 17 percent of the Cascades portion of the watershed is considered suitable habitat for nesting and/or foraging (suitable), 56 percent is functional as dispersal and 44 percent is non-habitat. Of the non-suitable habitat, 85 percent is capable of becoming suitable habitat over time.

The only portion of the Crabtree Watershed that was found to be viable for nesting spotted owls was the upper portion of North Fork Crabtree SWB on BLM lands in LSR. The North Fork Crabtree SWB and the Church Creek SWB were found to be marginal to limiting for nesting spotted owls. The Beaver Creek, Richardson Gap, Roaring River, and South Fork Crabtree SWBs were found to be non-viable for nesting spotted owls.

Spotted owl habitat on federal lands in the Cascades portion of the Crabtree Watershed was further analyzed and categorized by LUA. See Table 5-7, Spotted Owl Habitat on Federal Lands in the Cascades Physiographic Province of the Crabtree Watershed by LUA.

Table 5-7 Spotted Owl Habitat on Federal Lands in the Cascades Physiographic Province of the Crabtree Watershed by LUA.

Spotted Owl Habitat Class	GFMA	%	CONN	%	LSR	%
Nesting	560	8%	1,018	25 %	3,030	45 %
Foraging	765	11%	369	9%	615	9%
Dispersal	2,412	30%	459	11 %	206	3%
Capable	3,130	50%	2,144	53 %	2,353	35 %
Non-Capable	63	1%	70	2%	535	8%
Totals	6,930		4,060		6,738	

Approximately 35 percent of federal lands in the watershed are considered to be suitable habitat, 52 percent is functional as dispersal and 47 percent is non-suitable habitat. Of the non-suitable habitat present on federal lands, 92 percent is capable of becoming suitable habitat over time. The amount of suitable habitat is 19 percent in GFMA, 34 percent in CONN, and 54 percent in LSR.

The Cascades portion of the watershed is viable for dispersal of spotted owls. The Crabtree Watershed provides for dispersal to/from the Quartzville Watershed to the east. The Quartzville LSR (RO213) and Middle Santiam Wilderness complex is about 92,400 acres in size and spans four major watersheds from Crabtree on the west, through Quartzville, into the North Santiam to the north toward Detroit Reservoir and south and east into the Middle Santiam watershed. This very large reserve is an integral and important link in the predominant north-south LSR/wilderness network where the majority of dispersal between known spotted owl sites in the Cascades Range takes place. Approximately five percent of the Quartzville LSR is located in the Crabtree Watershed, mostly in the upper end of the North Fork Crabtree SWB. The majority of

the Crabtree Watershed consists of BLM and private lands, and is located just outside, to the west of this major LSR/wilderness network in the Cascades Mountain Range.

In the LSR Assessment, between LSR connectivity analysis showed that the Crabtree Watershed is not only an important link between the Quartzville LSR to the east, but also to the Thomas Creek LSR to the north and west. However, connectivity of federal lands between the Quartzville and Thomas Creek LSR is disrupted by the scattered ownership pattern. To the north of Thomas Creek is the North Santiam River Corridor, and the cities of Lyons, Mill City, and Gates. To the north about 10 miles across the North Santiam River Corridor is the Little North Santiam Watershed.

To the south of the Crabtree Watershed is Hamilton Creek, a low elevation watershed comprised mostly of private lands in the foothills of the Cascades. To the south of Hamilton Creek and Crabtree are the communities of Lebanon and Sweet Home and the South Santiam River Corridor, which acts as a barrier to spotted owl movement to the south.

The western portion of the Crabtree Watershed including the majority of the Richardson Gap and Beaver Creek SWBs, and immediately to the west is the Willamette Valley floor. Spotted owl dispersal is cut off and the Willamette Valley acts as an effective barrier to movement west of the watershed.

Spotted owl dispersal out of the Crabtree Watershed is limited by the scattered federal ownership and the North Santaim River Corridor to the north, the South Santiam River Corridor to the south and the Willamette Valley on the west. The most significant lands in the watershed for spotted owl movement are the BLM lands in the North Fork Crabtree SWB. These lands are directly connected to the large LSR/wilderness network to the east of the watershed where the majority of dispersal between known spotted owl sites in the Cascades Range takes place. Most of the BLM lands in the North Fork Crabtree SWB are designated as Critical Habitat for the spotted owl in Critical Habitat Unit OR-14, which includes the federal lands in the Quartzville Watershed. There are 6,830 acres of Critical Habitat in the Crabtree Watershed, almost all of it within the North Fork Crabtree SWB. Approximately 87 percent (5,966 acres) is in LSR and 13 percent (864 acres) is in the matrix LUAs. Approximately 84 percent of the Critical Habitat in the matrix is in GFMA and 14 percent is in CONN. In addition, there are 755 acres designated as LSR in the vicinity of Snow Peak that are not designated as Critical Habitat. See Table 5-8, Spotted Owl Critical Habitat by SWB in the Crabtree Watershed; and Map 9, Spotted Owl Habitat.

Critical Habitat was further analyzed for suitability and dispersal capabilities both inside LSR and on adjacent matrix lands outside of LSRs. The amount and condition of suitable and dispersal habitat in LSR Critical Habitat was found to be considerably better than in adjacent matrix Critical Habitat. Critical Habitat within the LSR was found to be viable for both nesting and dispersal of spotted owls. However, Critical Habitat in the matrix was found to be limiting for nesting and dispersal of spotted owls. See Table 5-9, Spotted Owl Critical Habitat on LSR and adjacent Matrix lands.

Table 5-8 Spotted Owl Critical Habitat by SWB in the Crabtree Watershed.

Sub-Watershed Basin (SWB)	Critical Habitat Acres in LSR (%)	Critical Habitat Acres in Matrix (%)	Total Critical Habitat Acres (%)	LSR not in Critical Habitat
Beaver Creek	0 (0%)	0 (0%)	**0 (0%)**	**0**
Church Creek	0 (0%)	0 (0%)	**0 (0%)**	**230**
North Fork Crabtree	5,743 (87%)	864(13%)	**6,607(97%)**	**525**
Richardson Gap	0 (0%)	0 (0%)	**0 (0%)**	**0**
Roaring River	0 (0%)	0 (0%)	**0 (0%)**	**0**
South Fork Crabtree	223(100%)	0 (0%)	**223 (3%)**	**0**
TOTALS	**5,966 (87.3%)**	**864 (12.7%)**	**6,830 (100%)**	**755**

Table 5-9 Spotted Owl Critical Habitat in LSR and Adjacent Matrix Lands in the Crabtree Watershed.

Spotted Owl Habitat Class	Critical Habitat in LSR		Critical Habitat in Matrix		Critical Habitat totals	
	Acres	%	Acres	%	Acres	%
Nesting	2,967	50%	188	22%	3,155	46%
Foraging	34	1%	0	0%	34	1%
Dispersal	188	3%	124	14%	312	5%
Capable	2,278	38%	534	62%	2,812	41%
Non-capable	499	8%	18	2%	517	7%
TOTALS	5,966	100%	864	100%	6,830	100%

Once the overall habitat conditions were analyzed across the watershed, each individual known spotted owl site (KOS) was analyzed. The KOS is established by buffering the site center with the provincial home range radius for the spotted owl. The provincial home range radius for the Western Oregon Cascades province is 1.2 miles. Once the KOSs were established, the habitat within each was classified as either suitable, dispersal, or non-suitable habitat for the spotted owl. The results were used to estimate viability of each site. A KOS that has an intact 70 to 100-acre core area, and the equivalent of over 40 percent suitable habitat within its provincial home range radius is considered to be viable.

There are seven spotted owl site centers located in the watershed. Four of these seven are in LSR and the other three are in matrix. Two of the three located in matrix have an unmapped LSR (core area) associated with them. Of the seven KOSs with site centers in the watershed, three were found to be viable. These three sites are located in the North Fork Crabtree SWB on BLM lands in LSR. Of the other four sites, three are considered to be non-viable and one site, located in the Church Creek SWB, is limiting, but occupancy and reproduction appears to be stable.

In addition, there are seven spotted owl site centers located just outside of the watershed. Due to their location, surrounding topography, and past harvest patterns, the Crabtree Watershed does not contribute significant habitat to these sites. Four of these sites are located in the Quartzville Watershed to the east, where connectivity between the major LSR/wilderness network is more important. Two of the other three are located to the north in the Thomas Creek Watershed and one is to the south in Hamilton Creek Watershed.

Barred owls compete directly with spotted owls for territory and to a lesser extent prey. They are more aggressive than spotted owls and broader in their habitat requirements. The number of barred owl sightings in the watershed has increased greatly in recent years. They have been documented as nesting in the lower end of the Crabtree Watershed. Barred owls have been observed in the Richardson Gap, Roaring River, Church Creek, and Beaver Creek SWBs. There are no known sightings in the upper end of the watershed in North Fork or South Fork Crabtree SWBs.

Current acres of federal suitable, dispersal, capable habitat, and number/condition of KOSs in the Crabtree Watershed were calculated and the results are shown in Table 5-10.

Table 5-10 Current Status of the Spotted Owl and Its Habitat Within Crabtree Watershed

	Total in WA	Total in LSR (%)	Total not in LSR (%)
Acreage within Boundary	100,022	6,738 (7%)	93,284 (93%)
Acreage of Federal	18,008	6,738 (37%)	11,270 (63%)
Federal Suitable Spotted Owl Habitat	6,411	3,645 (57%)	2,766 (43%)
Federal Dispersal Plus Spotted Owl Habitat	9,488	3,851 (41%)	5,637 (59%)
Federal Capable Plus Spotted Owl Habitat	17,333	6,204 (36%)	11,129 (64%)
Federal Critical Habitat	6,830	5,966 (87%)	864 (13%)

(% suitable habitat)	Total in WA	Total Protected (in LSR)	Total Unprotected (in LSR)
Spotted owl sites (>40%)	3	3	0
Spotted owl sites (20-40%)	1	0	1
Spotted owl sites (<20%)	3	1	2
Total Spotted Owl Sites	7	4	3

Aquatic

Hydrology and Water Quality

The Crabtree Watershed contains approximately 100,022 acres or 156 square miles of forest and agricultural land on the west slope of the Oregon Cascade Mountains. The watershed is contained within the larger South Santiam sub-basin covering 1,061 square miles, which in turn flows into the 11,100 square mile Willamette River Basin; the largest river basin in Oregon. A large percentage of the state's population and major cities are located in the Willamette River Basin including Portland, Salem, and Eugene. The United States Geologic Survey (USGS) has divided the Willamette River Basin into hydrologic units and assigned each a hydrologic unit code. The Crabtree Creek watershed analysis is synonymous with the Crabtree Creek 5th field hydrologic unit (1709000602). The 5th field boundary extends from the mouth of Crabtree Creek upstream to the headwaters. Crabtree Creek Watershed has been sub-divided into six SWBs, also known as 6th field watersheds. See Map 5, Sub-Watershed Basins. SWB names and acreages are listed in Table5-1 in the Introduction to Chapter 5.

Total miles of streams were calculated and stream densities across the Crabtree Watershed were mapped by SWB. See Maps 11 and 12, Stream Order and Stream Flow. There are approximately 926 miles of stream in the watershed analysis area. Stream densities by SWBs are shown in Table 5-11. The SWB stream densities vary from 7.2 miles per square mile in North Fork Crabtree to 4.9 miles per square mile in Beaver Creek. Analysis areas further upstream in the watershed exhibit higher stream densities than analysis areas nearest the mouth. Figure 5-4 displays the differences between analysis areas and identifies the higher elevation North Fork and South Fork Crabtree SWBs as the highest in stream density, Roaring River, and Church Creek SWBs as about average, and the lower elevation Richardson Gap and Beaver Creek SWBs as below average. In addition to natural streams, there are approximately 31.5 miles of diversion ditch in the watershed. The diversions are used to support irrigation, and several transfer water across sub-watershed boundaries. Stream densities and road densities interact. The higher the stream density, the greater the potential for road impacts to streams. Sub-watersheds with higher stream densities often have greater topographic relief, which can affect erosion processes.

Table 5-11 Crabtree Creek Stream Densities by Sub-Watershed Basin.

Sub-Watershed (6th Field)	Stream Densities (mi./sq.mi.)
North Fork Crabtree	7.2
South Fork Crabtree	6.7
Church Creek	6.2
Roaring River	5.8
Richardson Gap	5.6
Beaver Creek	4.9
Watershed Average	5.9

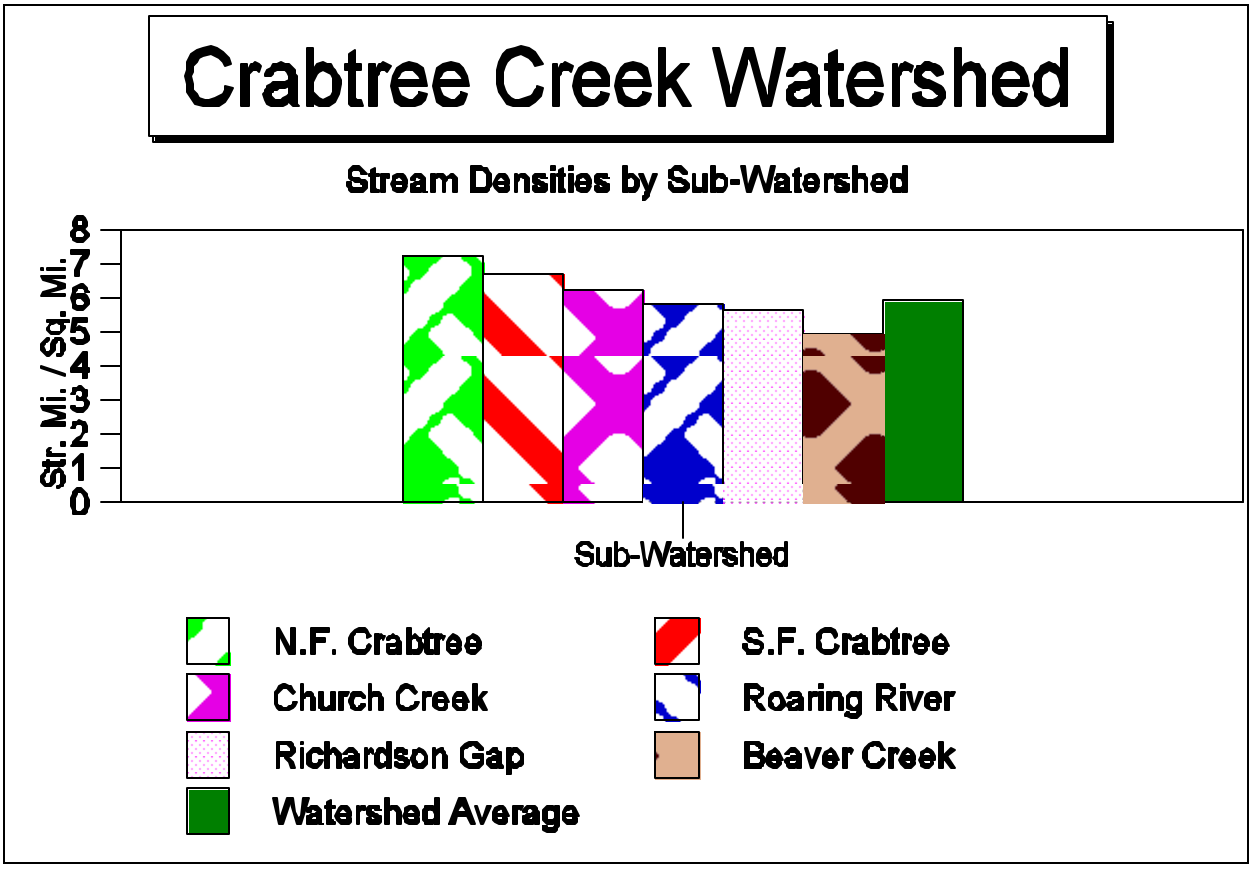

Figure 5-4: Stream Density by Sub-Watershed

Stream flow

The watershed analysis area exhibits high winter flows and low summer flows typical of the Cascade Range drainages, with approximately 73 percent of the flow occurring November through March. Approximately 65 percent of annual precipitation is also received during this period (See Figure 5-5).

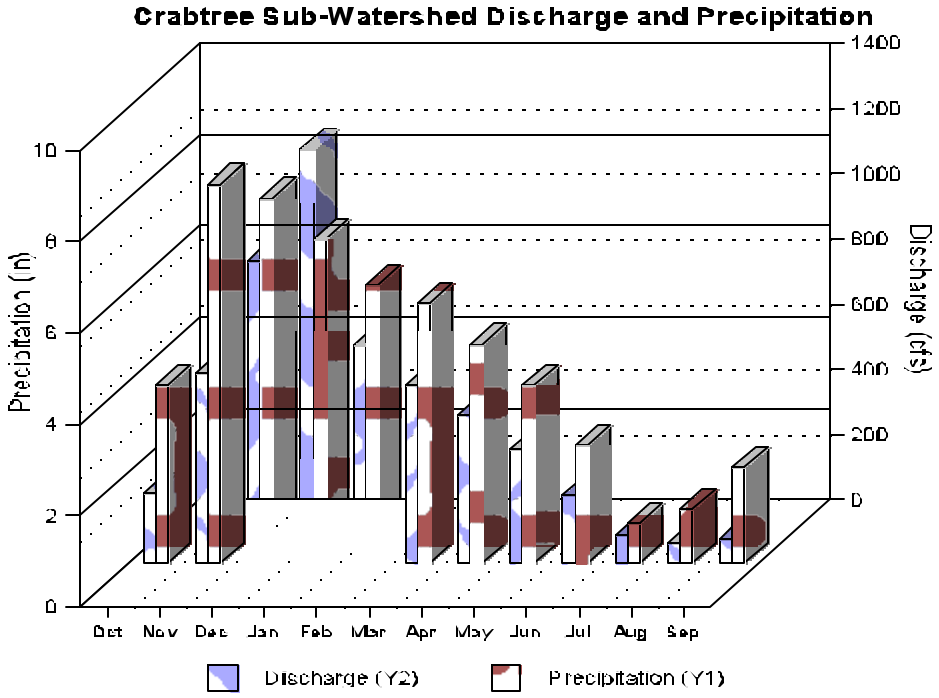

Figure 5-5 Discharge and Precipitation.

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

Annual stream hydrographs from the USGS stream gaging station number 14188700, Crabtree Creek near Crabtree, Oregon were used to analyze stream discharge in the watershed. In a year of average precipitation, the groundwater recharge due to storms occurs between early October and the end of April, and stream flow is regulated predominantly by precipitation. From May through September, groundwater discharge occurs and is the main component of stream flow available for runoff.

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 5-12 contains a summary of permitted water withdrawals or diversions for the Crabtree Watershed Analysis from the Oregon State Water Rights Information System (WRIS).

Table 5-12 Water Rights Summary for the Crabtree Creek Analysis Watershed

	Domestic	Irrigation	Power	Industrial	Municipal	Fish/Wildl.	Misc.
CFS	0.1	125	65	2	0	26	1
AFT	0	62	5	0	0	38	48

CFS: Cubic Feet 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.

Minimum stream flows were converted to instream water rights in Crabtree Creek in 1983 to protect aquatic life and for pollution abatement. 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 5-13 provides an example of the potential for insufficient flows during the summer and fall low flows at the mouth of Crabtree Creek, from the South Santiam Watershed Assessment 2000 data. An 80 percent exceedence flow value was used for the analysis, which means in a given month the average discharge will be higher than the exceedence value eight years out of ten, and lower than the exceedence value two years out of ten.

Table 5-13 Low Flow Water Availability in Crabtree Creek at 80 Percent Exceedence.

	Percent of streamflow appropriated for Consumptive use				
	Jun	Jul	Aug	Sept	Oct

Crabtree Creek at Mouth	14	52	61	28	2

July and August have the greatest potential for conflict between consumptive uses and instream water needs with 52 and 61 percent of water allocated to consumptive uses respectively at an 80 percent exceedence flow.

