United States
Department
of Agriculture

Forest Service

Pacific Northwest Region

1995

Zigzag Watershed Analysis

Mt. Hood National Forest

United States Department of Agriculture | Forest Service | Mt. Hood National Forest | Zigzag ~~Ranger~~ District
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File Code: 2300

Date: August 12, 1996

Dear Forest Neighbor and Interested Citizen

You are receiving this letter since you have, in the past, been sent a copy of the Zigzag Watershed Analysis, Mt. Hood National Forest, 1995. The purpose of this letter is to correct a statement in the Water Quality Section (page 4-96) of that analysis. It has been brought to our attention that identifying an area as a point source of pollution has implications under the Clean Water Act (Public Law 92-500) that were not intended when the term was used in the analysis.

Water quality was assessed at three scales within the analysis: over the entire watershed, within subwatersheds, and from specific sources. This was done in order to obtain a large scale view of the conditions in the watershed, then narrowing the analysis to a smaller scale and specific areas of the watershed.

Septic systems within the Recreational Residence tracts and the salting of Palmer Snowfield are listed in the document as point sources of pollution. The listing of these was referring to a point source as a specific source of potential water quality pollution. This reference was in no way intended to identify these areas as point sources as defined under the Clean Water Act. Based on our interpretation of the Clean Water Act, the septic systems within the Recreational Residence tracts and the salting of Palmer Snowfield would be considered potential non-point pollution sources. The section at the bottom of page 4-96 should read:

Potential Pollution Sources

During the completion of this watershed analysis, three specific sources of potential pollution were identified:

1. The Government Camp Sewage Treatment Plant.
2. The septic systems within the Recreational Residence tracts.
3. The salting of Palmer Snowfield

Please make these changes in your copy of the watershed analysis.

Sincerely,

/s/Michael E. Platz for
E. R. HARDMAN
District Ranger

PROJECT 96 REVIEW
ZIGZAG RIVER WATERSHED ANALYSIS DOCUMENT

November 6, 1995

In attendance: Marty Stein, Mike Redmond, Paul Norman, Larry Bryant, and Julie Schreck.

REVIEW METHODOLOGY

1. List overall general comments about the document.

2. Move through the document page-by-page recording specific comments directly in the document.

3. Assess if the document met the following expectations.
   a- Develops restoration opportunities within the watershed.
   b- Describes the existing condition.
   c- Describes the desired future condition.
   d- Refines interim riparian reserve boundaries.
   e- Identifies gaps/missing information.
   f- Identifies areas of the watershed where certain resources/values would be emphasized.
   g- Concise user friendly document.
   h- Analyzes trends due to recent "proactive" management.
   i- Meets the 8-steps as identified in the Watershed Analysis Guide, page 10-11.
   j- DFC tied to LA&D.
   k- Issue driven.
   l- Appropriate scale.
   m- Tracks logically.
   n- Synthesizes information.

4- Summarize overall concerns for the document.

1. GENERAL COMMENTS

The comments reflect the views of the group as a whole. The group discussed their general perceptions of the document as a whole before they tackled the page-by-page review.

1. Easy to read and well written. Consistent writing style through out document. The major subject headings helped to tie the information in the document back to the key questions. It was easy to pull information out of the document for each resource area. Well presented and well organized!

2. Good use of graphics and visuals in the document. Lots of good information presented in the graphics. Many of the map legends were difficult to read. It would be helpful to put a few more landmarks on the maps i.e., streams.

3. Nice tie between the monitoring/recomendation sections and the body of the text. Good job!

4. It would be helpful to include some additional information on the special forest products with in the watershed.

5. Well worth the wait for this document....nice job!

6. Good fire history section.

7. Aquatics information well presented! However, the amount of information presented may be more than the issues warrented. The team could possibly place some of the aquatic information not related to the key issues into an appendix or the WA working file.

8. The sedimentation discussion may need some field validation. It was identified as a data gap (see the riparian surveys and monitoring/evaluation reports). Clarify if the sedimentation model is a yield or delivery model in the document.

9. The first 3-4 Chapters were very good! Chapter 3 well presented and focused on the important issues. Chapter 4 has lots of good information but it got a little bogged down in the aquatic section.

10. Good job at tying the information back to the key questions. Good job at limiting the key questions.

11. Synthesis of the management recommendations and restoration opportunities was incomplete. Synthesis of the information presented earlier in the text did not occur thoroughly in these sections. This may have been due to the short time frame the team had to create this document.

12. The Project group recommends that the WA team spend the limited time available for revisions on the recommendation/restoration sections. All the information needed to synthesize this section is in the document.

2. PAGE-BY-PAGE REVIEW

The comments have been written directly in the document.