Water Quality

Protection and enhancement of water quality in the Willamette River Basin was identified by Oregon Department of Environmental Quality (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 traceable. 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 Crabtree Creek 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. See Table 5-14, below.

Table 5-14 Selected Water Quality Criteria For Crabtree Watershed.

pH	6.5 to 8.5
Water temperature	Fish rearing: 64 degrees F. or less
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*, surface waters are listed where problems were

thought to occur using existing data or by observation. The publication lists Crabtree Creek water quality as being moderately impacted, supported by data in the upper reaches, and by observation in the lower sections. Problems identified include: turbidity, erosion, sediment, low dissolved oxygen, and low flows. The probable causes were listed as erosion, road runoff, vegetation removal, and water withdrawals. Affected values were identified as fisheries, aquatic life, water recreation, irrigation, wildlife, aesthetics, and livestock. The 319 report was an initial assessment of water quality in Oregon, and was used as a bench mark for future studies. Since the report, additional data has been collected in the SWBs. Data collected by the South Santiam Watershed Council indicate dissolved oxygen and pH are probably not of concern in Crabtree Creek.

The *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. Unlike the 319 report, sufficient data to show a specific problem exists is required to place a stream on the list. Crabtree Creek is listed on the 303(d) list as water quality limited for summer stream temperature, from the mouth upstream to White Rock Creek. Summer temperatures have been found to be above the 64 degree Fahrenheit threshold for fish rearing for notable periods of time. See the stream temperatures section below.

Several water quality studies have been conducted in the Willamette River Basin in the past decade. Some provide information for the Santiam sub-basin which contains the Crabtree Watershed; however data specific to Crabtree is limited. Tetra Tech (1993) estimated non-point pollution annual loads of nitrogen, phosphorous, and total suspended solids for watersheds in the Willamette River Basin. Table 5-15 compares the Santiam sub-basin with the average for the entire Willamette River Basin. Results suggest the non-point pollution levels are 5 to 20 percent higher in the Santiam sub-basin than the Willamette Basin average; however sources have not been identified .

Table 5-15 Phosphorous, Nitrogen, and Suspended Solids.

Area	Total Phosphorous (kg/ha)	Total Nitrogen (kg/ha)	Total Suspended Solids (kg/ha)
Santiam Sub-Basin	0.78	5.47	770
Willamette Basin	0.74	4.57	680

A summary of information on aquatic biota in the Willamette Basin was published by the USGS in 1997. The report cited the results of a pesticide and trace metal study in fish found in Willamette Basin watersheds. Squaw Fish collected in the Santiam Watershed at river mile 0.5

were found to contain small amounts of chlorinated pesticides, PCBs, and trace metals. However, because fish are mobile it is difficult to estimate the level of contamination from the Santiam Watershed.

Stream Temperatures

The South Santiam Watershed Council, and BLM have collected summer and fall water temperatures since 1997 at sites on mainstem Crabtree Creek, and several tributaries using temperature data loggers. 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 Crabtree Creek is 17.8 degrees C (64 degrees F).

In the Crabtree Creek Watershed, the main channel has been listed as water quality limited due to temperature from the mouth upstream to White Rock Creek (river mile 29). Temperature monitoring sites on the mainstem are located at river mile 10 near Richardson Gap, river mile 14 near Roaring River, river mile 28 at Snow Peak road, and river mile 30 at a low water ford. River miles are measured in an upstream direction, beginning with 0 at the mouth. Data have also been collected at the mouth of Church and Green Mountain creeks, tributaries of Crabtree Creek. Data from 1999 were summarized by calculating seven day maximum averages, which are an average of the maximum recorded temperatures for a given date, the three days prior and the three days after the date. The seven day maximum average was used rather than straight daily maximums, 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.

The Crabtree Watershed 7-day averages are plotted in Figure 5-7. The figure indicates temperatures in Crabtree Creek at river mile 30 were below the basin standard of 17.8 degrees C (64 degrees F)., but all other Crabtree stations were above the standard for extended periods of time. 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 17 degrees Celsius threshold, salmon are forced to seek refuge in cooler water in places such as deep pools, or cooler tributaries. Green Mountain Creek was below the standard the entire period of record, and Church Creek most of the time. Both creeks were cooler than mainstem Crabtree Creek over the entire period of sampling. Focusing on data at river miles 28 and 14 early in the summer, water temperatures increase in a downstream direction which is expected. However, beginning mid July temperatures at river mile 14 are significantly cooler than found at river mile 28, and in the fall temperatures at river mile 14 fall below the 17 degree Celsius temperature standard long before temperatures at river mile 28. This phenomenon indicates one or several sources of cooling water exist between the two stations in the warmest part of the year. Tributaries like Green Mountain, and Church creeks are located between these stations and have a cooling effect on Crabtree Creek. Other tributaries and groundwater inputs may exist that also lower the temperatures between these stations.

Figure 5-6 presents the Crabtree Creek temperature data on four different 1999 dates, plotted by river mile. The location of Church Creek and Green Mountain Creek have also been included on the graph for reference. The graph shows water temperatures at river mile 30 below the basin standard on all dates, however temperatures increase sharply by the time water reaches river mile 28, decreasing again by river mile 14 (except for the July 1st plot), then again rising by river mile 10. Aerial photographs were used to assess Crabtree Creek for potential sources of the temperature increase. 1998 photos of Crabtree Creek in the vicinity of river miles 28 and 30 display an open riparian canopy, and the creek appears to have suffered high flows and large sediment loads. Sediment has been deposited on the flood plain, removing vegetation and

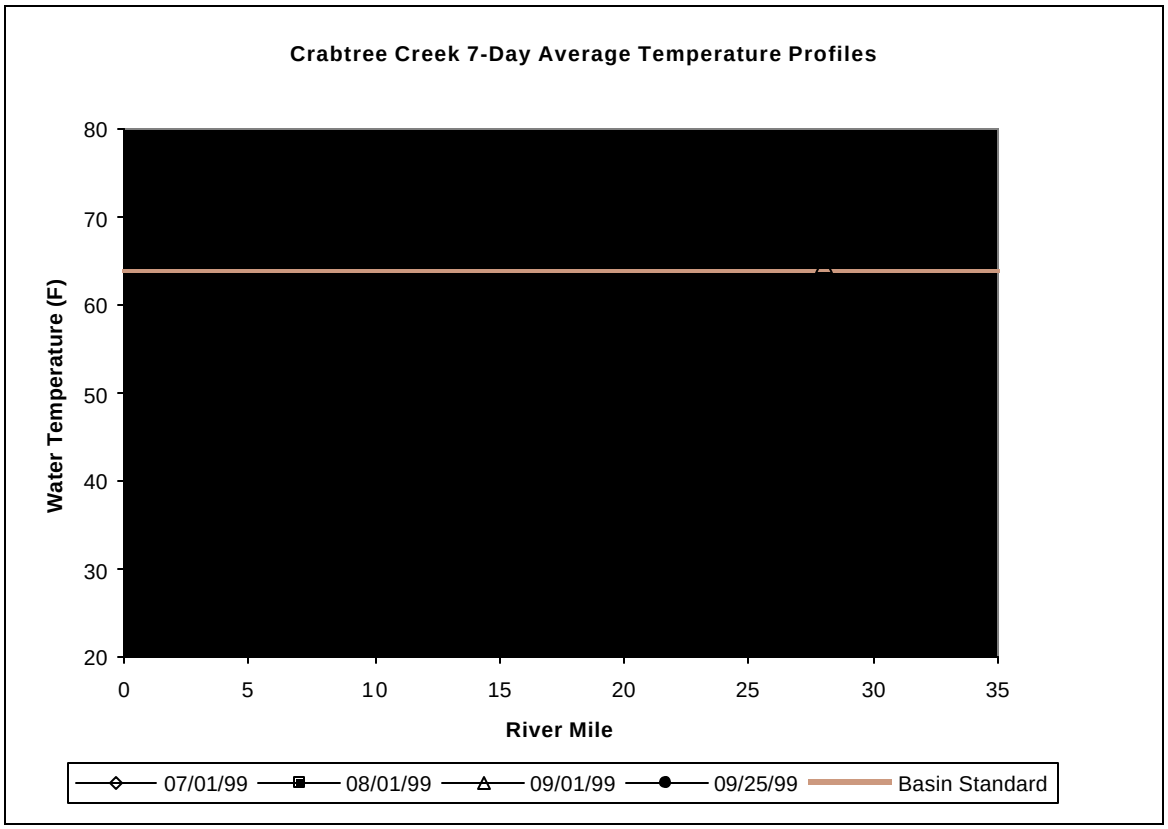

Figure 5-6 7-Day Maximum Average Temperature Profiles: Crabtree Watershed.

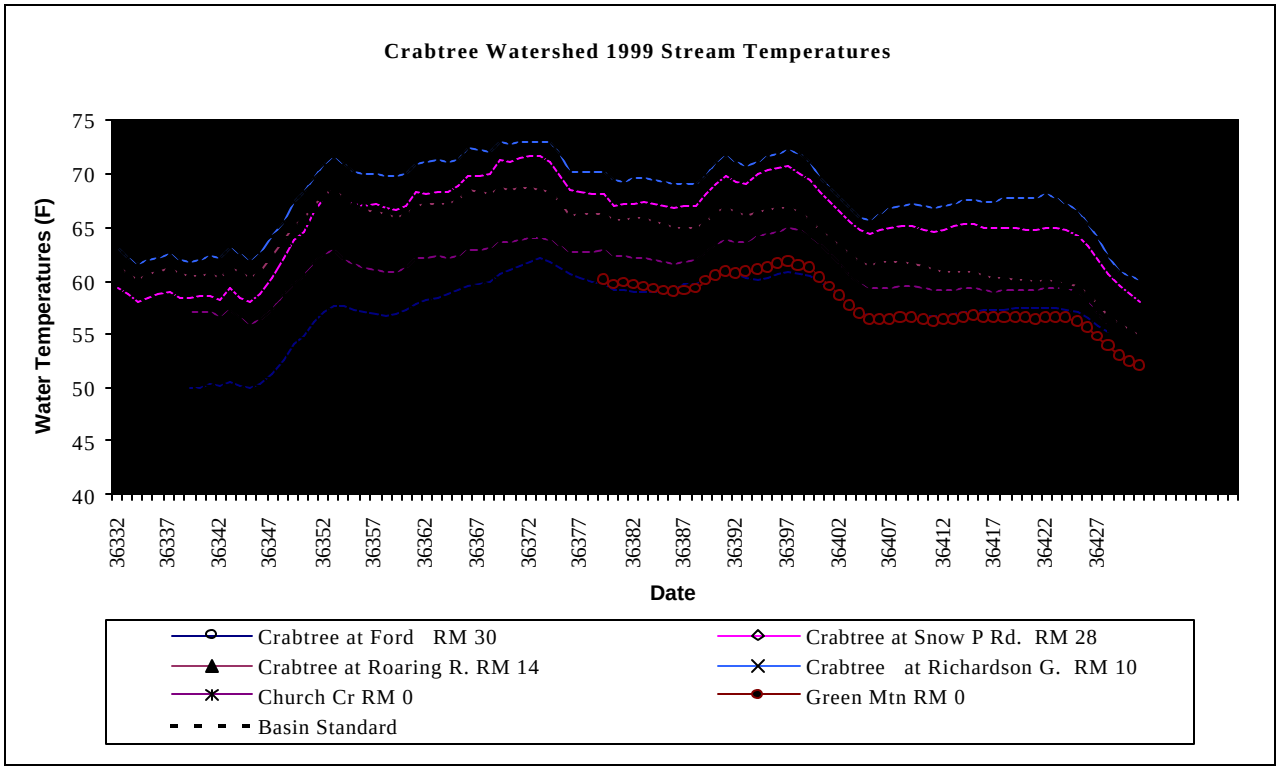

Figure 5-7. 7-Day Maximum temperatures: Crabtree Watershed.

allowing direct solar input. Several shallow ponds are obvious on the photographs and may also be contributing to warmer water temperatures in the upper sections of Crabtree Creek. Looking downstream of river mile 28, riparian cover appears to improve slowly and the stream shade increases. Downstream of river mile 14, the creek enters open agricultural lands and riparian cover is non-existent. Increases in temperature in this section of Crabtree Creek are not unexpected.

1993 aerial photographs of the area display riparian cover over much of the stream, and some existing landslide activity. So, an increase in landslide activity and the loss of riparian cover apparently occurred between 1993 and 1998. The flood of February 1996 affected much of northwest Oregon, and may have triggered the changes observed on the photographs.

Road Summary

Total miles of road and road densities across the Crabtree Watershed were calculated by SWB and ownership. See Map 10, Transportation, and Table 5-5, Road Densities by SWB and Ownership in the Crabtree Watershed. There are approximately 603 miles of road on all ownerships within the watershed, and the average total road density is estimated at about four miles per square mile. The highest road densities are over five miles per square mile and occur in the South Fork and North Fork Crabtree SWBs. Church Creek and Roaring River SWBs have moderately high road densities of between 4 and 5 miles per square mile.
Of the 603 total road miles in the watershed, 130 miles are on federal lands (22 %). Road densities on federal lands are estimated to be about five miles per square mile, which is high.

Road densities on federal lands are highest in the South Fork Crabtree, Richardson Gap, and Church Creek SWBs (over five miles per square mile).

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 SWB. Table 5-16 lists miles of stream, miles of roads within 100 feet of an existing stream, and the estimated channel network expansion due to roads. Roaring River SWB has greater than 20 percent channel expansion, which is considered high.

Table 5-16 Estimated Channel Network Expansion.

SWB	Stream Miles	Road Miles Within 100 Feet of Streams	Estimated Channel Network Expansion (Percent)
Beaver Creek	191.9	16.8	8.7
Church Creek	157.6	24.6	15.6
North Fork Crabtree	184.5	28.9	15.7
Richardson Gap	201.0	21.2	10.5
Roaring River	81.8	21.2	25.9
South Fork Crabtree	109.3	17.9	16.4

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.

Cumulative Effects

In past watershed analyses, cumulative effects were estimated using data on forest stand birth

dates. Interpretation of stand birth dates from aerial photographs for non-BLM lands is labor intensive and expensive. Due to funding and time constraints, *Western Oregon Digital Imagery Project* (WODIP) data was used to classify tree overstory ages rather than specific stand birth dates. WODIP data is produced by interpreting satellite imagery, and places areas of like vegetation into categories based on the species, diameters, and amount of crown closure. Vegetation maps derived from WODIP data are estimated to be 80 percent accurate for the type of stand. However, because the data must be grouped into broad age bands, the age estimates are not as accurate as birth date information collected from aerial photographs.

The WODIP images were grouped into age bands based on estimates of forest type, crown closure, and tree stem diameter. A comparison of actual stand ages where existing data was available with WODIP data for the same areas revealed errors in the cumulative effect calculation of up to 30 percent. In several cases the WODIP results showed the SWBs to be in better condition than when analyzed using actual ages, however the error could be in either a positive or negative direction. Due to the level of error inherent on the calculations, project specific cumulative effects analysis will need to be conducted in the future as projects are proposed.

A general condition ranking was accomplished using WODIP data to compare SWBs to each other and the Crabtree Watershed. The intent was to estimate which SWBs appear to have the largest amount of forested acres in young age classes, and which have the least. The goal was to provide a rough estimate where watershed restoration activities might be most useful within the Crabtree Watershed.

Agriculture is a major land use in the lower elevation SWBs, and is a long term traditional use of the land in these areas. In order to rank the SWBs into relative condition based on forest management activities, only forest management acres were used in each SWB. Table 5-17 lists the total acres in each SWB, forest management acres and percentages.

Table 5-17 Acres Managed as Forest in Crabtree Watershed.

Crabtree SWB	Total Acres	Forest Management Acres	Forest Management Acres (Percent)
Beaver Creek	24,909	9,073	36
Church Creek	16,223	15,573	96
N.F. Crabtree Creek	16,362	15,678	96
Richardson Gap	23,161	5,949	26
Roaring River	8,980	8,439	94
S.F. Crabtree	10,384	10,258	99
Total for Crabtree Watershed	100,022	64,972	65

Forest management acres within each SWB were evaluated, and the percent of forest in a young age class and mature age class estimated. The age of overstory trees within the young age class is approximately 0 to 30 years. The mature overstory age class contains stands approximately 80 year old and older. Table 5-18 lists the SWBs in order of decreasing percent forests in the young age class.

Table 5-18 Percent Forest Lands in Younger and Older Age Classes.

Crabtree SWB	Forest Management Acres	Forest in Young Age Class (Percent)	Forest in Older Age Class (Percent)
Richardson Gap	5,949	65	7
Beaver Creek	9,073	49	10
N.F. Crabtree Creek	15,678	39	29
S.F. Crabtree	10,258	29	10
Church Creek	15,573	29	19
Roaring River	8,439	24	9
Total for Crabtree Watershed	64,972	37	16

The SWBs with the greatest percent of forested land in the young age class were Richardson Gap and Beaver Creek. Lands in these SWBs are owned and managed by private non-industrial parties with small landholdings, and BLM land managed as GFMA. In contrast, Church Creek

and Roaring River SWBs currently have the lowest percentage of forest lands in the younger age class. These watersheds are managed to a greater degree by private industrial companies and BLM. The SWB with the greatest amount of older forest is North Fork Crabtree Creek with 29 percent. Most of the older forest stands in this SWB are located on BLM lands in the upper reaches managed as LSR.

Future harvest plans by private land owners are not known, and can change quickly. The level of harvest by industrial companies depends on several factors, including national or local economic conditions. However, many companies in western Oregon use a 50-year rotation age for determining when to harvest managed forest lands. Assuming that much of the private land 50 years or older will be harvested in the next decade, an estimate of the level of potential future harvest was made for the Crabtree SWBs. Table 5-19 lists the acres of private land and the percent in a greater than 40 year age class

Table 5-19 Private Lands in the Greater Than 40 Year Age Class.

SWB	Private Forest Acres	Percent in Greater than 40 Year Age Class
S.F. Crabtree	6,879	67
Church Creek	7,962	51
Roaring River	4,231	50
Beaver Creek	2,816	31
N.F. Crabtree Creek	3,544	27
Richardson Gap	1,598	27
Watershed Total	27,034	42

South Fork Crabtree Creek, Church Creek, and Roaring River have the highest percentages of private land at an age where harvest is likely. Since the timing of actual harvest cannot be predicted, an in depth cumulative effects analysis will have to be completed for SWBs when BLM projects are proposed.

Transient Snow Zone

Transient snow zones (TSZ) are areas where snow normally accumulates and melts several times a winter, often melting rapidly. See Map 15, Snow Zone/Slope Stability. 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 bankfull flows, which

correspond to the two-year event in lower gradient steams and apparently to the five-year event in steeper mountain streams (Leopold et.al 1964, Washington Forest Practices Board 1993). Change in the magnitude of frequent flood flows can affect channel scour and fish habitat.

Existing data did not provide enough information to analyze the effects of management on transient snow. Future projects will require additional data collection and analysis on a site specific basis.

Soils

Soil properties, classifications, series descriptions, and soil maps of the Crabtree Watershed are contained within the *Soil Survey of Linn County Area Oregon*.

Slope Hazard and Stability

Slope hazard ratings for erosion were estimated using slope steepness. Slopes under 60 percent were rated as a low hazard, 60 to 75 percent slopes were rated as moderate, 76 to 90 percent slopes were rated high and slopes over 90 percent were rated as severe. See Map 15, Precipitation Zones/Slope Stability Hazard.

Slope stability by SWB was estimated using geographic information systems maps and database information. Slope stability ratings were based on slope hazard ratings and age of the overstory vegetation. Table 5-20 lists the assumptions used to calculate slope stability. Values were tallied and presented here to identify the SWBs with the highest percentage of unstable ground. These unstable areas may be prone to mass movement under certain environmental conditions.

Table 5-20 Slope Stability Assumptions.