3. MEETING EXPECTATIONS

We evaluated if the document met each of the following expectations.

a- Develops restoration opportunities within the watershed.

YES. More detailed and site-specific projects would be helpful.

b- Describes the existing condition.

YES. Very good job!

c- Describes the desired future condition.

YES. Good tie to the PFP and the NWFP. The LA&D desired future condition could have been more developed and more descriptive.

d- Refines interim riparian reserves boundaries.

YES. Clear support of the interium riparian reserves and good visual diplay of the reserves.

e- Identifies gaps/missing information.

YES. Good job!

f- Identifies areas of the watershed where certain resources/values would be emphasized.

YES. The management recommendations could have focused a little more on this.

g- Concise user friendly document.

YES. Well indexed and well headed, easy to find information.

h- Analyzes trends due to recent "proactive" management.

YES. Information could have been a bit more highlighted, though.

i- Meets the 8-steps as identified in the Watershed Analysis Guide, page 10-11.

1-Identify issues, describe desired conditions, and formulate key questions.
YES

2- Identify key processes, functions and conditions.
YES

3- Stratify the watershed.
YES

4- Assemble analytic information needed to address the key questions.
YES

5- Describe past and current condition.
YES

6- Describe condition trends and predict effects of future land management.
YES.

7- Integrate, interpret, and present findings.
YES

8- Manage information, monitor, and revise.
YES

j- DFC tied to LA&D

YES. More to come.

k- Issue driven.

YES

l- Appropriate scale.

YES

m- Tracks logically.

YES. Good job!!

n- Synthesizes information.

YES. Needs additional synthesis of background information into the the recommendation section.

4- SUMMARIZE OVERALL CONCERNS

Summarizes overall concerns about the document.

*The late seral information needs language consistency.

*B (Scenic Viewsheds) lands are available to contribute to the PSQ. Since the team did not really do an extensive PSQ analysis but the analysis that they did do seemed to correlate well with the projected PSQ they should note that in the document. Also they could further state that it appeared from their observations that this PSQ could be met in the drainage.

*The Project group recommends that the team identify additional management recommendations for the vegetative conditions. Tie the recommendations into forest health issues and then tier to the DFC.

ACTION ITEMS

*The Project 96 group would welcome the opportunity to meet with all the Zigzag River WA team members. If so desired, give Julie Schreck a call in the S.O.

*These notes will be distributed to the Zigzag River WA team, Project 96, the Water Board, and Dick Hardman.

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Figures

Tables

Chapter 1 - Introduction

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Watershed Analysis

Watershed analysis develops and documents a scientifically-based understanding of the ecological structures, functions, processes and interactions occurring within a watershed. In doing so, this analysis process identifies trends, conditions, and restoration opportunities. Watershed analysis supports broad ecosystem management objectives at the watershed scale, as described in the Northwest Forest Plan (The Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl).

Watershed analysis is one of the Northwest Forest Plan's four elements of the Aquatic Conservation Strategy. The four elements are designed to operate together to maintain and restore the productivity and resiliency of riparian and aquatic ecosystems.

The information contained in this report will assist in making sound resource management decisions for the watershed. This analysis also develops restoration and monitoring priorities that will move landscape units from existing to desired conditions, identifies opportunities for commodity outputs, identifies management recommendations, and recommends Riparian Reserve widths.

Watershed analysis is an ongoing, iterative process. This report is a dynamic document, intended to be revised and updated as new information becomes available.