Slope Hazard Slope Range (%)	Overstory Age (years)	Stability
Low (0 to 59)	Any	Stable
Moderate (60 to 75)	Less Than or Equal to 10	Potentially Unstable
	Greater Than 10	Stable
High (76 to 90)	Less Than or Equal to 20	Unstable
	Greater Than 20	Potentially Unstable
Severe (90 and Above)	Any	Unstable

Overstory ages for non-federal lands were not available, so an age of less than 10 was used in these areas. Results are listed in Table 5-21 by SWB and ownership.

Table 5-21 Slope Stability by Sub-Watershed and Ownership (acres).

SWB	Ownership	Stable	Potentially Unstable	Unstable
Beaver Creek	BLM	1,979	5	3
	Other	22,875	44	2
	Total	**24,854**	**49**	**5**
Church Creek	BLM	3,812	12	2
	Other	11,940	343	115
	Total	**15,752**	**355**	**117**
North Fork Crabtree	BLM	8,252	126	58
	Other	7,662	215	50
	Total	**15,914**	**341**	**108**
Richardson Gap	BLM	738	4	0
	Other	22,371	48	0
	Total	**23,109**	**52**	**0**
Roaring River	BLM	2,322	0	0
	Other	6,560	85	13
	Total	**8,882**	**85**	**13**
South Fork Crabtree	BLM	694	0	0
	Other	9,579	95	16
	Total	**10,273**	**95**	**16**

Church, and North Fork Crabtree Creeks appear to have the greatest acreage by far in an unstable condition. The SWB with the most extensive BLM ownership classified as unstable is North Fork Crabtree SWB (58 acres).

1998 photos of Crabtree Creek in the vicinity of river miles 28 and 30 in North Fork Crabtree SWB display an open riparian canopy, and the creek appears to have suffered high flows and large sediment loads. Sediment has been deposited on the flood plain of Crabtree Creek, and riparian vegetation has been removed. A few large landslides in the area added considerable sediment to the creek, and most appear to have initiated at roads. BLM road 11-2E-14.1 suffered a few large slides that appears to have added sediment to the creek. It is difficult to distinguish without doubt, but several tributaries entering the section of Crabtree Creek between river mile 28 and 30 appear to have delivered heavy sediment loads in the recent past.

Fisheries

There are two listed anadromous fish species and a number of resident species found in the Crabtree Creek Watershed. See Map 13, Fish Presence in the Crabtree Watershed.

Chinook Salmon

Chinook salmon within the Upper Willamette River Evolutionarily Significant Unit (ESU) were listed as 'threatened' by the National Marine Fisheries Service (NMFS) in March 1999. Populations are in sharp decline from historic levels, and the native run is thought to be extinct, with the present run believed to be of hatchery origin. 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. Recent (1994-99) releases of spring chinook from S. Santiam Hatchery have been conducted by Oregon Department of Fish and Wildlife (ODFW) in an attempt to reestablish a population in Crabtree Creek. Surveys to determine whether the effort has been successful are ongoing, but the results are not yet conclusive. Chinook salmon are found in mainstem Crabtree Creek, using approximately 33 miles of stream within the watershed, but Chinook are not known to utilize any Crabtree Creek tributaries. Upstream migration of chinook in mainstem Crabtree Creek is blocked by a barrier waterfall at approximate river mile (RM) 33.

Steelhead Trout

Steelhead within the Upper Willamette River ESU were listed as 'threatened' by NMFS in March 1999. The proportion of Willamette Basin winter steelhead produced in the Crabtree Creek watershed is unknown. Runs of Willamette Basin 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. Steelhead are found in approximately 41 miles of streams in the watershed. In mainstem Crabtree Creek steelhead are suspected to have access up to a barrier falls at approximate RM 34.5. The lowest major tributary to Crabtree Creek, Beaver Creek, flows through mostly agricultural lands, and may be used by steelhead, but that is considered unlikely because the majority of the stream has a very low gradient with substrates mainly consisting of silt and mud. Only two tributaries, Roaring River and South Fork Crabtree Creek are known to support steelhead. In Roaring River, which enters Crabtree Creek at approximate RM 15, upstream migration of steelhead is blocked by a weir at Roaring River State Fish Hatchery at approximate RM 1. In South Fork Crabtree Creek, which enters Crabtree Creek at approximate RM 27, steelhead distribution is suspected to extend to a barrier waterfall at approximate RM 3.5, as well as to approximate RM 2 in Bald Peter Creek, a tributary that enters South Fork Crabtree Creek at approximate RM 0.25.

Resident Fish

Resident fish species known to inhabit the Crabtree Creek watershed are cutthroat trout (*O. clarki*), mountain whitefish (*Prosopium williamsoni*), coarse scale sucker (*Catostomus macrocheilus*), dace (*Rhinicthys spp.*) and sculpin (*Cottus spp.*). The lower reaches of Crabtree Creek support populations of redside shiner (*Richardsonius balteatus*), northern pikeminnow (*Ptychocheilus oregonensis*) and non-native smallmouth bass (*M. dolomieui*), brown bullhead (*Ameiurus nebulosus*) and yellow bullhead (*A. Natalis*).

Cutthroat trout (*O. clarki*) and sculpins (*Cottus spp.*) are generally present throughout the watershed. For the purpose of this watershed analysis, where distribution data are lacking, fish are assumed to be present in all 3rd order and larger streams. Using that assumption, resident fish are found in approximately 233 miles of stream within the watershed. Resident rainbow trout (*O. mykiss*) may still be present in Crabtree Creek as a result of stocking, although survival of hatchery rainbow trout is assumed to be very low. An isolated population of resident rainbow trout is suspected to exist above the waterfall at RM 34.5, but probably originated from stocked fish that dropped out of Crabtree Lake.

The Roaring River Fish Hatchery is located in the Crabtree Watershed, and is involved with raising rainbow trout for the Catchable Trout Program. Stocking of non-native resident fish in flowing waters statewide was discontinued in 1998 to comply with ODFW's Wild Fish Management Policy, which discourages release of catchable trout in anadromous waters. Hatchery rainbow trout are released in lakes and streams in Oregon that do not have anadromous fisheries, including Crabtree Lake. The Roaring River Fish Hatchery is also used for rearing summer steelhead from the South Santiam Fish Hatchery.

Instream Habitat Conditions

ODFW has conducted habitat inventories on several streams in the basin in conjunction with BLM and the Oregon Forest Industries Council. Surveyed streams are shown in Table 5-22. With the exception of the lower Crabtree Creek survey, surveys began at the mouth of each stream, and typically ended at road crossings with barrier culverts, property ownership lines, or headwater areas where the stream went dry. The lower Crabtree Creek survey began at the Hwy. 226 bridge at approximate RM 8. Reach changes were generally determined by changes in valley or channel form, major changes in vegetation type, changes in land use or ownership, or tributary junctions.

Table 5-22 Streams With Completed Aquatic Habitat Inventories in the Crabtree Creek Watershed.

Stream	Year Surveyed	No. of Reaches	Miles Surveyed
Lower Crabtree Cr.	1993	1	7.75
Upper Crabtree Cr.	1995	7	21.26
S.F. Crabtree Cr.	1995	2	7.01
Rock Cr.	1995	2	3.74
W.F. Rock Cr.	1995	3	2.68
Hunter Cr.	1995	1	0.80
S.F. Crabtree Cr.(trib.1)[1]	1995	1	0.48
S.F. Crabtree Cr. (trib. 2)[2]	1995	1	0.60
S.F. Crabtree Cr. (trib. 3)[3]	1995	1	0.75
Dorgan Cr.	1995	1	2.92
Shafer Cr.	1995	2	1.20
Total:		22	49.19

[1] Mouth in T. 11S, R. 2E, Sec. 34, NW¼, NW¼
[2] Mouth in T. 11S, R. 2E, Sec. 34, SW¼, NE¼
[3] Mouth in T. 11S, R. 2E, Sec. 34, SE¼, NE¼

ODFW has established benchmarks of desirable and undesirable values for the various habitat parameters included in the surveys, shown in Table 5-23.

Table 5-23 ODFW Aquatic Inventory and Analysis Benchmarks.

	Undesirable	Desirable
Pools Pool Area (percent total stream area) Pool Frequency (channel widths between pools)	 <10 >20	 >35 5-8
Riffles Gravel (percent area)	 <15	 >35
Secondary Channel % of Total Area*	<2	>6
Percent Eroding Streambank*	>10	<5
Large Woody Debris Pieces (per mile) Volume (m^3 per mile) "Key" Pieces (>60cm dia. & >10cm long per mile)	 <160 <320 <16	 >320 >480 >48

* Not included in ODFW Inventory and Analysis Habitat Benchmarks.

Table 5-24, following the narrative habitat descriptions below, is a summary of instream habitat conditions in surveyed reaches throughout the watershed.

Pool Habitat

Pools are a critical habitat element for many fish species, anadromous salmonids in particular. Deep pools provide cover from predators for juvenile and adult fish, holding areas for adult spring chinook in the mainstem rivers, rearing areas for juveniles, refuge from the velocities of high flows, and often provide cooler water during times of elevated water temperatures. Pools in higher order, constrained channels tend to be large and deep and are anchored geomorphically. Such pools may be relatively insensitive to effects of management activities, as their formation and maintenance are more determined by flow and geology. Effects of management activities and high flow events are likely to be greatest in low gradient, unconfined reaches of tributaries where bedload deposition and aggradation can occur.

Most of the surveyed reaches of the mainstem and South Fork of Crabtree Creek have pool frequencies and percent pool area that are considered “fair” to “desirable”, particularly in the lower reaches where anadromous fish are found. Hunter Creek, reach 2 of Rock Creek, both reaches of Shafer Creek, reach 3 of West Fork Rock Creek and one tributary to the South Fork received a “undesirable” rating for pool frequency and pool area.

Spawning Gravel Quantity

Instream gravels are highly mobile during high flow events. Where stable instream structure is lacking, gravels may be completely flushed out of the channel to flood plains and downstream areas. High flows can cause bank erosion and landslides that can be either detrimental or beneficial for spawning areas. Erosion and slides can negatively impact spawning gravels by depositing fine sediments in gravels but may also be beneficial by introducing new gravels into channels that are gravel limited.

All of the surveyed reaches rate "desirable" or "fair" for gravel quantity (percent gravel substrate, estimated in riffles). This assessment was not possible in the South Fork tributaries, reach 1 of Dorgan Creek, Rock Creek and reach 3 of West Fork Rock Creek due to absence of riffle habitat.

Off-Channel Habitat

Off-channel habitats include secondary channels and backwater areas. Both can be critical rearing areas for salmonid fry and also provide refuge for fish from the velocity of high flows. Secondary channels are most likely to develop in unconstrained and moderately constrained, low gradient reaches. Streams that have been channelized and/or subjected to large woody debris (LWD) removal and streams constrained by roads within the riparian zone often have less off-channel habitat than their gradient and level of confinement would allow in a natural state.

Reaches 1-4 of the Upper Mainstem, both reaches of the South Fork, Hunter Creek and reaches 1 and 2 of West Fork Rock Creek had high percentages of off-channel habitat. Most of the surveyed reaches with very low percentages of secondary channel habitat are headwater reaches with high gradient, confined channels in which secondary channel habitat does not usually develop, as noted above.

Streambank Stability (Percent Eroding Streambank)

Erosion of streambanks is a natural process and is necessary to ensure a continuous supply of gravel and cobble to stream channels. However, human activities such as agriculture, timber harvest and road construction often cause weakening of land forms that eventually lead to landslides and accelerated erosion of streambanks.

ODFW survey methods record the percentages of streambank within each reach that show signs of active erosion. All of the upper mainstem reaches, Dorgan Creek, Shafer Creek, Rock Creek, West Fork Rock Creek and reach 1 of the South Fork had very low percentages of bank erosion. The lower mainstem reach, which flows through predominantly agricultural lands had almost 30 percent actively eroding banks and was rated "undesirable," as were South Fork tributaries 1 and 2 with 37 and 31 percent. Reach 2 of the South Fork and tributary 3 were rated "fair."

In-Channel Large Woody Debris

LWD in streams helps to dissipate stream energy, retain gravels, nutrients, and organic debris,

aid in pool formation and maintenance, increase stream sinuosity, create diverse habitat for fish and other aquatic organisms, and slow the nutrient cycling process. Besides providing instream and overhead cover for aquatic organisms, LWD also provides a nutrient base and/or preferred substrate for many taxa of aquatic invertebrates. High flow events transport much of the LWD downstream, particularly in mainstem channels. Mainstem channels typically contain lower levels of LWD than tributary channels. Due to the greater channel width and higher stream energy of mainstem rivers, generally only the larger pieces are retained. LWD in tributary streams may be flushed downstream by high flows or debris torrents or it may remain if flows are not high enough to float the larger pieces. Landslides that occur during storms are a primary source of new instream LWD.

ODFW survey methods record the number of pieces of LWD (>15cm in diameter and >3m in length) per 100 meters of stream, as well as the volume of wood in cubic meters and the number of "key pieces" of LWD (>60cm in diameter and >10m in length) per 100 meters of stream. In Table X3, LWD counts have been converted to number of pieces and volume per mile of stream. Generally, LWD is severely lacking in the watershed particularly in the lower portions of the larger streams where anadromous fish are present. Some of the headwater reaches have good quantities of LWD that may eventually be flushed down into lower reaches of the watershed.

Table 5-24 Summary of Instream Habitat Conditions in the Crabtree Creek Watershed. Based on ODFW Habitat Benchmarks, unshaded values indicate desirable conditions while dark gray shading indicates values associated with undesirable conditions. Light gray shading indicates values that are in-between.

Reach	Length (miles)	Gradient (%)	Avg. Active Channel Width (ft.)	Pool Frequency (chan.widths per pool)	% Pools	% Gravel in Riffles	2º chan. %	% Eroding stream-bank	Woody Debris per Mile		
									Pieces[1]	Volume (m^3)	Key Pcs.[2]
Lower Mainst.	7.75	0.4	87	6	37	37	3.2	28.7	23	23	n/a
Upper Mainst. 1	5.06	1.0	126	7	18	33	15.7	1.0	26	24	<1
Upper Mainst. 2	5.37	1.7	78	11	15	18	10.1	0	78	110	<1
Upper Mainst. 3	4.16	3.5	78	9	10	30	21	0.4	166	148	4
Upper Mainst. 4	2.82	6.1	44	11	8	17	9.6	0	154	238	12
Upper Mainst. 5	1.94	1.9	31	18	18	55	2.3	0	105	134	3
Upper Mainst. 6	0.72	10.6	18	15	16	45	0.5	0	271	449	35
Upper Mainst. 7	1.20	2.4	11	43	88	32	0.1	0	177	223	7
Dorgan Cr. 1	1.23	6.5	17	19	6	N/A	0.6	2.3	307	553	11
Dorgan Cr. 2	1.69	4.7	23	17	23	29	1.3	2.1	609	2016	69
Hunter Cr.	0.80	6.9	N/A	N/a	0	20	7.7	4.7	136	306	10
Rock Cr. 1	1.17	9.3	30	15	5	N/A	3.4	0.7	108	306	3
Rock Cr. 2	2.57	9.3	10	54	9	28	1.2	0	168	346	2
Shafer Cr. 1	0.46	3.6	19	65	3	35	0	0	217	496	24
Shafer Cr. 2	0.74	11.1	13	99	3	32	0	0	231	747	32
WF Rock Cr.1	0.90	3.6	25	18	9	35	9.3	0	362	1107	38
WF Rock Cr.2	0.78	3.4	24	16	30	25	42.4	0.2	386	972	24

Reach	Length (miles)	Gradient (%)	Avg. Active Channel Width (ft.)	Pool Frequency (chan.widths per pool)	% Pools	% Gravel in Riffles	2º chan. %	% Eroding stream-bank	Woody Debris per Mile		
									Pieces[1]	Volume (m^3)	Key Pcs.[2]
WF Rock Cr.3	1.00	14.3	14	37	5	N/A	0.1	0	421	1312	65
S.F. 1	2.34	4.9	44	8	21	18	14.4	4.8	83	269	11
S.F. 2	4.67	7.9	27	15	11	30	5.5	8.9	168	448	11
S.F. Trib. 1	0.48	7.9	22	12	37	N/A	0.4	37.1	658	1604	40
S.F. Trib. 2	0.60	14.9	15	108	9	N/A	0	30.6	503	1550	28
S.F. Trib. 3	0.75	18	22	7	16	N/A	2.3	7.2	572	1928	80

[1] Includes all pieces of woody debris with a minimum diameter of 15cm and a minimum length of 3m.
[2] Includes all pieces of woody debris with a minimum diameter of 60cm and a minimum length of 10m.

LWD Recruitment Potential

Recruitment of LWD into a particular stream reach occurs when instream wood is moved from an upstream reach or when stream adjacent trees fall into the channel. The ultimate source of instream LWD is the adjacent riparian forest, generally within 100 feet of stream channels. The potential for suitable LWD input is partially dependent on the size and health of trees in the riparian zone. Trees in young stands (less than 40 years of age) may be too small to affect stream processes. Trees in the 40- to 80-year age classes may have adequate size but these stands are vigorous, and little mortality is likely to occur for several decades. Coniferous trees are generally more beneficial to streams than deciduous trees due to much lower decay rates in the aquatic environment.

In the Crabtree Creek Watershed, 15.5 percent of the riparian areas (within 30 meters of stream channels) have high potential for LWD recruitment to streams (dominant age-class >130 years) and only about 2.4 percent have moderate potential (conifer dominated or mixed forest, 80-130 years). The remaining 82 percent have low potential (conifers <80, hardwoods and non-forest). The North Fork Crabtree and Church Creek sub-watersheds have the highest potential for LWD recruitment (Table 5-25). The high percentage of riparian acreage with low potential is mainly due to the large number of acres of agricultural lands in the lower watershed and young conifer stands in the mid and upper portions of the watershed. Riparian areas with young conifer stands are common in all of the sub-watersheds but are most prevalent in the Roaring River and South Fork Crabtree sub-watersheds.

Table 5-25 LWD Recruitment Potential Within 30m of Stream Channels, by SWB.

SWB	Low		Moderate		High		Total Acres
	Acres	Percent	Acres	Percent	Acres	Percent	
Beaver Cr.	1623	89	20	1	193	11	1836
Church Cr.	2805	79	215	6	520	15	3540
NF Crabtree	3087	73	99	2	1057	25	4243
Rich. Gap	1371	93	16	1	93	6	1480
Roaring R.	1543	89	16	1	190	11	1749
SF Crabtree	2160	87	0	0	334	13	2494

Social

Human use is the predominant disturbance factor in the Crabtree Watershed. It is therefore important to have some understanding of the types and extent of human uses in the watershed. This section will more fully describe human uses in the watershed, the current social environment, and concerns associated with those uses. The influence of disturbance related to human uses on the other biological resources are more fully addressed in the terrestrial and aquatic sections of this chapter.

General Socioeconomic Environment

Before discussing specific human uses in the Crabtree Watershed, it is important to provide a general socioeconomic context surrounding and including the watershed. Linn County was selected as the scale of analysis because it includes all of the lands in the Crabtree Watershed and most of the communities within the zone of influence to those lands.

The Crabtree Watershed is in the northern portion of Linn County. The major source of the socioeconomic information provided is from the 1998 and 2000 "*Regional 4 Economic Profile,*" prepared by the Oregon Employment Department. Region 4 includes Linn, Benton, and Lincoln Counties.

County Population and Demographics

With Linn County's proximity to the I-5 travel corridor and the relatively high quality of life it offers, migration into the county is expected to be the major driving force of expected population growth in the county. The population of Linn County was 91,227 in 1990 and is expected to increase by 27 percent by the year 2010 to116, 053. Most of the increases will most likely occur near the larger cities and towns in the county, with additional growth in rural areas. Some of these areas include Lebanon, Sweet Home and Scio. The Crabtree Watershed is also within commuting distance to larger economic centers such as Salem and Albany, making private lands in the watershed desirable for residential development, where county zoning allows.

The median population age for Linn County is most likely to increase as the "baby boomers " of the 1950s and 1960s become older. U.S. Census figures rank Oregon's population as sixth nationally, for the oldest median age at 36.6 years of age. It is even higher in Linn County at 39.6 years of age.

Ethnic diversity is also increasing in Linn County. Census data from the 1980 survey indicated that three percent of those surveyed identified themselves in a nonwhite category. This increased to five percent in the 1990 Census survey. The largest growth occurred in the Asian/Pacific Islanders and the Hispanic categories.

Economy

Linn County's economy and employment have historically been dominated by agricultural,

lumber/wood, and rare metals industries. The largest industry shift has been a decline in the lumber/wood industry. The majority of this shift is due to technological improvements and a reduction in the timber supply on federal forests. In the 1970s, lumber products production accounted for one in every four non-farm payroll jobs in Linn County. Between 1979 and 1987, the mechanization of mills and other increases in efficiency resulted in a 40 percent reduction in the number of workers required for a given level of production. By 1994 through 1999, lumber products accounted for only one in every ten jobs. It is estimated that 2,100 jobs in the lumber products industry were lost in Region 4 between 1989 and 1994.

Mobile home manufacturing in Linn County has helped to mitigate the economic effect of declining lumber products. The manufacturing of mobile homes is a fast-growing business in the same industry designation as logging and lumber mills. In 1995 Palm Harbor Homes opened a Millersburg plant, providing 300 jobs.

While Linn County faces some economic challenges in the short term, the long term picture is encouraging. The production of grass and legume seed and other agricultural products continue to be major industry in Linn County. With Linn County's proximity to I-5, it is a prime location for future business development. This is beginning to pay off even now, as firms and businesses look further south into the Willamette Valley for relocation and expansion. Linn County's neighboring counties are also growing, providing jobs within commuting distance for many Linn County residents (Region 4 Economic Profile).

Forest Products

Federally Managed Lands

The BLM manages approximately 18 percent (18,008 acres) of the Crabtree Watershed. Timber management activities on BLM-administered lands are tied to the LUA specified in the Salem District RMP.

Under the guidance of the Salem District RMP, regeneration and thinning harvest is expected in GFMA and CONN. Some habitat management activities may also occur in Riparian Reserves and LSRs in an effort to meet habitat enhancement or other restoration objectives. Timber management practices on federal lands would meet or exceed the requirements of the Oregon Forest Practices Act (OFPA). See Table 2-1, Land Use Allocations for BLM lands, and Map 3, BLM Land Use Allocations with Riparian Reserves.

Private Industrial Timber Lands

Industrial forestry is the predominant private land use in the Crabtree Watershed. Approximately 38 percent (37,763 acres) of the land in the Crabtree Watershed is managed by private industrial timber companies or individuals for the primary purpose of providing commercial timber products.

Most private industrial forest companies seek to meet the economic objectives of their firm, while managing their lands on a sustained yield basis. However, changes in economic factors and differences in individual company policy can significantly affect harvesting levels and practices in the short and long term. For this reason, general assumptions about the management of private industrial forest lands in the Crabtree Watershed must be made. These assumptions are based on observed past and present management practices. For the purposes of this analysis, it is assumed that unless otherwise stated, private industrial forest lands in the Crabtree Watershed 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 nonindustrial private landowners vary, however, for the purposes of this analysis, it is assumed that these lands would be managed in a similar manner as private industrial forest lands. Private industrial and nonindustrial landowners are required to meet standards and guidelines provided in the OFPA.

State of Oregon Administered Lands

The Oregon Department of Forestry (ODF) manages approximately two percent (1,751 acres) of the land in the Crabtree Watershed. These lands are in a fairly contiguous block in the southern portion of the watershed, and are surrounded almost entirely by private industrial forest lands. ODF lands are managed to provide a continued source of revenue to counties and the state general fund on a sustained yield basis. They also provide for other public uses (i.e., recreation, water and wildlife) when appropriate. For the purposes of this analysis it is assumed that state lands would be managed in a similar manner as private industrial forest lands with an average rotation age of 50 to 60 years. Management of state lands is also required to comply with the Oregon State Forest Practices Act.

Special Forest Products

The collection of Special Forest Products (SFPs) for personal and commercial use is allowed on most BLM-administered lands in the Crabtree Watershed in compliance with the Salem District RMP. There is no formal inventory data on the type and amount of SFPs on BLM-administered lands in the watershed. When possible, information about SFPs is gathered during stand exams. Permits for the collection of SFPs are issued in response to requests. Based on past permits issued, moss and floral greenery are the most popular commercial SFPs in the Crabtree Watershed. Some of the other SFPs collected on BLM-administered lands in the watershed include mushrooms, transplants, boughs, edible plants, and non-sawtimber wood products like firewood. Authorized and unauthorized collection of similar SFPs most likely occurs on private

forest lands.

Major Concerns

Both the private land owners and public land management agencies are concerned with growing problems with illegal dumping, equipment and sign damage, vandalism, fire danger, long term occupancy, drug use/production, and the unauthorized removal of forest products.

With the increasing regulation and restriction of forest management activities on public forest lands, private forest landowners are concerned about being able to manage their lands according to their own objectives. This is a general concern in the forestry industry as a whole and extends beyond the boundaries of the Crabtree Watershed.

Residential and Agricultural Uses

Most of the residential dwellings and agricultural activities are in the western portion of the Crabtree Watershed, in the foothills of the Willamette Valley. These lands are intermixed with private and public forest lands where timber harvest activities are observable.

Forest management activities on BLM-administered lands located adjacent to or near private non-forest uses, especially residential dwellings, can create concerns for the BLM and residential property owners. In an effort to address these concerns early in the project planning process, areas with a potential for high sensitivity were identified in the Salem District RMP, as Rural Interface Areas (RIAs). These RIAs include BLM-administered lands within a ½ mile of private lands zoned for 1 to 20-acre lots or larger lots with homes nearby. Additional RIAs were identified on BLM-administered lands within a ½ mile of private lands with a *Rural Residential* County Zoning.

The Crabtree Watershed has approximately 1,613 acres of BLM-administered lands located within a RIA ½-mile buffer. See Map 18, Rural Interface Areas. The expected intensity of forest management activities within an RIA is guided by the underlying LUA. Approximately 986 acres within RIAs in the Crabtree Watershed would be expected to have a higher frequency and intensity of forest management activities GFMA. A lower frequency and intensity of forest management activities would be expected for the remaining 627 acres in CONN.

Most of the RIAs in the Crabtree Watershed have the potential for moderate to high sensitivity depending on the project type, size, and location. Some of the potential water quality and visual concerns associated with timber management activities may be mitigated by Riparian Reserves or green tree retention requirements. However, consideration of RIA issues and public scoping early in the project planning process is very important in this watershed.

Major Concerns

Most of the residential landowner concerns in RIAs are associated with timber management and recreational use. Timber management concerns are associated with potential negative impacts to water quality, scenic quality, recreational values and short term disturbance during logging operations (i.e., noise, dust, log truck traffic). Problems such as littering, vandalism, theft, trespass, fire use, shooting, and noise, and shooting associated with public use of BLM-administered lands near private property is also a concern. BLM concerns are associated with continuing to manage public lands in the watershed for forest products while minimizing significant impacts to adjacent and nearby private landowners.

Water Uses

Water uses and concerns within and downstream from the Crabtree Watershed are described in the Aquatic Section of this chapter on pages 26-28.

Roads and Access

Roads also play an important role in the level and pattern of human use in a watershed. Most of the agricultural and residential lands in the western portion of the Crabtree Watershed are accessed by public county roads. The forested lands in the eastern portion of the watershed are accessed by three main routes. These routes include Neal Creek Road (BLM controlled road) from the north, Snow Peak Mainline (privately controlled) from the west, and Quartzville Road (BLM controlled road) from the South. Though privately owned, the Snow Peak Mainline is the most frequently used route. The landowner recently installed a gate along the Snow Peak Mainline, but is currently leaving it open, except during periods of higher fire danger. All three of these roads are for the most part paved and are used by both passenger and high clearance vehicles. Several of the other main haul routes such as the D-line's and K-line's are rocked surfaced and may be passable by some passenger vehicles. Most of the secondary roads leading from these main access and haul roads are narrow, rock surfaced roads and may require a high clearance or four-wheel-drive vehicle.

Easements and Rights-of-Way

Access to public lands in the Crabtree Watershed is complicated by the checkerboard pattern of federal and private land ownership. This ownership pattern has resulted in the development of a complex system of road easements and right-of-way agreements between the BLM and private landowners. The following is a summary of the most common types of right-of-way agreements associated with roads.

Exclusive Easement: Grants control of the right-of-way of a road on private land to the United States Government and allows it to authorize third party use and set rules of use.

Nonexclusive Easement: Only allows use of a road on private land by the United States, its agents, and those authorized to do business on lands administered by the United States. The underlying private landowner still controls the road, subject to the rights granted to the United

States.

Reciprocal Right-of-Way: Grants the exchange of use between the United States and a private landowner. This right-of-way agreement provides for each party to use the other's roads or construct roads over the other's land.

Public use of BLM controlled roads: BLM controlled roads on public or private lands are not public roads. They are considered administrative roads designed and maintained for managing public land resources. Historically the public has been allowed to use these roads to access public lands. However, the road system is not static. To offset new road construction or to reduce road densities, existing roads may be closed and decommissioned. Roads may be left intact, but blocked to reduce full sized motorized vehicle access and disturbance to wildlife or resource damage such as garbage dumping, or erosion from excessive off-road use.

Access on Private Lands: Though not expressly authorized, use of private forest roads by the public to access public lands does currently occur unless the road is physically restricted. The gating or blocking of roads on private land is increasing, due to problems with vandalism, garbage dumping, resource damage, fire hazard and other criminal activity.

Major Concerns

Some segments of the public will continue to be concerned about maintaining public use of roads accessing public lands, while others may advocate for the closure of roads to encourage more non-motorized use. Private landowners will continue to be concerned about their access rights and the impacts of public use of their roads and lands. The BLM is concerned about providing for public access while still complying with right-of-way agreements and meeting other resource management objectives for the Crabtree Watershed and the Salem District.

Recreational Uses

The Crabtree Watershed offers a wide spectrum of scenic settings in the forested foothills of the Cascade Mountain Range for variety of dispersed recreation opportunities. The watershed's proximity to large population centers of such as Salem and Portland make it an important recreation resource in the Willamette Valley.

Yellowstone Special Recreation Management Area (SRMA)

An SRMA is an area that has been administratively designated by the BLM as having high quality recreation opportunities and significant recreation investment on BLM-administered lands. An SRMA designation provides the BLM with a way of emphasizing both staff and other resources related to recreation management in an SRMA, but does not in any way prescribe management objectives for non-BLM lands.

Approximately 39,000 acres of BLM-administered lands in the Crabtree and Quartzville watersheds have been designated as the Yellowstone SRMA (Salem District RMP). Crabtree Lake and the Snow Peak area are the major features in the Crabtree Watershed that fall within the boundaries of the Yellowstone SRMA. Green Peter Reservoir, Quartzville Creek, and the Quartzville National Back Country Byway are the major recreational features in the Quartzville Watershed that fall within the boundaries of the Yellowstone SRMA.

Recreation Opportunity Spectrum

To more clearly describe the recreational experience the Crabtree Watershed offers, the Recreation Opportunity Spectrum (ROS) planning system was used to help describe the recreation resources on private and public lands in the watershed. In classifying recreation opportunities, ROS considers access, remoteness, naturalness, facilities and site maintenance, social encounters, visitor impacts, and visitor management. There are seven major categories which progress from the most urban to the most primitive. These consist of ***urban, rural, roaded modified, roaded natural, semi-primitive (motorized and non-motorized), and primitive*** (see Appendix G). The Crabtree Watershed offers several of these settings including ***rural, roaded modified, roaded natural, and semi-primitive non-motorized.***

Rural Setting and Recreational Activities

ROS Rural Setting Characterization*: Characterized by an environment that is culturally modified to the point that it dominants. Cultural modifications are usually associated with agricultural activities, residential activities, and utility corridors. Moderate social interaction is expected.*

Most of the agricultural and residential lands the western portion of the Crabtree Watershed fall within a ***Rural*** setting. The primary cultural modifications are associated with grass seed and crop fields, pasture lands, and farm or residential dwellings. Though the cultural modifications dominate the landscape, the pastoral setting of this part of the watershed is quite scenic.

Existing Developed Recreation Facilities: The only developed recreation site is Larwood County Park located along Roaring River, near the southwest edge of the watershed boundary. Larwood County Park is a popular day-use area which features the Larwood Historical Covered Bridge. The site also offers picnic facilities, vault restrooms and parking.

Recreation Activities: Outside of Larwood Park, most of the land within the ***Rural*** setting is privately owned. As a result, recreational activities in this setting are primarily limited to those which occur on public roads, such as scenic driving and bicycle riding.

Other Significant Features: Both the Larwood and the Hoffman Historical Covered Bridge are located within the watershed and are part of several state and local covered bridge and historical tour routes.

Roaded Modified Setting and Recreational Activities

ROS Roaded Modified Setting Characterization: *Forest or other natural environment, with obvious modifications such as logging or mining activities, road access and limited facility development, within an open space context. Moderate social interaction is expected.*

Most forest lands in the eastern portion of the Crabtree Watershed fall within a ***Roaded Modified*** setting. These lands are characterized by a forested environment in varying states of seral stage development. See Map 8, Seral Stages. The natural setting on private and public lands 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 both private and BLM-administered lands are associated with restrictive signage and gates.

Existing Developed Recreation Facilities: There are no developed recreation facilities in this setting that are open to the general public.

Recreational Activities: The main recreational activities most likely occurring in this setting include undeveloped camping, hunting, target shooting, swimming, fishing, equestrian use and bicycle riding. Camping is prohibited on most of the private forest land in the watershed. Other uses which may occur more infrequently include berry and mushroom picking, and rock hounding.

In addition to the recreation activities listed above, the Hunter/Church Creek area (T. 11 S. R. 1 E. sections 15,16,17, 21, 23) historically received relatively high levels of f-highway vehicle (OHV) use. A fairly extensive trail system was informally developed by users that consisted of dirt skid roads and single track motorcycle trails. Due to concerns about erosion and wildlife disturbance, the area has been temporarily closed. With the closure of the Hunter Church Creek area, OHV use in the Snow Peak area may increase.

Significant Features: The Snow Peak area is receiving moderate levels of use and is the most significant feature on BLM-administered lands in this setting.

Roaded Natural Recreation Setting and Activities

ROS Roaded Natural Setting Characterization: *Forested or other natural environment, that is mostly natural appearing as viewed from sensitive roads and trails. Social interaction is moderate, but with some chance of privacy expected.*

Most of the BLM-administered lands in this setting fall within Carolyn's Crown, Shafer Creek and Crabtree Area of Critical Environmental Concern (ACEC). See Map 19, Special Areas. The setting in these areas is characterized predominately by mature and old-growth forests. Like the ***Roaded Modified*** setting, most of the roads are rock surfaced and on site controls of recreational use are associated with directional and restrictive signing and vehicle access restrictions to sensitive areas.

Existing Developed Recreation Facilities: There are no developed recreation facilities in this setting.

Recreational Activities: The main recreational activities occurring in this setting are very similar to those occurring in the ***Roaded Modified*** setting. Additional activities which most likely occur include hiking, nature study and photography.

Significant Features: Crabtree Lake and Crabtree Meadow are the significant features receiving recreation use in this setting. Below is a summary of each:

Crabtree Lake: Crabtree Lake along with Shafer Creek and Carolyn's Crown make up a 1,222-acre ACEC. Crabtree Lake is an Outstanding Natural Area (ONA) and Shafer Creek and Carolyn's Crown are Research Natural Areas (RNAs). Use of both RNA's is low and recreational use is not encouraged.

Crabtree Lake has historically received low to moderate levels of use. The main activities included camping, hunting, hiking, boating, fishing, motorcycle use, and use by educational and research groups. There are no developed facilities at the lake. Though use levels were relatively low, in the early 1990s the lake was showing signs of increasing resource impacts such as trash around and in the lake, human waste and damage to trees, and increasing fire rings. In an effort to reduce these impacts and encourage more non-motorized use, vehicle access was blocked approximately a quarter of a mile from the lake in 1992. A dispersed campsite inventory was conducted in 1993 and six established sites were identified. No new dispersed sites around the lake have been established since that time and resource impacts are significantly reduced. Since the closure, vegetation has grown in and the old road up to the lake now resembles a trail.

Currently the lake continues to receive low levels of use. Overnight use and day use is still allowed, but the area is not highly promoted to the public. More of the overnight use is occurring adjacent to the parking area below the road block. Though trash, human waste, and fire hazard are still a concern at these lower sites, they are well established and are not as sensitive as the area adjacent to the lake. In addition, the last mile of the road accessing the general area has deteriorated to the point of being difficult for passenger vehicles to use. The long term management of this road and the level of vehicle access that will be allowed needs to be evaluated for the area.

Crabtree Meadow: Crabtree Meadow is a large subalpine bear grass meadow located in the vicinity of Crabtree Mountain on the divide between Crabtree and Quartzville watersheds. The meadow is very scenic and has historically received low to moderate levels of use. It was accessed by a single-track jeep road running through the meadow. Vehicles generally stayed on the jeep road and impacts associated with dispersed camping were minimal. In the spring of 1998, off-highway vehicle users began driving off the jeep road throughout much of the meadow, causing significant damage to vegetation. In addition, large quantities of trash were found and several small trees were cut down or damaged from gunshot. To prevent further damage, vehicle access was blocked. In the summer of 2000, staff reported that vehicles were getting around the road block and again driving throughout the meadow.

Off Highway Vehicle (OHV) Use and Designations

An OHV is defined by the BLM in the Code of Federal Regulations (Subpart 8340.0-5) as "Any motorized vehicle capable of, or designed for, travel on or immediately over land, water, or other natural terrain, excluding:

(1) Any non-amphibious registered motorboat; (2) any military, fire, emergency, or law enforcement vehicle, while being used for emergency purposes; (3) any vehicle whose use is expressly authorized by the authorized officer, or otherwise officially approved; 4) Vehicles in official use; and (5) any combat or combat support vehicle when used in times of national defense emergencies."

Though BLM-administered roads are not public roads, motorized vehicle use of both the BLM and private forest roads does occur. This use is an important resource to many people in accessing public lands. The Salem District RMP provides a designation system that sets guidelines for the use of OHV vehicles on all BLM-administered lands in the District. The mapping and updating of OHV designations for the area including the Crabtree Watershed, were recently completed in 1999. Below are the designations for OHV use in the Crabtree Watershed:

Limited to Existing Roads and Designated Trails (ERDT): Approximately 11,270 acres of BLM-administered lands in GFMA and CONN are designated as ERDT. See Map 20, Off-highway Vehicle Designations. This includes the Riparian Reserves around all streams. This designation limits motorized use to existing rock surfaced roads, while still providing an opportunity for the designation of off-road trails. Currently no off-road trails have been designated as open to OHV use and no candidate areas have been identified.

OHV Designation	Acres
Limited to Existing Roads and Designated Trails	11,270
Limited to Designated Roads	6,426
Closed	312
Total	18,008

Table 5-27 OHV Designations in the Crabtree Watershed

Much of the BLM-administered lands in this designation are intermixed with private industrial forest lands. These landowners currently discourage off-road use by motorized vehicles. This makes it very difficult for the BLM to provide off-road opportunities, without contributing to trespass and resource damage on adjacent private lands. There is also growing concern about the resource impacts of off-road use on BLM-administered lands such as erosion into streams with threatened fish species, damage to vegetation, and disturbance to wildlife. These impacts could be somewhat mitigated in a managed trail system, however, without the involvement of adjacent landowners, such a system in not realistically feasible. Previous discussions with private landowners in the area indicate that they are not ready to enter into a cooperatively managed off-road OHV trail system due to liability and resource impact concerns. Groups or individual users may still propose existing or new trails for designation, however, obtaining adjacent landowner support and addressing resource damage concerns will be important factors in the approval process.