Figure 1-1 -- Mt. Hood National Forest Vicinity Map

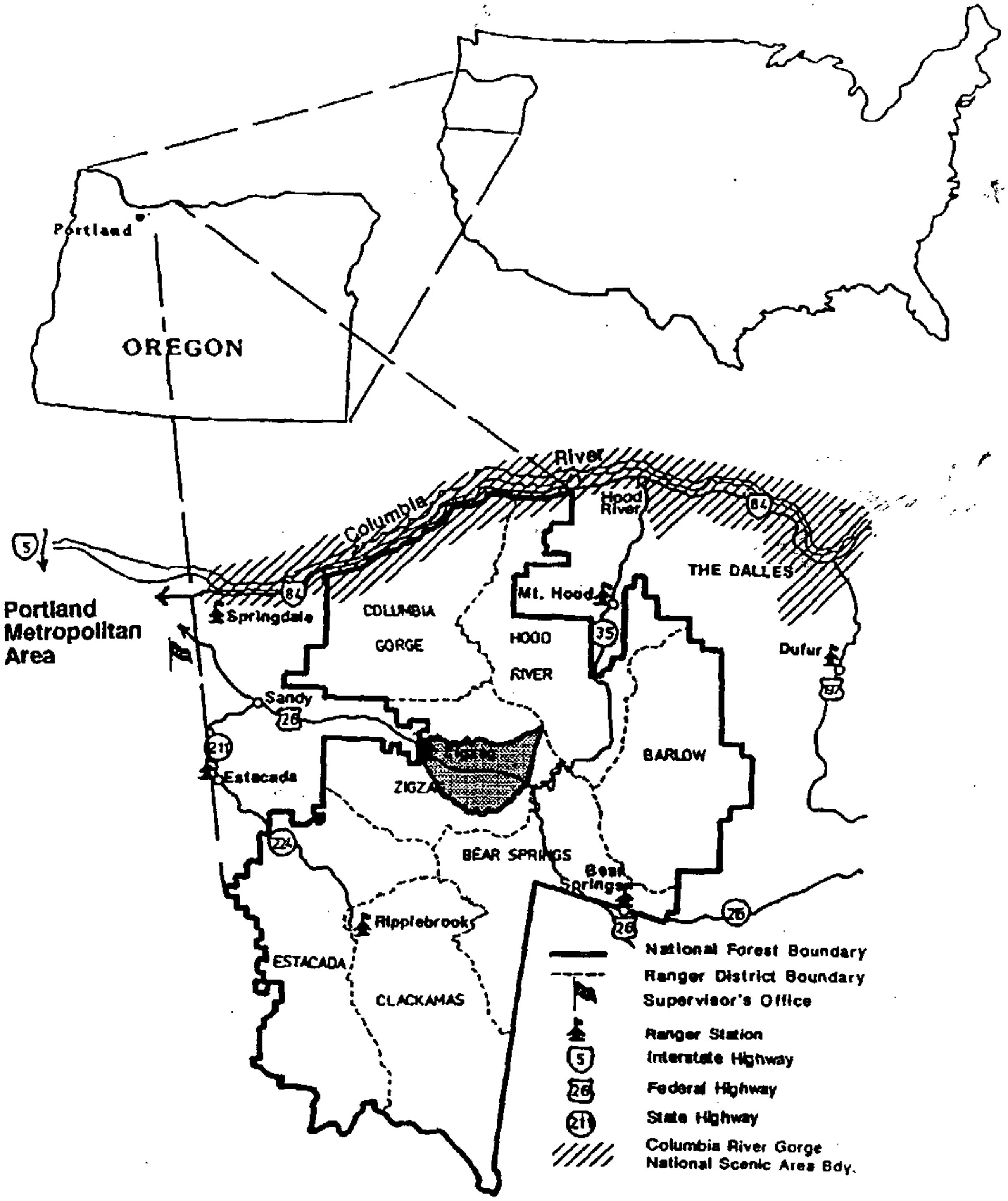
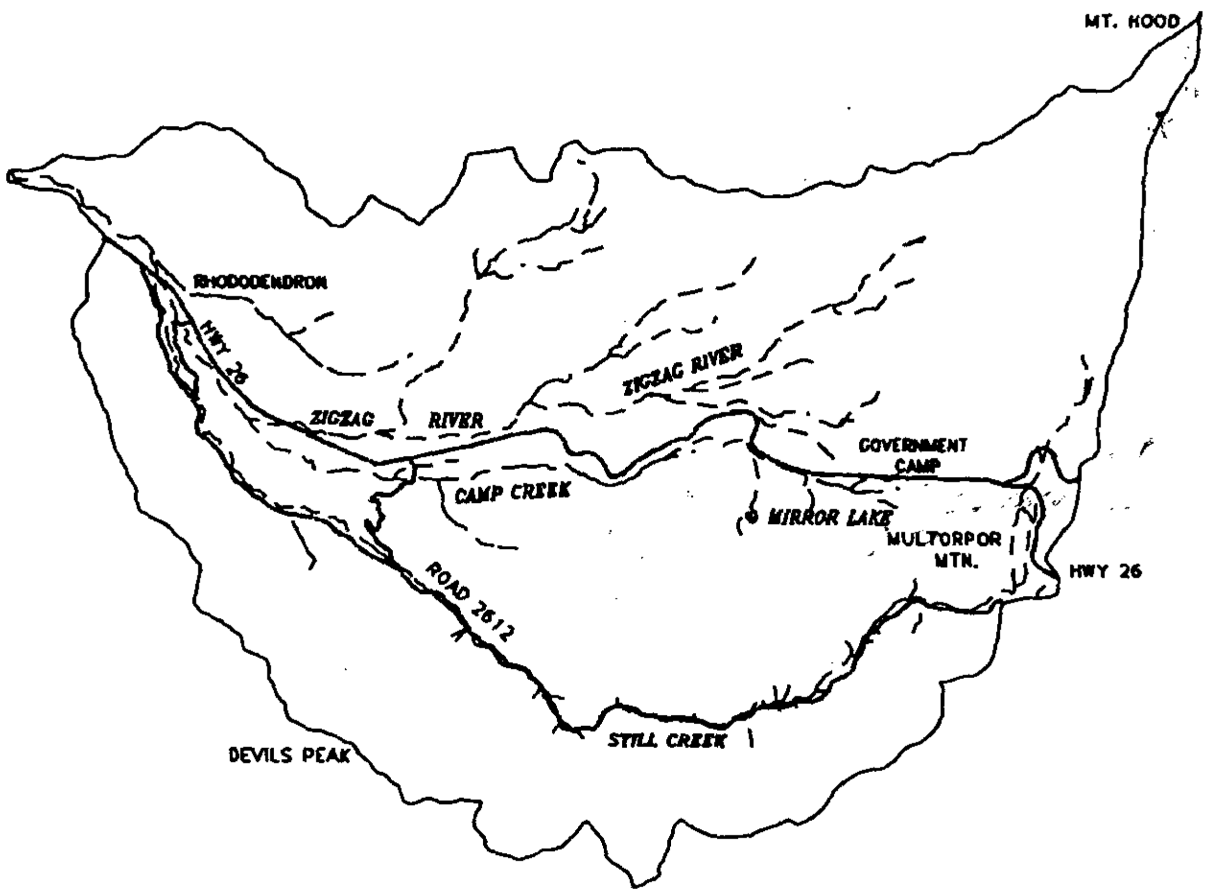