Limited to Designated Roads (DR): Approximately 6,426 acres of BLM-administered lands with an LSR are limited to designated roads (See Map 20, Off-highway Vehicle Designations). This designation is related to resource concerns listed for ERDT, with special emphasis associated with reducing disturbance to wildlife. Off-road use by motorized vehicles is not generally compatible with Late-Successional Reserve management objectives, so no existing or new trails would be designated for OHV use. The DR designation has not yet been fully implemented, so use of a majority of the existing roads is still occurring. Even with maps and signage, past observations indicate that the use of roads not designated as open is likely to continue until the road is gated or blocked. To be successful, this DR designation will require more aggressive road management and decommissioning efforts.

Closed: Carolyn's Crown ACEC (261 acres) and White Rock Fen ACEC (51 acres) are the only areas permanently closed to OHV use in the Crabtree Watershed. Currently there are no compliance problems in the Carolyn's Crown area.

Temporary Motorized Vehicle Closure: In October 1999, the BLM temporarily closed approximately 2,280 acres to all motorized vehicle use in the Church/Hunter Creek Area (T. 11 S. R. 1 E. sections 15,16,17, 21, 23), due to problems with loss of vegetation, soil erosion, and wildlife disturbance associated with off road use by four wheel drives, all-terrain vehicles and motorcycles. This temporary closure was instituted under the Closures and Restrictions authority in the Code of Federal Regulations, Subpart 8364.1. The temporary closure lasts until August 31, 2001, while restoration work takes place. After the closure expires, motorized access would revert back to the existing OHV designation which is ERDT. What level of long term motorized vehicle access will be allowed after that date needs to be determined.

Implementation Needs: Internal mapping of the OHV designations has been completed, however, maps for public use, brochures, and signage still need to be developed. In addition, the BLM is currently developing a new national strategy for OHV use. The development of district materials should follow the completion of the national strategy (December 2000) to ensure consistency. Staff time and funding for this program have historically been very limited. More support is needed if the program is to be adequately managed.

Visitor Use Estimates and Recreation Demands

There is no quantitative field-based recreation visitation data available for the Crabtree Watershed. Limited field observation indicates that visitation to this watershed is low to moderate, with the peak-use season being in the summer and early fall. More field-based use data is needed for estimating accurate visitations.

The Crabtree Watershed falls within Region 8 of the Statewide Comprehensive Outdoor Recreation Plan (SCORP). SCORP 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 setting. The SCORP report compared categories of "Used" verses a "Preferred" levels of demand for a recreational activity in each ROS setting. Those activities that show a higher demand in "Preferred" than "Used" suggests that there may be an inadequate supply of that setting for a particular activity. The SCORP data indicates that there is a shortage of ***primitive*** and ***semi-primitive*** settings for most of the recreational activities in Region 8 and that the "Used" category outweighs the "Preferred" category for most recreation activities occurring in ***rural*** and ***roaded natural*** settings. This is true for most of the other regions in western Oregon.

The ROS settings in the Crabtree Watershed reflect the SCORP findings, with the majority of public and private lands falling into the ***rural, roaded modified,*** and ***roaded natural settings***. Both ***semi-primitive*** and ***primitive settings*** can be found to the east in the adjoining Quartzville Watershed.

Major Concerns

Those groups or individuals that participate and support motorized off-road use will continue to be concerned about maintaining current use and providing new opportunities. Other users may support greater restrictions on off-road motorized use in favor of non motorized activities. Private landowners will continue to be concerned about their access rights and the impacts of public use on their roads and lands. The BLM is concerned about providing both motorized and non-motorized opportunities in a variety of ROS settings, while still meeting other resource management objectives for the Crabtree Watershed and the Salem District.

Visual Resources

Though not a direct human use, visual resources are an important resource to those living in or visiting the Crabtree Watershed. Much of the viewshed in the western portion of the Crabtree Watershed has been modified by human occupation or uses associated with agriculture, pastureland and residential activities, and power line corridors. While these modifications are readily evident, they tend to blend in with the form and texture of the natural landscape from more pastoral setting in the lower elevations near the valley to a forested setting in the higher elevations of the watershed.

The western portion of the viewshed in the Crabtree Watershed is dominated by forest lands. Visual modifications in this portion of the watershed are associated with roads, utilities, and timber harvest activities on BLM and private lands. The lines created with the removal of trees for roads, utilities and timber harvest units on private and public lands often contrast with lines, color and texture of adjacent forested areas.

To address visual resources on BLM-administered lands, a Visual Resource Management (VRM) classification system was developed and used to inventory all BLM-administered lands in the Salem District (Salem District RMP). There are four classes of scenic values within the VRM system. The classes range from Class I lands having the highest scenic values and receiving the greatest protection down to Class IV lands having the lowest scenic values and fewer modification restrictions.

Below is a summary of the visual resources on BLM-administered land in each VRM Class for the Crabtree Watershed. See Map 21, Visual Resource Management.

Table 5-28 VRM Classifications in the Crabtree Watershed.

Class I	Class II	Class III	Class IV
1,249 acres	0 acres	3,234 acres	13,525 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. The level of 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 (Salem District RMP, page 37)."

Approximately seven percent (1,249 acres) of BLM-administered lands in the Crabtree Watershed have a VRM Class I status. Most of these Class I lands are within the Carolyn's Crown, Shafer Creek, and Crabtree Lake ACEC's. The rest are waterfalls located in various locations throughout the watershed. There is no developed access to any of the waterfalls. All of the falls are located within Riparian Reserves, which should provide an adequate buffer from any adjacent projects. Timber management activities in these areas are expected to be low. In general any development associated with recreational use should be kept to a minimum for resource protection and public safety. Potential design and mitigation features would need to be developed on a site specific basis for any project that might potentially impact visual resources.

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 (Salem District RMP, page 37)."

There are no Class II lands in the Crabtree Watershed.

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. (Salem District RMP, page 37)."

Approximately 18 percent (3,224 acres) of the BLM-administered lands in the Crabtree Watershed have a VRM Class III status. Class III lands tend to be located on prominent peaks in the foothills or near residences.

The general sensitivity of the Class III lands in this watershed is moderate given that much of the Class III lands can be seen from several locations along county roads and from residences in the valley directly west of the foothills. Snow Peak is nearly 4,300 feet high and is one of the most prominent features in the area. Though only 1,320 feet in elevation, Buzzard Butte is one of the more prominent features in the valley foothills of the Crabtree Watershed, and is located in T. 11 S., R. 1 E., Section 17. Any projects planned on either of these features would be subject to greater sensitivity and should be evaluated carefully.

Many of the Class III lands are also intermixed with private industrial forest lands where timber management activities is often observable. A proposed project's impacts to visual resources on Class III lands will vary depending on the specific project design features and a number of mitigating factors such as the presence and location of riparian reserves, roadside vegetation buffers and vegetation buffers around residences. Visual resource impacts and potential mitigation measures should be considered for all projects on Class III lands.

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 (Salem District RMP, page 37)."

Approximately 75 percent (13,525 acres) of BLM-administered land in the Crabtree Watershed are classified as Class IV lands. Class IV lands generally have a low visual sensitivity and fall into the "seldom seen" category. In this watershed, Class IV lands are often adjacent to private industrial forest lands in which forest management activities are often observable. While sensitivity on Class IV lands is generally low, the impacts of proposed projects to visual resources should still be evaluated and mitigation measures considered.

Lands and Minerals

Interest in the commercial extraction of mineral resources and energy resources is currently low and is not expected to increase significantly in the near future. The primary mining activities on public and private lands in the Crabtree Watershed are associated with rock quarries for road building. Other uses are associated with right-of-way agreements for roads, utilities and two communication sites located on Snow Peak and Yellowstone Mountain. There are no known gas leases in the Crabtree 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 addition to the work done by the Salem Districts Law Enforcement Officer, an organization called the Linn Forest Protective Association was formed to try and resolve these issues for public and private forest lands in Linn County, including those lands in the Crabtree Watershed. The Linn Forest Protective Association is made up of state, local and federal agencies, and private industrial timber company representatives which meet on a regular basis to discuss and try to cooperatively resolve these prohibited uses. One of the outcomes of this association has been the cooperative funding of a Linn County Sheriff in since 1995, whose sole responsibility is to patrol forest lands in Linn County. The BLM started contributing in 1996. This has been a successful program to date, however, budget constraints may limit the BLM's ability to participate in this program.

Chapter 6 Future Conditions and Trends

Management Objectives and Direction

This chapter projects future trends of vegetation and ecological processes functioning in the watershed under the Northwest Forest Plan (NFP), Salem District Resource Management Plan (RMP), and other applicable federal and state laws and management plans. Lands within the Crabtree Watershed are managed by many landowners under a variety of management objectives.

The Oregon Department of Forestry (ODF) manages about 2 percent (1,751 acres) of the Crabtree Watershed as part of the Santiam State Forest. The final draft of *"Northwest Oregon State Forests Management Plan"* was issued during the fall of 2000. The *"Clackamas-Marion District Interim Implementation Plan"* describes forest management for all forest resources on the Clackamas-Marion District, and includes the State lands in Crabtree Watershed, which are located in Linn County. These documents describe a Structure Based Management Plan, based on current and desired future landscape design. Individual forest stands were classified by Forest Stand Types, which roughly correspond to seral stages. Current percentages of each Forest Stand Type were calculated and desired Future Conditions were determined based on a variety of management considerations.

A large percentage of State lands in the watershed are in the closed stand condition. Due to significant amounts of root disease and soil compaction caused by past logging, these stands probably would not be able to attain older forest structure in the next forty years. The district's primary goal is to eradicate root disease and regenerate stands that could develop into older forest structure over the long term. This goal would produce diverse stand structures in some areas through patch cuts, and increase species diversity by planting disease resistant species in disease pockets. Most of the older forest structure stands would be located along the streams. The desired future condition of State lands in the watershed would be to reduce the amount of acreage in closed stand conditions by about half and increase the amount of regenerated stands over current conditions. The amount of older forest structure would increase as previously logged stands along streams mature.

There are a large number of private landowners in the Crabtree Watershed with varying land management strategies and objectives. During the analysis, private lands were classified as either non-industrial or industrial private lands. Non-industrial private lands are owned by smaller private landowners and include the majority of the urban/rural residential, agricultural and non-forest types, especially in the Willamette Valley portion of the watershed. Non-industrial private lands comprise about 42 percent of the watershed. The industrial private lands are managed by commercial forest landowners, companies or corporations primarily for timber management. Industrial private lands comprise about 38 percent of the watershed. These lands are managed in compliance with the Oregon Forest Practices Act (OFPA), primarily on economic rotation lengths of 40 to 70 years. For the purposes of analysis, rotation lengths for private industrial and private non-industrial lands was assumed to be similar.

All of the 18,008 acres of federal lands in the Crabtree Watershed are managed by the Salem District BLM. These lands are managed according to the standards and guidelines of the Salem District RMP and the NFP to meet or exceed the OFPA. There are several Land Use Allocations (LUAs) within the Crabtree Watershed. See Map 4, BLM Land Use Allocations within the Crabtree Watershed. The majority of BLM lands in the Crabtree Watershed (7,209 acres) is in the General Forest Management Area (GFMA). These lands are to be managed on rotation lengths defined by culmination of mean annual increment, which generally is 70 to 100 years. Green tree retention is lower than that required for the Connectivity (CONN) LUA.

Contained within the Crabtree Watershed are portions of CONN blocks (4,061 acres) identified during the planning process. These blocks are located mostly in the Church Creek SWB and North Fork Crabtree SWBs. According to the Salem District RMP, these lands are to be managed on a 150 year rotation with greater green tree retention than GFMA. These CONN blocks are also designed to maintain 25 to 30 percent in older forest (late seral) conditions through time. The GFMA and CONN together form the Matrix LUAs on federal lands.

There are 6,738 acres of Late Successional Reserves (LSR) in the Crabtree Watershed located in the upper end of the watershed primarily in the North Fork Crabtree SWB, and to a lesser extent the Church Creek and South Fork Crabtree SWBs. See Map 4, BLM Land Use Allocations. There are 755 acres of LSR in the vicinity of Snow Peak that straddles the divide between Thomas Creek and Crabtree Creek. The remaining LSR in the watershed is part of the Quartzville/Middle Santiam LSR Wilderness complex. The Quartzville/Middle Santiam Wilderness complex is 92,400 acres in size and spans four major watersheds from Crabtree to the west, through Quartzville, into the North Santiam to the north towards Detroit Reservoir and south and east into the Middle Santiam watershed. Only about five percent of the complex is within the Crabtree Watershed. In addition to these mapped LSRs, there are two core areas on BLM lands for known spotted owl sites (KOSs) established before January 1, 1994. These core areas are to be managed as LSRs. According to the NFP, RMP and the LSRA, LSRs are to be managed to maintain and enhance late seral conditions over time.

Overlaying the entire BLM land base are Riparian Reserves. See Map 3, BLM Land Use

Allocations with Riparian Reserves. They have been identified as a buffer along all standing and flowing water, intermittent stream channels, ephemeral ponds, and wetlands. Riparian Reserves are to be managed to maintain and enhance riparian and late seral conditions to meet Aquatic Conservation Strategy objectives. 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. Stream densities in the Crabtree Watershed are fairly high and it is estimated that 44 percent of the total BLM land base is within a Riparian Reserve. Refer to the NFP and Salem District RMP for more details regarding standards and guidelines, and best management practices for the various land use allocations. See Figure 2-2, BLM Land Use Allocation Acres and Percentages in Crabtree Watershed, and Table 2-1, Land Use Allocations for BLM lands in the Crabtree Watershed.

Terrestrial

Vegetation Patterns

The current 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 Crabtree 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 events) will continue to affect the terrestrial domain across the watershed and may be exacerbated by fire exclusion and resource extraction related activities.

The current proportion of forest/non-forest types is expected to remain approximately the same at 65 percent forest, and 35 percent non-forest types. The non-forest types in the urban/rural residential/agricultural areas may increase slightly over present conditions as urbanization continues its eastward expansion into the lower reaches of the watershed. Declines in hardwood/mixed forest types in the lower portion of the watershed are expected to continue as a result.

Seral Stages

Late seral habitat on non-federal lands is expected to stabilize at levels of less than five percent of the watershed. OFPA riparian buffers and resource protection sites on non-federal lands are expected to contribute to late seral habitat in the future. Assuming an average rotation of 60 years on non-federal lands with even flow of harvestable acres over time, approximately a third of the forest types would be distributed between each of the 20 year age classes (0 to 20; 20 to 40; and 40 to 60 years of age). However, due to harvest patterns in the past, a larger percentage will be reaching harvestable age than would if the acreage was on a even flow of harvest over the length of the rotation. Currently, closed sapling stands over 40 years of age occupy almost half of the forest types on non-federal lands. These stands are expected to be thinned and harvested as they approach 60 years of age. This uneven distribution of age classes is expected to continue in the future as large acreages reach harvestable age within the next 20 years. This is the case in the South Fork Crabtree SWB, where 67 percent of non-federal lands are over 40 years of age. In Church Creek and Roaring River SWBs, about 50 percent of non-federal lands are over 40 years of age.

According to the NFP and the RMP, a minimum of 15 percent of the federal lands in any given watershed should be in late successional (late seral) conditions over time. Currently, about 35 percent of the federal land in the watershed is in late seral habitat. The amount of late seral habitat on federal lands is expected to increase under the NFP and RMP. The distribution of late seral habitat would generally follow riparian reserves on matrix lands, and would include LSRs and the 25 percent late seral in Connectivity blocks. As LSRs and Riparian Reserves are allowed to develop over time, about 64 percent of the federal lands in the watershed have the potential to become late seral habitat within 80 years under current management. In the long term, the 15 percent late seral retention guideline and the 25 to 30 percent older forest retention in CONN would be represented entirely within LSRs and Riparian Reserves.

Currently, about 11 percent of the watershed (all ownerships) is in late seral habitat. With the development of riparian reserves and LSRs on federal lands and OFPA buffers on non-federal lands, the entire watershed has the potential to support 14 to 16 percent late seral habitat within 80 years under current management. There would be a shift in the distribution of late seral habitat across the watershed, however the total amount of late seral in the watershed would increase only slightly over current conditions. This is due to the relatively small total percentage of federal lands (less than 20 percent) which limits how much these lands can contribute to late seral conditions in the Crabtree Watershed over time.

Ultimately, the Matrix (excluding Riparian Reserves) across all ownerships in the watershed will consist of early to mid seral stages 0 to 60 years of age. The patch elements will continue to be older forests 80 to 200 years plus. Distribution and connectivity of late seral 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 lands would provide some degree of connectivity in the future.

Habitat Quality

The amount of interior late seral habitat is expected to increase on federal lands as LSRs and Riparian Reserves develop into older forest. Currently, there is very little interior forest habitat on non-federal lands, which is expected to be the case in the future as well. No future regeneration harvest within the LSR and road closures will enhance the quality of interior late seral in the upper portion of the watershed.

Special Habitats

The majority of the identified special habitats on federal lands within the Crabtree Watershed are either within Riparian Reserves, ACEC or LSR and would be protected from most human intrusion. However, these areas are not immune to degradation. Meadows, wetlands, and lakes can be diminished by the regrowth of trees and invading brush. In the past, disturbance caused by wildfires and beavers have helped maintain these systems. Based on comparisons of aerial photos from the 1950s and 1998, the Snow Peak ecosystem exhibits signs of encroachment due to fire exclusion. This process can be expected to continue unless prescribed fire or other means is used to limit forest encroachment on meadow ecosystems.

A comparison of aerial photos from the 1950s and 1998 show degradation due to roads and off-highway vehicle (OHV) use. Special habitats adjacent to forest roads that are open to public vehicle use are at the greatest risk from human impacts. These areas are the most accessible to OHV use. The result of OHV use can be compaction, vegetation trampling, channeling and altering of water courses, and the degradation of sensitive plant and animal habitats. With our current OHV management, these practices may continue and accelerate the degradation of these sensitive ecosystem components.

The majority of Buzzard Butte is located on BLM lands in GFMA. Buzzard Butte meadows and the adjacent streams would be protected with buffers and Riparian Reserves. The resulting buffers would leave small, unprotected areas in the vicinity of the Buzzard Butte.

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 down and decompose. Over the long term, the amount of standing dead on federal lands is expected to approach 60 percent of potential cavity dwelling wildlife populations as late seral develops in LSRs and Riparian Reserves and green tree retention guidelines are implemented. On non-federal lands, OFPA requirements for standing dead and stream buffers would help contribute to the standing dead resource across the watershed.

Down CWD is expected to decline in the short term as material in more advanced stages of decay continues to decompose. Over the long term, down CWD on federal lands is expected to increase as LSRs and Riparian Reserves develop into late seral and green tree retention guidelines are implemented. The OFPA requirements for down logs and buffers would help contribute to down CWD on non-federal lands in the future.

Roads and Transportation

Road densities are expected to increase slightly within the watershed as additional roads are constructed for timber harvest on non-federal lands. Average total road density on federal lands is estimated at about five miles per section, which is high. BLM 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. This trend is expected to continue, with no net increase and likely a net decrease in road densities on federal lands in the future.

Currently, there is a high percentage of roads which are at least seasonally closed which helps reduce disturbance to wildlife, particularly on non-federal lands. 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

Plants

Two of the species identified previously, *Cimicifuga elata,* tall bugbane, and *Huperzia occidentalis,* fir clubmoss, that occur in the Crabtree Watershed are associated with riparian areas. Potential habitats for *Corydalis aquae-gelidae,* a riparian dependent species, will increase over time with the development of Riparian Reserves. The other species that occurs in the watershed is *Bridgeoporus nobilissimus*, which is associated with higher elevation old growth forests. Management recommendations for this species involve protection with reserves. Other old-growth associated species suspected to occur in the watershed include: *Allotropa virgata, Ptilidium californicum,* and *Corydalis aquae-gelidae*. Habitat conditions on federal lands for these species are expected to improve in the long term.

Most of the native Willamette Valley habitats have been converted to agricultural/rural areas. Invasive plant species have become established in the ecosystem, and are expected to continue to compete with native vegetation. Habitat conditions for Willamette Valley Special Status plant species known or suspected to occur in the Crabtree Watershed are expected to remain stable or continue to 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.

Animals

Habitat conditions for late seral species of concern are expected to improve slightly in the long term. Although the amount of late seral habitat on federal lands is expected to increase significantly, the relatively small percentage of federal lands in the Crabtree Watershed (less than 20 percent) limits how much federal lands can contribute to late seral conditions over time. There would be a shift in the distribution of late seral habitat to federal lands over time.

Habitat conditions for early and mid seral stage species are expected to improve over time as non-federal lands approaching harvestable age are harvested.

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 both federal and non-federal lands.

Threatened and Endangered Species

Bald Eagle

Habitat conditions for the bald eagle are expected to improve over time as riparian areas along larger streams develop, providing more trees suitable for nesting and perching. This will especially be the case on federal lands in the vicinity of the mainstem of Crabtree Creek and the Roaring River. Bald eagles have been observed in these areas, and there is a nesting pair known to occur just outside of the lower end of the watershed.

Northern Spotted Owl

Suitable habitat for the northern spotted owl is expected to follow the same trends as described previously for late seral habitat and species. Overall, habitat condition for the spotted owl is expected to decline then stabilize in the long term. The Crabtree Watershed will continue to be an important link by providing dispersal between the Quartzville LSR to the east, and the Thomas Creek Watershed to the north and west. However, spotted owl dispersal out of the Crabtree Watershed is limited by the scattered federal ownership and the North Santiam River Corridor to the north, the South Santiam River Corridor to the south and the Willamette Valley on the west. The most significant lands in the watershed for spotted owl movement are the BLM lands in the North Fork Crabtree SWB. These lands are directly connected to the large LSR/wilderness network to the east of the watershed where the majority of dispersal between known spotted owl sites in the Cascades Range takes place. Suitable and dispersal habitat conditions in this portion of the North Fork Crabtree SWB are expected to improve as LSR continues to develop late seral conditions over time.

The distribution of suitable and dispersal habitat will follow Riparian Reserves on federal lands and will include the LSRs and the 25 percent late seral in the CONN blocks. Distribution and connectivity will be disrupted by the fragmented pattern of federal ownership in the watershed. Due to harvest patterns in the past, closed sapling stands over 40 years of age occupy almost half of the forest types on non-federal lands. As a result, these stands are expected to be thinned and harvested as they approach 60 years of age. This uneven distribution of age classes could limit dispersal capabilities from Thomas Creek and the western portion of Crabtree Watershed through South Fork Crabtree, Church Creek and Roaring River SWBs. North Fork Crabtree SWB should remain viable for dispersal, however, ownership patterns will limit dispersal capabilities through this SWB as well.

Of the seven known spotted owl sites (KOSs) with site centers in the watershed, three were found to be viable. These three sites are located in the North Fork Crabtree SWB on BLM lands in LSR. Of the other four sites, three are considered to be non-viable. The other one, located in the Church Creek SWB is marginal, but occupancy and reproduction appears to be stable. In the long term, the three viable sites on BLM lands in the LSR are expected to remain viable. Due to the lack of suitable spotted owl habitat and fragmented federal ownership, the remaining four sites in the watershed are not expected to be viable or stable in the long term.

The number of barred owl sightings in the watershed have increased dramatically in recent years, and are expected to continue to increase as nesting pairs produce young. Nesting has been documented in the lower end of the Crabtree Watershed. Barred owls have been observed in the Richardson Gap, Roaring River, Church Creek, and Beaver Creek SWBs. To date, there have been no known sightings in the upper end of the watershed in North Fork or South Fork Crabtree SWBs. However, in the future, barred owls are expected to continue their expansion into these SWBs.

Potential future conditions of the spotted owl and its habitat in the Crabtree Watershed was estimated and the results are shown in Table 6-1.

Table 6-1 Future Status of the Spotted Owl and its Habitat within the Crabtree Watershed

	Total in WA	Total in LSR (%)	Total not in LSR (%)
Acreage within Boundary	100,022	6,738 (7%)	93,284 (93%)
Acreage of Federal	18,008	6,738 (37%)	11,270 (63%)
Federal Suitable Spotted Owl Habitat	10,878	6,204 (57%)	4,674 (43%)
Federal Dispersal Plus Spotted Owl Habitat	13,027	6,204 (48%)	6,823 (52%)
Federal Capable Plus Spotted Owl Habitat	17,333	6,204 (36%)	11,129 (64%)
Federal Critical Habitat	6,830	5,966 (87%)	864 (13%)

(% suitable habitat)	Total in WA	Total Protected (in LSR)	Total Unprotected (not in LSR)
Spotted owl sites (>40%)	3	3	0
Spotted owl sites (20-40%)	0	0	0
Spotted owl sites (<20%)	1	0	1
Total Spotted Owl Sites*	4	3	1

*** Estimates of individual sites are based on current known spotted owl sites at current locations.**

Aquatic

Hydrology

Peak flows, low flows, and annual water yields will continue to fluctuate depending on precipitation and temperatures. Yearly precipitation in the area tends to cycle between wetter than average periods and dryer than average periods approximately every 20 years. Stream flow in forested basins is also affected by evapotranspiration. Forest harvest has been shown to reduce evapotranspiration. Harvesting may also affect snow accumulations and melt.

Future harvesting and the addition of new roads may affect water yields, peak flows and stream dynamics, depending on the timing of harvest and road locations. Roads affect stream flows and yields 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 basins 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).

The major uses in the watershed will continue to be forest products, wildlife habitat, and water. Agriculture will continue to be the major use in the lower portion of the watershed. The potential conflicts over allocation of stream flow during low flow periods could escalate due to an increase in consumptive use over time.

Under the Salem District RMP and OFPA, much of the Crabtree Watershed will continue to be harvested on a rotational basis. On federal lands, the average age of forest stands will increase as areas classified as Riparian Reserve and LSR mature. 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 access stands for harvest in the future.

Water Quality

Most of the Crabtree Watershed is forested and managed for the production of wood products. In general, private forest lands are harvested under a rotation age of approximately 50 to 60 years. While harvesting in the watershed occurs almost constantly, large tracts of forests which were previously harvested and regenerated are approaching 50 years in age, and could be harvested within the next decade. This harvest cycle will continue into the future resulting in a disturbance regime much shorter than the pre-European settlement disturbance cycles.

Water quality in the watershed will continue to be affected primarily by commercial and agricultural activities. The current disturbance cycle will continue to affect steam dynamics and sediment regimes. Roads will continue to have a major influence on storm water routing and stream sediment loading.

Under 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 of the NFP will improve overall water quality within the watershed. Stream shade and woody debris recruitment will improve in the long term as forest practices evolve and young stream adjacent forests mature in Riparian Reserves. This could result in lower stream temperatures, improved fish habitat and stream structure.

Soils

Soil properties, classifications, series descriptions, and soil maps of the Crabtree Watershed are contained within the *Soil Survey of Linn County Area Oregon*.

Soil Stability

The relationship between pyroclastic rock and slope stability was studied by the USFS on the H.J. Andrews Experimental Forest by Dyrness (1967). In this study, 94 percent of mass soil movement events occurred on the 37 percent of the area made up of pyroclastic material, and 8 percent of the area made up of green tuff and breccias. 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, 2.45 cubic meters per hectare per year for clearcuts, and 26.19 cubic meters per hectare per year associated with roads. 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 on areas of steep to extremely steep slopes (70 to 100%) occur in old-growth Douglas-fir stands.

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. Future mass erosion and slumping rates will be influenced by logging and roading activities in the watershed, which will cycle as large tracts of forest land reach harvest age. Upper reaches of the watershed under federal control and designated as LSRs will approach natural erosion rates, except where influenced by existing roads.

Fisheries

Fish and Aquatic Habitat

Management of federal lands under the standards and 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, provided that climatic conditions and harvest restrictions remain favorable for threatened fish populations. However, in the Crabtree Creek Watershed, most of the federal lands are in the upper portions of the Beaver Creek, Roaring River and North Fork Crabtree SWBs, upstream of the range of anadromous fish. Improvement in the LWD recruitment potential in the upper SWBs due to retention of NFP Riparian Reserves will benefit downstream threatened anadromous fish populations, but to a far lesser degree than if anadromous habitat existed on blocked-up federal lands. Specific management policies and actions expected to result in improvement of fish habitat conditions are retention of NFP Riparian Reserves, attainment of Aquatic Conservation Strategy Objectives and watershed restoration, in upland as well as riparian and instream areas.

Fish habitat conditions on non-federal lands, managed under the OFPA are expected to continue to decline until a considerably 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 Plan for Salmon and Watersheds* and the *Willamette Restoration Initiative* may lead to improvement in fish habitat conditions on non-federal lands.

Social

With Linn County's proximity to the I-5 travel corridor and the relatively high quality of life it offers, migration into the county is expected to continue as the major driving force of expected increases in the county's population. The population of Linn County was 91,227 in 1990 and is expected to increase by 27 percent by the year 2010 to116,053. With Linn County's proximity to I-5, it is a prime location for future business development. This is beginning to pay off even now, as firms and businesses look further south of the Portland area into the Willamette Valley for relocation and expansion. Though the smaller rural areas may not see as rapid rate of growth, some economic development would be expected. In addition, growth in neighboring urban such as Salem, Albany, Corvallis and Lebanon would also provide employment opportunities for those willing to commute from outlying rural areas.

Forest Products

Federally Managed Lands

Wood products will continue to be provided from BLM lands consistent with the Salem District RMP and NFP. The majority of wood products will most likely come from lands in the GFMA and CONN LUAs. No specific estimates of volume have been forecasted in this analysis.

Private Industrial Timber Lands and State of Oregon Lands

It is expected that unless a desirable and cost effective substitute becomes available, demand for wood products will most likely remain fairly high. 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 makes it likely that the predominant land use on private lands in the Crabtree 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, as well as economic and regulatory factors. Similar trends are expected for small private woodlot lands and lands managed by ODF.

Special Forest Products

Special Forest Products (SFP) has potential for growth as demand for existing products grow and if noncommercial products become more marketable. A SFP inventory and modeling system may increase the marketability of these products, both on private and public forest lands.

Residential and Agriculture

Much of the forecasted population growth for Linn County will most likely occur around the existing population and economic centers of the county such as Albany and Lebanon. However, the Crabtree Watershed is close enough to the I-5 corridor that some growth in residential activity would be expected in the watershed. Current zoning in the majority of the watershed would restrict the lot division to no less than 80 acres, unless a county variance is granted.

Sensitivity to timber management activities and public use on BLM lands adjacent to residential lands will continue to be a concern. Sensitivity would be expected to increase if the number of residences around BLM lands increases. Harvest of private industrial timber lands may also reduce buffers between residential dwellings and BLM lands, increasing sensitivity of specific areas.

Water Rights

The existing water rights will most likely be maintained. Currently, there are concerns about water quantity and quality in the Crabtree Watershed. These concerns will most likely increase as the demands for water use increase.

Roads and Access

Overall public motorized vehicle access to BLM lands is expected to decrease over time. This is partially due to gates on private lands and efforts by the BLM to reduce road densities including road decommissioning, storm proofing, blocking and gating. Public access would be significantly limited if the Snow Peak Mainline was permanently or seasonally closed to motorized vehicle use.

Recreation Uses

Roaded Natural and Roaded Modified will continue to be the predominant setting on BLM lands and on most of the private industrial timber lands. Lands classified as rural are not expected to increase or decrease significantly in the next ten years.

One of the trends that may become a concern in this watershed is the ongoing reduction of public access for both passenger car use and off-highway vehicle use. It has become increasingly difficult for the BLM to provide for this activity given the resource concerns associated with motorized use and the patchwork ownership pattern with private land. This trend may become a concern on a regional basis as well. As a result of the Hunter/Church Creek closure, OHV use in the Snow Peak and Hammond Camp area may increase.

In contrast, opportunities for participation in recreational activities in non-motorized roaded natural and semi-primitive settings will most likely increase, helping to meet the demand shortages that currently exist.

With growing time and economic constraints, recreational opportunities close to communities will become more popular. Given the proximity of the Crabtree Watershed to the I-5 corridor, the demand for local developed and undeveloped recreational opportunities in all the ROS settings is expected to increase.

Visual Resources

In general, it is expected that most of the modifications to the Crabtree viewshed would be associated with timber harvest on private and public lands. These modifications would continue to be readily observable in most of the watershed. If population continues to grow in the rural areas within the Crabtree Watershed, sensitivity associated with timber management activities on BLM lands may increase. The majority of the viewshed modifications would take place in the GFMA and CONN LUAs.

Lands and Minerals

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

Prohibited Uses

Under the existing management situation, prohibited uses would most likely increase in the Crabtree Watershed. If the closure of private and public lands continues, prohibited uses on the remaining lands open to motorized use are likely to increase. It is hoped that the efforts of cooperative organizations such as the Linn County Forest Association and the Salem District's Law Enforcement Officer can help deter such activities.

Chapter 7 Management Recommendations

Terrestrial

Findings:

Terrestrial Finding #1- Late Seral or Late Successional (mature and old-growth) Forest Habitat: The amount and quality of late seral forest habitat is limited in the Crabtree Watershed. The analysis of current conditions shows 11 percent late seral forest across all ownerships. Less than five percent is in old-growth over 200 years of age. For BLM lands, the amount of late seral is considerably higher at 35 percent. About 21 percent of BLM lands is in old-growth forests. Sixty percent of the late seral forest in the Crabtree Watershed is on BLM lands.

The amount and quality of late seral forest was further analyzed by sub-watershed basin (SWB). North Fork Crabtree SWB and Church Creek SWB have the most late seral with 27 percent and 17 percent, respectively. Seventy percent of the remaining late seral in the watershed is found in these two SWBs. Late seral forest is most scarce in Richardson Gap SWB (<2%), Beaver Creek SWB (3%), Roaring River SWB (8%), and South Fork Crabtree SWB (10%).

Twenty one percent of the remaining late seral in the watershed is functioning as interior late seral forest habitat. With the development of Riparian Reserves and Late Successional Reserves (LSRs) on federal lands and Oregon Forest Practices Act (OFPA) buffers on non-federal lands, the entire watershed (all ownerships) has the potential to support 14 to 16 percent late seral forest habitat within 80 years under current management. Due to the small total percentage of federal lands in the Crabtree Watershed (less than 20 percent), there are limits to how much federal lands can contribute to late seral forest habitat over time.

Terrestrial Finding #2 - Standing Dead/Down Coarse Woody Debris (CWD): There is a scarcity of standing dead/down CWD habitat, especially larger material in the early stages of decay. Estimates show that the amount of standing dead/down CWD are below *Northwest Forest Plan* (NFP) and *Salem District Resource Management Plan* (RMP) standards. Over the long term, the amount of standing dead material on federal lands is expected to approach 60 percent of potential cavity dwelling wildlife populations as late seral forest develops in LSRs and Riparian Reserves and green tree retention guidelines are implemented. There would be a slight increase of standing dead/down CWD on private/state lands as relatively new OFPA requirements continue to be implemented.

Terrestrial Finding #3 - LSR Boundaries: LSR boundaries in the vicinity of Harry Mountain Ridge and the Snow Peak area delineated by the Salem District RMP follow interior section lines rather than topographic features and/or known Special Status/Special Attention Species occurrence. Managing along legal boundaries irrespective of ecological features and species occurrence would be inconsistent with the management of these LSRs as ecosystems and protection of known Special Status/Special Attention Species. Adjustment of LSR boundaries along topographic features, type changes or even roads rather than legal boundaries would make the LSRs more ecologically sound.

Terrestrial Finding #4 - Special Habitats: On BLM lands, the Snow Peak cosystem and Carolyn's Crown/Shafer Creek/Crabtree ACEC are priority special habitat complexes in the Crabtree Watershed. Buzzard Butte and White Rock Fen ACEC are unique special habitat features that are also important.

Terrestrial Finding #5 - Willamette Valley Habitats: A fairly large portion of the Crabtree Watershed is within the Willamette Valley Physiographic Province. A number of bird species that are considered to be Willamette Valley habitat specialists are known or are suspected to occur on non-federal lands in the watershed. These species include the yellow-breasted chat, grasshopper sparrow, vesper sparrow, and western meadowlark. They prefer native Willamette Valley habitats such as grasslands and riparian areas along larger streams and rivers. The Richardson Gap area has been identified as a Grassland Bird Conservation Area (BCA), according to the *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (American Bird Conservancy, March, 2000). Under the Conservation Strategy, non-federal landowners can pursue cooperative agreements and funding to maintain, improve, restore and/or protect native Willamette Valley habitats, especially in the Richardson Gap Grassland BCA. Cooperative programs and funding opportunities are described in the Implementation Section, Chapter 9, of that document. A number of voluntary programs are available to private landowners which provide financial and technical assistance. Programs include those administered by the U.S. Department of Agriculture under the 1996 Farm Bill, the Wildlife Habitat Conservation and Management Program administered by Oregon Department of Fish and Wildlife, and matching funds provided by private foundations such as the National Fish and Wildlife Foundation.

Terrestrial Finding #6 - Road Densities: There are approximately 603 miles of road on all ownerships within the watershed. Currently, the average total road density across all ownerships is estimated at about four miles per section. Of the 603 total road miles in the watershed, 130 miles are on federal lands (22 %). Average total road density on federal lands is estimated at about five miles per section, which is high. Road densities on federal lands are highest in the South Fork Crabtree, Richardson Gap, and Church Creek SWBs (over fivemiles per section). North Fork Crabtree Creek and Roaring River SWBs have road densities between four and five miles per section. Road densities on federal lands are lowest in Beaver Creek SWB.

Terrestrial Finding #7 - Special Status/Special Attention Plant Species: There are four known populations of BLM special status plant species populations and numerous known survey and manage species sites in the watershed. These species include tall bugbane, *Cimicifuga elata,* fir clubmoss, *Huperzia occidentalis*, meadow sidalcea, *Sidalcea campestris*, and noble fir polypore fungus, *Bridgeoporus nobilissimus*.

Terrestrial Finding #8 - Noxious Weeds: New invader and established infestation noxious weed species are present along many roadsides in the watershed. These noxious weeds are present and will continue to invade native plant habitats if no action is taken. Noxious and invasive weeds will continue to be a concern over time because of the increased human use of the watershed, especially at lower elevations and in travel corridors.

Terrestrial Finding #9 - Special Status/Special Attention Animal Species: There are three Survey and Manage mollusk species that are documented to occur in the Crabtree Watershed. The Oregon megomphix *(Megomphix hemphilli)*, and two tail-dropper slugs, the blue-gray tail dropper *(Prophysaon coeruleum)* and the papillose tail dropper *(Prophysaon dubium)*.

The red tree vole, a Survey and Manage species, has been documented to occur in the Church Creek SWB, and is highly likely to occur elsewhere in the watershed. The Crabtree Watershed is 18 percent federal ownership, of which 52 percent is suitable habitat for the red tree vole. The majority of red tree vole habitat occurs in the Church Creek and North Fork Crabtree SWBs.

Four bat species identified in the NFP as species in need of additional protection are highly likely to occur in the Crabtree Watershed. They are the silver-haired bat, long-legged myotis, long-eared myotis, and pacific western big-eared bat.

Eight additional Bureau Sensitive species have been documented or are highly likely to occur in the watershed. These include the harlequin duck, peregrine falcon, goshawk, common nighthawk, Lewis' woodpecker, purple martin, yellow-breasted chat and western meadowlark (See Appendices C-1 and C-2).

Terrestrial Finding #10 - Bald Eagles: There is one known bald eagle nest site near the lower end of the Crabtree Watershed. The nest tree itself is just outside the watershed, however, the bald eagles are known to utilize Crabtree Creek in the lower end upstream as far as Church Creek and Roaring River SWBs. There are no bald eagle concentrations or winter roosts in the Crabtree Watershed. Wintering birds are thought to be the local birds that nest in the vicinity. There is suitable bald eagle nesting habitat on BLM lands in the vicinity of Crabtree Creek in the Church Creek SWB.

Terrestrial Finding #11 - Nesting Spotted Owls/Habitat: The only portion of the Crabtree Watershed that was found to be viable for nesting spotted owls was the upper portion of North Fork Crabtree SWB on BLM lands in the LSR. The North Fork Crabtree SWB and the Church Creek SWB were found to be marginal to limiting for nesting spotted owls. The Beaver Creek, Richardson Gap, Roaring River, and South Fork Crabtree SWBs were found to be non-viable for nesting spotted owls.

Of the seven known spotted owl sites (KOSs) with site centers in the watershed, four were found to be viable. Three sites of these sites are located in the North Fork Crabtree SWB on BLM lands in the LSR. One located in the Church Creek SWB is limiting, but occupancy and reproduction appears to be stable. The other three sites are considered to be non-viable.

Terrestrial Finding #12 - Connectivity/Dispersal Habitat: Connectivity between the Snow Peak LSR in Thomas Creek and the Quartzville LSR is through the Crabtree Watershed along the Riparian Reserves. The Mid-Willamette LSR Assessment (LSRA) modeled connectivity and the analysis showed restoration within Riparian Reserves would improve connectivity by 14 percent.

The Cascades portion of the watershed is viable for dispersal of spotted owls. The Crabtree Watershed provides dispersal to/from the Quartzville Watershed to the east. Spotted owl dispersal out of the Crabtree Watershed is limited by the scattered federal ownership and the North Santiam River Corridor to the north, the South Santiam River Corridor to the south and the Willamette Valley on the west. The most significant lands in the watershed for spotted owl movement are the BLM lands in the North Fork Crabtree SWB. These lands are directly connected to the large LSR/wilderness network to the east of the watershed where the majority of dispersal between KOSs in the Cascades Range takes place.

Recommendations:

Terrestrial Recommendation #1 - Density Management/Thinnings (Findings 1, 2, 11 and 12): Timber harvest should emphasize enhancement and restoration opportunities that target stands in Riparian Reserves, LSR, Connectivity lands (CONN) and General Forest Management Area (GFMA) lands in Critical Habitat that have been managed primarily for timber in the past. Implement density management prescriptions to develop and maintain late seral forest stand characteristics. Desirable stand characteristics include larger trees for a large green tree component and recruitment of large standing dead/down coarse woody debris in future stands, multi-layered stands with well developed understories, and multiple species that include hardwoods and other minor species.

General Criteria for Density Management/Thinnings: Density Management would be prescribed primarily in mid-seral stands in the stem exclusion stage to encourage the development of late seral conditions. Priorities for density management to accelerate the development of late seral forest conditions would be high in Riparian Reserves, LSR, Connectivity lands (CONN) and General Forest Management Area (GFMA) lands in Critical Habitat.

Stand modeling indicates that there is a large range of tree sizes attainable in the 30 to 80 year age range. Typical tree sizes without previous stocking control can range from 7" dbh and 56 feet tall at age 30 to 15.1" dbh and 128 feet tall at age 80. With one thinning at age 15, tree sizes can average 8.6" dbh and 56 feet tall at age 30 to 17.6 inches dbh and 128 feet tall at age 80. With thinnings at ages 15, 40, and 60 years of age at densities maximizing stand growth, the average tree sizes could be expected to reach 20" dbh and 130 feet tall at age 80. These tree sizes can be further increased by density management treatments that maximize individual tree growth rather than stand growth.
Objectives in all stands would be to develop and maintain late seral forest conditions, meet Aquatic Conservation Strategy (ACS) Objectives and maintain and enhance existing habitat for the spotted owl.

Density management treatments should be done cautiously if at all in stands experiencing moderate infestations of Swiss needle cast (SNC) or drainages where there is a high incidence of this disease. Caution is advised in SNC infected areas because similar treatments in the Coast Range have resulted in accelerated SNC development. SNC infections can reduce diameter and height growth because of decreased photosynthetic ability with the loss of older needles. Severe SNC infestations may result in near cessation of Douglas-fir growth, or mortality from competition by non-susceptible species, pathogens or insects and sometimes directly from the disease itself. Initial indications in the Coast Range are that stocking levels greater than 60 trees per acre may allow stand development with minimal growth reductions.

Additional Criteria for Density Management/Thinnings:

In young stands less than 30 years of age generally having less than commercial diameters, additional criteria for identifying and implementing projects include:

a. Use a range of residual tree densities. Consider creating small isolated openings, less than 1/4-acre in size, over less than 5 percent of the area, and leaving 10 percent unthinned .

b. Stocking control: Highest priority are overstocked even-aged stands in excess of 250 dominant/co-dominant trees per acre or 20 percent over target levels of 200-250 trees per acre.

c. Species composition control: favor minor species including hardwoods by increasing growing space around them.

d. Retain developing understories that do not interfere with the development of dominant and co-dominant trees in the stand.

e. Standing dead/down CWD recruitment: retain enough green tree capital for recruitment in future stands.
f. Identify stands for treatment through GIS queries, aerial photo interpretation, stand exams, riparian surveys and/or stocking surveys.
g. These projects could be implemented through jobs-in-the-woods or accomplished collaterally with timber stand improvement projects on GFMA and/or CONN lands.

In 30 to 80 year old aged stands where dominant trees are generally less than 20" dbh. These age classes generally provide the greatest opportunities for acceleration of tree diameter growth and understory development through density management. Criteria for identifying projects include:

a. Maintain average 40 to 50 percent crown closures. Use a wide range of residual tree densities. Density management leaving 30 to 60 trees per acre residual stocking should occur over 5 to 15 percent of the area. Consider creating small isolated openings, less than 1 acre in size, over 5 to 15 percent of the area, and leaving 10 percent unthinned.
b. Stocking control: Highest priority are overstocked even-aged stands of over 40 Relative Density (Curtis, 1982). Relative Density is a measure that estimates stocking density of stands using stand basal area and tree diameters.
c. Species composition control: maintain minor species in treatment areas including hardwoods.
d. Enhance developing understories where present by reducing overstory stocking to allow for their growth.
e. Understories can be developed by natural regeneration, planting in openings or beneath density management treatments.
f. Standing dead/down CWD recruitment: retain enough green tree capital for recruitment in future stands. Consider creating smaller standing/down dead material to meet criteria as outlined in Recommendation #2 and the LSRA.
g. Lightly stocked areas and openings created by *Phellinus weirii* infections can be treated where canopy closure is less than 40 percent. Timber harvesting followed by site preparation may occur. Native disease resistant conifer and/or hardwood species can be planted. Highest priority for disease treatment would be on GFMA lands.
h. Identify stands for treatment through GIS queries, aerial photo interpretation, stand exams, riparian surveys and/or stocking surveys.
i. These projects can best be implemented through commercial timber sales. Logs may be removed provided standing dead/down CWD recruitment goals and ACS objectives are met.

Mature stands 80 to 150 years of age: Density management treatment of stands over 80 years of age is expected to be rare. Such stands would normally qualify as late seral forest habitat suitable for the spotted owl. However, age is a less important factor than the forest structure present. Late successional characteristics may be lacking in some stands due to timber management activities in the past which simplified forest structure. Past timber management practices such as commercial thinning from below, and salvage operations targeting dead, down

and dying trees have removed important elements of late seral forest and habitat suitable for the spotted owl. High stocking levels may delay the attainment of late seral forest conditions in some stands due to small tree sizes and poor understory development.

In stands where late successional characteristics are lacking, treatment to create structure and/or reduce high stocking levels could occur. The primarily objectives of such treatments would be to create standing dead/down CWD, develop layering of understory vegetation and increase diameter growth and structure of the residual trees. Commercial timber sales would not occur in stands over 80 years of age in LSR. Criteria for identifying projects include:

a. Enhance suitable spotted owl habitat conditions. Variable density management treatments could occur in stands previously managed for timber production, to create more natural, late successional conditions, where elements of suitable habitat for spotted owls are lacking.

b. Highest priority are single story overstocked even-aged stands that lack components of late successional structure, such as standing dead/down coarse woody debris, large limby/cull trees, and multilayered canopies, and do not qualify as habitat suitable for the spotted owl.

c. Species composition control: Manage for species diversity in treatment areas.

d. Enhance developing understories where present by reducing overstory stocking to allow for their growth.

e. Understories can be developed by natural regeneration or planting in openings or beneath density management treatments.

f. Create enough large, hard material to achieve standing dead/down coarse woody debris criteria (see Recommendation #2). Large material could be created adjacent to streams for recruitment as large woody debris and/or placed in streams.

g. Openings created by *Phellinus weirii* infections can be treated where canopy closure is less than 40%. Timber harvesting followed by site preparation may occur provided standing dead/down coarse woody debris recruitment goals are attained. Native disease resistant conifer and/or hardwoods can be planted. Highest priority for disease treatment would be on GFMA lands.

h. Identify stands for treatment through GIS queries, aerial photo interpretation, stand exams and/or riparian surveys.

i. These projects can best be implemented through commercial timber sales or topping/falling contracts to create standing dead/down CWD. Logs may be removed provided standing dead/down coarse woody debris recruitment goals are met.

Terrestrial Recommendation #2 - Standing Dead/Down CWD (Findings 1 and 2):
Implement NFP and Salem District RMP standards and guidelines for green tree retention for the recruitment and development of standing dead/down CWD and to contribute to the development of late seral forest stand characteristics. Protect existing material and leave additional green trees in future harvest units to make up for deficiencies in current conditions.

Criteria: For **GFMA and CONN**, leave trees should be over 12 inches dbh and represent the current range of conifer species, size and diameters. In GFMA, leave 6 to 8 green trees per acre; and in CONN, leave 12 to 18 trees per acre for recruitment of standing dead/down CWD and development of a large green tree component in future stands. Leave additional green trees in areas where standing dead/down CWD does not meet *Northwest Forest Plan* (NFP) and *Salem District Resource Management Plan* (RMP) standards. Typically, up to four additional trees per acre are left in areas where standing dead/down CWD is lacking. Create enough large, hard standing material to meet the 40 percent level of potential cavity dwelling wildlife populations. It is anticipated that natural decay/falldown and blowdown of green tree retention will meet or exceed NFP requirements for down CWD.

For **Riparian Reserves and LSR**, standing dead/down CWD requirements should approximate those cited in the LSRA for the area. Treatment objectives in these allocations would be for individual tree growth and/or stand structure enhancement for the purposes of accelerating late seral forest development in younger age classes. Landscape level considerations include connectivity for species, past management and natural disturbances such as fire, insects, and disease. The long term landscape level goal is for 15 percent ground cover of all decay classes of down wood . Twenty-five percent of that cover is represented by sound wood. This represents from 3 to 4 percent cover which is 3 to 4 times the NFP goals for the GFMA lands. When decayed logs are deficient, compensation in sound logs can be achieved over time. Snag levels range from 10 to 50 trees per acres of which 50 percent are in the soft stage and 50 percent are the largest available. In general, small snags will not persist as long as large snags, nor provide the same wildlife habitat. Leaving trees to grow and become snags later is appropriate in early to mid seral stands.

Terrestrial Recommendation #3 - Special Habitats/Species/LSR Boundaries (Findings 3 and 4): Adjust boundaries of LSRs to better protect special habitats and Special Status/Special Attention Species in the Snow Peak and Harry Mountain Ridge areas.

Criteria:

Use more ecologically meaningful features to define LSR boundaries such as watershed boundaries, topographic features, roads, forest type breaks, and Special Status/Special Attention Species buffers and management areas rather than interior section lines.

Protect the Snow Peak ecosystem including late seral forest stands in the vicinity, special habitats and *Bridgeoporus nobilissimus* sites by adjustment of the LSR boundaries to coincide with roads, forest type breaks, special habitat locations, and Special Status/Special Attention Species buffers and management areas. Surveys for *Bridgeoporus nobilissimus* are currently in progress and are expected to be complete by the end of 2001. In the interim, the proposed LSR boundaries from the Thomas Creek Watershed Analysis should be considered as a minimum. See Map 22, Proposed LSR Adjustment.

Adjust the Quartzville LSR boundary to approximate the Harry Mountain ridge which separates Thomas Creek Watershed from Quartzville and Crabtree watersheds. For simplicity and clarity, the new proposed boundary could follow Harry Mountain Road between Crabtree/Quartzville and Thomas Creek as shown on Map 22. Adjusting this LSR boundary to approximate the topography would make this LSR more ecologically sound and better protect adjacent KOSs.

As a result of these proposed changes, there would be an net increase in LSR and protected acres of 1,212 total acres, of which 38 acres are in the Crabtree Watershed and 539 acres in the Quartzville Watershed to the east and 635 acres are in the Thomas Creek Watershed to the north.

Terrestrial Recommendation #4 - Special Habitats (Finding #4): Consider amending the RMP to protect habitat adjacent to the Buzzard Butte area and encourage the further development of late seral forest habitat in the vicinity.

Criteria:

This includes T.11S., R.1E., section 17, SW1/4, portions of Operations Inventory (OI) units #041, 051, 052, 060, and 070, in addition to #100, which is the meadow area on top of Buzzard Butte. #060 and 070 are old-growth and 041, 051, and 052 are younger stands that would be allowed to further develop into late seral forest habitat. The proposed protection area is 90 acres in size and includes 65 acres of Riparian Reserves, buffers and administrative withdrawals. See Map 23, Buzzard Butte Special Habitat.

Terrestrial Recommendation #5 - Noxious Weeds (Finding #7): Use the principles of integrated weed management to eradicate, control, and prevent the spread of established and new invader noxious weed infestations. Integrated weed management means using all suitable methods (cultural, physical, biological, chemical) in a compatible manner to reduce weed populations.

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 Crabtree Watershed as new agents become available.

Encourage washing of ground disturbing equipment from off site to limit the spread of all exotic and noxious weed species.

Terrestrial Recommendation #6 - Nesting Spotted Owls/Habitat (Finding #11): Coordinate management and protection around KOSs with adjacent private landowners and the state. Highest priority sites are those in Church Creek, South Fork and North Fork Crabtree SWBs.

Land Tenure

The highest priority lands in the Crabtree Watershed for retention in BLM ownership include lands with high ecological values. These lands include all LSR, Critical Habitat for the northern spotted owl, and Matrix lands in the vicinity of Buzzard Butte and Snow Peak. These lands are mapped as Zone 1 according to definitions under Land Tenure on page 53 of the Salem District RMP, with the exception of the LSR and Matrix lands in the vicinity of Snow Peak and Buzzard Butte, which are mapped as Zone 2. Consider amending the RMP to designate these lands as Zone 1, high priority for retention. The remaining lands in the watershed are in Zone 2 according to the RMP. There are no federal lands in the watershed that meet the definition of Zone 3, high priority to exchange out of federal ownership.

Aquatic

Findings:

Aquatic Finding #1 - Riparian Condition: Riparian surveys on BLM lands indicate that current riparian vegetation is composed largely of varied age classes which are heavily skewed toward stands less than 80 years old, resulting in a lack of mature to late successional dominated riparian vegetation. Stream adjacent vegetation along many sections of Crabtree Creek have been removed by high flows, and movement of sediment, large cobbles and boulders down the channel. Riparian areas with young conifer stands are common in all of the SWBs, but are most prevalent in the Roaring River and South Fork Crabtree SWBs. The North Fork Crabtree and Church Creek SWBs have the most late successional forest in riparian areas on the average.

Aquatic Finding #2 - Large Woody Debris (LWD): The combination of a lack of large woody structure in streams and several torrential flow events in the early 1970s and 1996, resulted in some channelization of the streams in the watershed, and a further reduction of LWD in the system. Generally, LWD is severely lacking in the watershed, particularly in the lower portions of the larger streams where anadromous fish are present. The high percentage of riparian acreage with low potential is mainly due to the large amount of agricultural lands in the lower watershed and young conifer stands in the mid- and upper portions of the watershed. Some of the headwater reaches have good quantities of LWD that may eventually be flushed down into lower reaches of the watershed. In the Crabtree Watershed, 15.5 percent of the riparian areas (within 30 meters of stream channels) have high potential for LWD recruitment to streams (dominant age-class >130 years) and only 2.4 percent have moderate potential (conifer dominated or mixed forest, 80-130 years). The remaining 82 percent have low potential (conifers <80, hardwoods and non-forest). The North Fork Crabtree and Church Creek SWBs have the highest potential for LWD recruitment (Table 5-25).

Aquatic Finding #3 - Stream Flows: July and August have the greatest potential for conflict between consumptive uses and instream water needs with 52 and 61 percent of water allocated to consumptive uses respectively, at an 80 percent exceedence flow.

Aquatic Finding #4 - Water Quality: In the Oregon Department of Environmental Quality (ODEQ) publication, *1988 Oregon Assessment of Non-point Sources of Water Pollution* (ODEQ 1988), also known as the *319 Report*, Crabtree Creek water quality is listed as being moderately impacted, supported by data in the upper reaches, and by observation in the lower sections. Problems identified include: turbidity, erosion, sediment, low dissolved oxygen, and low flows. The probable causes were listed as erosion, road runoff, vegetation removal, and water withdrawals. Impacted values were identified as fisheries, aquatic life, water recreation, irrigation, wildlife, aesthetics, and livestock. Since the report, additional data has been collected in the sub-watershed by the South Santiam Watershed Council. The data indicate dissolved oxygen and pH are probably not of concern in Crabtree Creek.

Roaring River SWB is listed as having greater than 20 percent steam channel expansion due to roads, which is considered high.

Aquatic Finding #5 - ODEQ 303(d) listing: In the *Oregon Department of Environmental Quality's 303(d) List Of Water Quality Limited Waterbodies*, also known as the *303(d) report*, Crabtree Creek is listed as water quality limited for summer stream temperature, from the mouth upstream to White Rock Creek. Summer temperatures have been found to be above the 64 degrees F. threshold for fish rearing for notable periods of time.

Aquatic Finding #6 - Stream Temperatures: Summer water temperatures in Crabtree Creek at river mile 30 were below the basin standard of 64 degrees F., but all other Crabtree stations were above the standard for extended periods of time. Because the data represent a seven day running average, it is apparent that water temperatures are high for extended periods of time during the summer. In early summer, water temperatures increase in a downstream direction which is expected. However, beginning mid July temperatures decrease in a downstream direction with temperatures at river mile 14 significantly cooler than found at river mile 28. This phenomenon indicates one or several sources of cooling water exist between the two stations in the warmest part of the year.

Aquatic Finding #7 - Slope Stability and High Water Flows: Analysis of aerial photographs indicate an increase in landslide activity and the loss of riparian cover occurred between 1993 and 1998. The flood of February 1996 affected much of northwest Oregon, and may have triggered the observed changes. 1998 photos of Crabtree Creek in the vicinity of river miles 28 and 30 display an open riparian canopy, and the creek appears to have suffered high flows and large sediment loads. Sediment has been deposited on the flood plain, removing vegetation and allowing direct solar input.

A few large landslides in the area added considerable sediment to the creek, and most appear to have initiated at roads. BLM road 11-2E-14.1 suffered a few large slides that appears to have added sediment to the creek. Several tributaries entering the section of Crabtree Creek between river mile 28 and 30 appear to have delivered heavy sediment loads in the recent past. Several shallow ponds are obvious on the photographs and may also be contributing to warmer water temperatures in the upper sections of Crabtree Creek.

Aquatic Finding #8 - Off Highway Vehicle (OHV) Use: OHV and motorcycle use in the Hunter/Church Creek area has created accelerated erosion affecting water quality. The area is under temporary closure until September 1st, 2001.

Aquatic Finding #9 - Non-point Pollution: Tetra Tech (1993) estimated non-point pollution annual loads of nitrogen, phosphorous, and total suspended solids for watersheds in the Willamette River basin. Results suggest the non-point pollution levels are 5 to 20 percent higher in the Santiam sub-basin than the Willamette basin average, however sources have not been identified.

Aquatic Finding #10 - Age Class Distribution: The SWBs with the greatest percent of forested land in the young age class (0 to 30 years old) are Richardson Gap and Beaver Creek. Lands in these SWBs are owned and managed by non-industrial private parties with small land holdings, and BLM land which is managed as General Forest Management Area LUA (GFMA). By contrast, Church Creek and Roaring River SWBs currently have the lowest percentage of forest lands in the younger age class. These SWBs are managed to a greater degree by industrial forest companies and BLM.

The sub-watershed with the largest amount of late seral is North Fork Crabtree Creek SWB. Most of the late seral stands in this sub-watershed are located on BLM lands in the upper reaches managed as LSR. South Fork Crabtree Creek, Church Creek, and Roaring River SWBs have the highest percentages of private land at an age where harvest is likely within the next decade.

Aquatic Finding #11 - Soils: Several major geologic hazards exist in the Crabtree Watershed which affect streams and water quality. Earth flows and slumps occur in large scattered areas of the watershed, and result in the delivery of soil material to streams through streambank erosion of the toe of the failure. Slope failures occur in steeply sloping, rocky mountainous terrain and include rockslides, debris avalanches and earth flows. Stream erosion and deposition are common within portions of the watershed resulting in higher turbidity, siltation of salmon spawning gravels, and a decrease in channel stability. Church, and North Fork Crabtree SWBs appear to have the greatest acreage of upland in an unstable condition. The SWB with the most extensive BLM ownership classified as unstable is North Fork Crabtree sub-watershed (58 acres).

Aquatic Finding #12 - Fisheries: Reaches 1-3 of the upper mainstem and reach 1 of South Fork Crabtree Creek are the primary reaches within the watershed that support, or have the potential to support anadromous fish. All of these reaches appear to have low habitat complexity and are the reaches in which instream restoration (placement of LWD) would probably result in the most benefit to anadromous fish production. These stream reaches are almost entirely in private ownership.

Aquatic Finding #13 - Water Quality and Fisheries: The lower mainstem of Crabtree Creek (from the mouth to Larwood) has high percentages of actively eroding streambank on private lands, primarily used for agriculture.

Recommendations:

Aquatic Recommendation #1 - Riparian Condition and LWD (Findings #1 and 2) on federal lands: Actively manage Riparian Reserves to achieve Aquatic Conservation Strategy Objectives on BLM lands. Plan and implement riparian silvicultural projects designed to accelerate growth of riparian conifers to improve potential for LWD recruitment on BLM lands. Criteria for treatment are included under Recommendation #1, of the Terrestrial Section. Improve and restore riparian habitat through planting and seeding with native vegetation. Activities could include planting, density management, thinning, road decommissioning, and erosion control in Riparian Reserves, such as seeding or planting.

Aquatic Recommendation #2 - Riparian Condition and LWD (Findings #1 and 2) on non-federal lands: Improve riparian conditions, and promote large conifer development in riparian areas through density management and thinnings. Work with other landowners in the watershed to improve riparian condition and overstory by implementing projects designed to accelerate growth of riparian conifers to improve potential for LWD recruitment. Bringing in and

anchoring large logs and rootwads in channels may work in some areas to improve fish habitat and stream structure.

Aquatic Recommendation #3 - Stream flows (Finding #3): Cooperate with ODFW to ensure instream flows are protected in summer and fall during extremely lowflow years.

Aquatic Recommendation #4 - Water Quality (Terrestrial Finding #6, Aquatic Findings #4 and 7): Reduce roaded miles that contribute flow or sediment to streams. Reclaim/decommission roads to reduce road densities in the watershed. Where roads cannot be decommissioned, close and storm proof unnecessary roads. Pursue road reconstruction and improvement projects on permanent access roads to reduce sediment to streams or prevent future water quality problems. Highest priorities for reducing roaded miles would be in North Fork and South Fork Crabtree SWBs, Roaring River SWB and Church Creek SWB. Permanently close Hunter/Church Creek areas to protect water quality, low elevation late seral forest habitat and reduce disturbance to wildlife species, including the KOS in the Church Creek SWB. Existing roads in the watershed were evaluated using Transportation Management Objectives and additional criteria and the results are displayed in Appendix F.

Aquatic Recommendation #5 - Water Quality (Findings #4, 7 and 11): Cooperate with state and private landowners to improve water quality. Improve drainage from existing roads and replace culverts that do not meet 100- year flood standards, to reduce loss of roads during large storms and addition of sediments and rock materials to streams. Divert runoff off from unstable slopes and stabilize slide areas.

Aquatic Recommendation #6 - ODEQ 303(d) listing (Findings #4 and 5): ODEQ is scheduled to set the Total Maximum Daily Load for temperature in Crabtree Creek during 2002. After ODEQ sets the maximum load, BLM will be expected to produce a Water Quality Restoration Plan (WQRP) for BLM managed lands within the watershed. The plan must include detailed restoration activities and time lines.

Aquatic Recommendation #7 - Stream Temperatures (Findings #4 and 6): Develop projects to improve stream shade on BLM lands. Work with other landowners and the South Santiam Watershed Council to increase effective stream shade, expand the temperature monitoring network and locate sources of high water temperatures. Expanded temperature monitoring would provide data for development of the WQRP discussed above.

Aquatic Recommendation #8 - Soils, Slope Stability and High Water Flows (Findings #4, 7 and 11): Conduct an assessment of landslides and erosion problems in the watershed. The pending WQRP for the Crabtree Watershed should address erosion problems and restoration actions. Stabilize slides where possible, by seeding, diverting water from unstable slopes, installation of erosion matting, and unweighting slides at the top. Improve road drainage, and replace culverts where needed. Improve riparian cover where possible. Restore vegetative cover on bare slopes. Work on joint projects with other landowners to improve upland conditions on

lands in all ownerships.

Aquatic Recommendation #9 - OHV Use (Finding #8): Permanently close the Hunter/Church Creek area to off -road vehicle and motorcycle use and rehabilitate trails affecting water quality.

Aquatic Recommendation #10 - Non-point Pollution (Finding #9): Support the South Santiam Watershed Counsel, and ODEQ efforts to quantify non-point sources of pollution.

Aquatic Recommendation #11 - Age Class Distribution (Finding #10): Conduct a cumulative effects analysis when a project is proposed by BLM. Redesign or defer projects where necessary, and consider restoration activities to reduce cumulative impacts where practical. Schedule BLM timber sales and other projects so as to reduce their contribution to cumulative effects.

Aquatic Recommendation #12 - Fisheries (Finding #12): Cooperate with private landowners to implement instream restoration projects and retain riparian overstory vegetation on the mainstem of Crabtree Creek and South Fork Crabtree Creek. Design and implement cooperative restoration projects on the mainstem of Crabtree Creek involving BLM, state and local governments and private landowners.

Aquatic Recommendation #13 - Water Quality and Fisheries (Finding #13): Work with the South Santiam Watershed Council to encourage private landowners in Lower Crabtree Creek (from the mouth to Larwood) to implement bank stabilization measures on agricultural lands, including exclosure of livestock from the stream channel where appropriate.

Social

Findings

Social Finding #1 - General: Public lands in the Crabtree Watershed are an important resource to those living within rural and urban communities in the mid-Willamette Valley for a variety of commodity and non-commodity values. Finding a balance between providing commodity based products such as timber with other values such as water quality, fish, wildlife, recreation, and visual resources will be an ongoing challenge that will only increase as rural and urban communities in the mid-Willamette continue to grow. These issues are further complicated by the intermixed ownership pattern of private land BLM-administered lands. The BLM's ability to develop partnerships with interested groups and adjacent landowners on a variety of issues and projects will be a key component of successful public land management in this watershed.

Social Finding #2 - Timber Management: Under the Salem District RMP, timber harvest activities will continue to occur at various levels relative to the land use allocations in the Crabtree Watershed. Timber harvest activities will include regeneration harvest, thinnings, density management and salvage operations conducted according to the NFP.

Social Finding #3 - Rural Interface: Approximately 1,613 acres of the BLM-administered in the Crabtree Watershed are located within Rural Interface Areas (RIAs). These RIAs have a low

to moderate level of sensitivity, that varies by RIA. Most of the residential landowner concerns in RIAs are associated with timber management and recreational/public use. Timber management concerns are associated with potential negative impacts to water quality, scenic quality, recreational values and short term disturbance during logging operations (i.e. noise, dust, log truck traffic). Recreational/public use concerns are related to problems such as littering, vandalism, theft, fire use, shooting, and other noise on public lands adjacent to or near residential lands. Problems with trespass associated with public use of BLM-administered lands near private property is also a concern.

Social Finding #4 - Public Access: Motorized access to public and private lands in the Crabtree Watershed will likely decrease in the long term. Both private landowners and the BLM have restricted vehicle access in areas because of problems with garbage dumping, erosion, damage to vegetation, vandalism, theft, long term occupancy, and reckless fire and firearm use. The restriction of vehicle access to private and public forest lands is a growing trend in many of the watersheds in western Oregon that are near rural and urban areas. These restrictions are becoming an increasing concern recreational activities which require motorized access. Without the funding to provide adequate enforcement and development of self-policing partnerships with user groups, limiting vehicle access is currently the only cost effective way of addressing these problems. Because of the intermixed ownership pattern of private and public lands in the Crabtree Watershed, any long term solution would have to be a collaborate effort between private and public land managers.

Social Finding #5 - Off-Highway Vehicle Use: Unmanaged off-road use by motorized vehicles may not be compatible with other resource management objectives for BLM-administered lands, due to concerns associated with erosion, vegetation damage, water quality, fisheries and wildlife disturbance. Due to the intermixed ownership pattern in the watershed, any area designated for off-road use by motorized vehicles would need to include both private and public lands. Currently, private landowner support for such a project is low.

Social Finding #6 - Recreation: The recreational settings in the greatest demand for SCORP Region 8 are semi-primitive and primitive. The Crabtree Watershed will likely never have a roadless area of significant size to meet the criteria for a primitive setting. The east half of the Crabtree Watershed and extending into the western portion of Quartzville Watershed does offer potential for providing a semi- primitive setting for both motorized and non-motorized recreational activities. Motorized use would be limited to those roads designated as open, but main routes on BLM-administered lands will likely remain open. There may be potential for developing a trail system for non-motorized use such as hiking, mountain biking, and horseback riding utilizing existing roads and trails and developing additional trails. This would include the development of a trail leading from Crabtree Lake to Green Peter Peninsula. Public lands in the west half of the Crabtree Watershed will continue to provide recreational opportunities such as hunting, fishing, target shooting in both rural and roaded modified settings. Private lands in the west half of the watershed would continue to provide similar activities to the extent that they remain open for public use.

Social Finding #7 - Crabtree Lake: Crabtree Lake Outstanding Natural Area (ONA) is one of the more significant features in the Crabtree Watershed. It receives recreational use and use for educational and research purposes. The condition of Crabtree Lake ONA has improved significantly since vehicle access was blocked approximately 1/4 mile from the lake in the early 1990s. Visitor use is relatively low and no new campsites have been established around the lake since the campsite inventory in 1993. Currently no visitor facilities such as restrooms or signage are provided on site. Past efforts at signing the area have been subject to frequent vandalism. The last mile of the road accessing Crabtree Lake has greatly deteriorated in the last ten years to the point that it may be difficult for passenger vehicles to use.

Social Finding #8 - Visual Resources: There are 1,249 acres of BLM-administered land in the Crabtree Watershed with a Class I rating, requiring the highest level of protection under the Visual Resource Management (VRM) system. These lands include the Carolyn's Crown, Shafer Creek, and Crabtree Lake ACEC's. There are no BLM-administered lands in the watershed with a Class II rating. Timber management activities will continue to be evident on private lands and on BLM administered lands with a Class III or IV rating. Of BLM-administered lands with a Class III or IV rating, the Snow Peak and Buzzard Butte areas were identified as having greater visual sensitivity. BLM-administered lands within RIAs would also be potentially more sensitive.

Social Finding #9 - Prohibited Uses: The occurrence of prohibited uses such as illegal dumping, vehicle abandonment, long-term occupancy, equipment and sign vandalism, wildlife poaching, unauthorized removal of forest products and the growing or manufacturing of illegal drugs is increasing on public and private land in the Crabtree Watershed. Cooperative law enforcement efforts between public and private landowners, such as the Linn County Protective Association, can help discourage these prohibited uses. However, current funding is not adequate to address this problem on BLM administered lands as a whole. If the closure of private lands to motorized public access continues, the incidence of these prohibited uses on

public lands that remain open may increase.

Recommendations

Social Recommendation #1 - Rural Interface Areas and Visual Resource Management (Findings #1, 2, 3 and 8): Many of the same mitigating management practices can be used to reduce the potential impacts to visual resources and rural interface areas, resulting from timber harvest activities. Of BLM-administered lands with a Class III or IV rating, the Snow Peak and Buzzard Butte areas were identified as having greater visual sensitivity. In addition, special consideration should be given to those BLM-administered lands which have Rural Interface and Visual Resource concerns. Below is a list of mitigating management practices that could be taken depending on the proposed action and site specific characteristics.

* Get adjacent landowner input early in the planning process for areas with a potential for high sensitivity to better determine areas of concern.

* Early in project planning, consider reducing visual or other disturbance factors in designing the size, shape, and location of the timber harvest units or project. Consider small patch cuts, thinning, or uneven aged management to better maintain forest cover.

* Where possible utilize green retention trees and riparian reserves to buffer the visual impacts from view. Consider leaving additional trees for added buffering where needed.

* Where possible, consider using alternative reforestation site preparation prescriptions to broadcast burning.

Social Recommendation #2 - Public Access and Road Use (Findings #4 and 9): Look for opportunities to work with private landowners, local and federal law enforcement and other user groups to keep public and private forest land roads open for public use and to discourage prohibited uses.

Social Recommendation #3 - Off-Highway Vehicle Use (Finding #5): Evaluate any proposals for providing off-road motorized use, including roads and trails. Private landowner support and mitigation measures for resource protection should be important criteria for consideration. Due to the current lack of private landowner support and resource concerns associated with water, fish and wildlife, BLM- administered lands in the Crabtree Watershed may be less suited to meeting the demand for motorized off-road use.

Social Recommendation #4 - Recreation (Finding #6): Evaluate the potential of establishing multi-use non-motorized trails in the Snow Peak and Crabtree Lake areas. Also consider possible connections to Green Peter Peninsula and other BLM-administered lands in the Quartzville Watershed.

Social Recommendation #5 - Crabtree Lake (Finding #7): Continue to monitor the condition of Crabtree ONA on an annual basis. Convene an interdisciplinary team to prepare a management plan for Crabtree ONA that addresses issues associated with the appropriate level of public access, facility development and other resource concerns.

Social Recommendation #6 - Prohibited Uses (Finding #9): Continue to work with private, local, state and federal partners to reduce prohibited uses and to clean up areas where dumping is occurring.

Chapter 8: Data Gaps, Inventory and Monitoring Needs

Terrestrial

Data Gaps

1. Special Status /Special Attention vertebrate species occurrence in the Crabtree watershed, especially the harlequin duck, peregrine falcon, goshawk, Western pond turtle, red tree vole, and bat species (see Appendix ##).

2. Special Status/Special Attention invertebrate species occurrence such as Oregon giant earthworm, and Survey and Manage mollusk species (see Appendix ##).

3. Presence and abundance of nonvascular plants and fungi, particularly *Bridgeoporus nobilissimus,* to determine appropriate management areas.

4. Density Management or thinning opportunities across all LUAs, particularly Riparian Reserves, LSR, CONN, and Critical Habitat in GFMA and CONN.

5. Noxious weed sites in the watershed on both federal and non-federal lands.

6. Swiss needle cast infection levels and trends in the watershed.

Inventory/Monitoring Needs

Recommendations:

1. Survey for priority vertebrate species in the watershed. Special emphasis should be placed on the harlequin duck, peregrine falcon, goshawk, Western pond turtle, red tree vole, and bat species. Continue cooperative efforts with adjacent non-federal landowners and the State to survey and manage known spotted owl sites in the lower portion of the watershed.

2. Survey for priority invertebrate species in the watershed. Special emphasis should be placed on strategic surveys for Oregon giant earthworm, and Survey and Manage mollusk species.

3. Survey for priority plant species in the watershed. Special emphasis should be placed on Survey and Manage nonvascular plants and fungi, particularly *Bridgeoporus nobilissimus*.

Surveys for this species are in progress and are recommended for BLM lands east of Snow Peak and in the Harry Mountain Ridge vicinity along the divide between Crabtree, Quartzville, and Thomas Creek Watersheds. Surveys for *Bridgeoporus nobilissimus* in the Snow Peak area will be complete by the end of 2001.

4. Stand exams, including CWD and standing dead components, across all LUAs to identify restoration/enhancement treatment opportunities in stands previously managed for commercial forest products, especially in appropriate Riparian Reserves and LSRs. Preliminary screening has been completed and identification of potential projects is in progress.

5. A comprehensive inventory of noxious weed sites in the watershed and coordination with other public and private parties for the development of weed control plans. Continue surveying and monitoring of noxious and invasive weeds. Develop partnerships and actively pursue funding for weed control projects.

6. Establish monitoring plots to measure current levels of defoliation due to Swiss needle cast and determine trends in the watershed over time.

Aquatic

Data Gaps

1. Stand ages and seral stages on non-federal lands for the purpose of estimating cumulative effects associated with future projects.

2. Adequate water temperature and stream modeling data to determine where temperature enrichment to streams may be occurring.

3. Sediment sources and potential failures associated with roads to identify road decommissioning and storm proofing opportunities.

4. Riparian treatment opportunities in the watershed to enhance stream shade, such as conifer planting in riparian areas.

5. Fragile soils on non-federal lands and landslide activity and erosion potential across the entire watershed.

6. The upstream limits of resident fish distribution on federal lands are not known on many streams within the watershed. Currently, where no field data are available, resident fish are assumed to be present in streams that are 3rd order and larger.

7. The upstream limit of anadromous fish distribution is not known in Church Creek, but is suspected to occur on BLM land.

8. Habitat inventories have been conducted on many streams within the watershed, but inventories on several more streams (primarily on private lands) would provide a more complete picture of aquatic habitat conditions in the watershed.

Inventory/Monitoring Needs

Recommendations:

1. Inventory of stand ages and seral stages on non-federal lands to create an accurate GIS layer for the purpose of estimating cumulative effects associated with future projects.

2. Increase water temperature data collection to help determine where temperature enrichment to streams is occurring. Model streams in the watershed using either the *Heet Source* model or *Shadow* model to help determine where temperature enrichment is occurring.

3. Inventory of roads on all ownerships to determine which are contributing sediment, have the highest risk of failure, and which could be decommissioned or storm proofed.

4. Stand exams, including photographic interpretation, in appropriate Riparian Reserves to identify projects that could enhance stream shade.

5. Inventory of fragile soils on non-federal lands and a detailed landslide and erosion inventory across the entire watershed.

6. Inventory streams on federal lands to determine the upstream limits of resident fish. Much of this inventory work will occur for site specific analysis of future projects proposed in the watershed.

7. Inventory Church Creek to determine the upstream limit of anadromous fish distribution.

8. Continue habitat inventories in the watershed. Support cooperative efforts to survey habitat and fish distribution across all ownerships in the watershed.

Social

Data Gaps

1. Visitation levels and recreational activities in the watershed.

2. Dispersed campsites, shooting areas, and OHV trails in the watershed.

3. Special Forest Products in the watershed on both federal and non-federal lands.

Inventory/Monitoring Needs

Recommendations:

1. As time and funding allow, collect additional field data on visitation levels and recreational activities.

2. As time and funding allow, inventory dispersed campsites, shooting areas, and OHV trails in the watershed.

3. A Special Forest Products inventory and strategy to increase the marketability of these products, both on private and public forest lands.