Figure 1-2 -- Zigzag Watershed



Watershed Setting

Terrestrial

The Zigzag Watershed is located on the west side of Oregon's Cascade Range, south of the Columbia River. The watershed incorporates portions of two major physiographic zones, the Cascade Mountain Range and the Columbia Basin, with elevations ranging from 1,400 to 10,000 feet. It encompasses 37,730 acres.

The Zigzag Watershed consists of three distinct stream systems: Still Creek, Camp Creek, and the Zigzag River. The Zigzag River originates from Zigzag Glacier, carves its way through volcanic debris flow in the upper watershed, then travels westerly through the central portion of the watershed's volcanic debris, terminating in alluvium near its confluence with the Sandy River. Still Creek originates from Palmer Glacier and a series of springs on Mt. Hood's west side. Camp Creek originates from a series of springs and wetlands above the Government Camp area. The Camp Creek subwatershed includes a number of large wetlands, including the Multorpor Fen, which is the Zigzag Watershed's largest wetland and an excellent example of a North Cascades subalpine mire.

Approximate annual precipitation within the Zigzag Watershed ranges from 130 inches at its highest elevations to 65 inches in the upper Still Creek drainage. Mt. Hood sustains a year-round snowpack at its highest elevations. This directly affects stream discharge into the Zigzag River, Camp Creek and Still Creek by providing water storage over the winter, then supplements this flow during the summer.

The landforms and soils within the watershed are forming on relatively young geologic surfaces. The geology of the toeslopes and sideslopes of the watershed's western portion consists of weak rocks that originated from volcanic debris flows. On the ridges above these slopes, more resistant volcanic flow rock caps the weaker material.

The watershed's eastern portion is dominated by large fans of unconsolidated materials from the glaciated volcanic slopes of Mount Hood. A small number of glacial cirques occur within the watershed's north facing uplands. Numerous rock outcrops, talus slopes and felsenmeers also occur within the Zigzag Watershed.

Soils forming on the slopes of the Zigzag River are, in general, poorly developed and contain many rock fragments. Soils in the upper watershed lost organic matter and nutrition following a series of wildfires in the early part of this century. Soils forming on the gentle uplands near Wind Lakes Basin, as well as within the upper reaches of Still Creek, are deeper and contain less gravel and cobble.

Fire has served as a major influence within the Zigzag Watershed. During this century, at least four significant fires of 1,000+ acres have burned here. The largest recorded fire covered 10,000 acres in August, 1917. The Zigzag Burn, the most recent significant fire, covered 1,000+ acres in October, 1952. Available historic information reveals that fire has burned over much of the Zigzag Watershed, as well as its surrounding (Eagle, Roaring River, and Salmon River) watersheds.

Three main vegetation zones occur within the watershed: Western Hemlock (33% of watershed), Pacific Silver Fir (51% of watershed), and Mountain Hemlock (11% of watershed). In addition, small areas of Subalpine and Alpine Zones (5% of watershed) occur near timberline.

The Zigzag Watershed's current vegetative condition is mainly even-aged, moderately dense stocked 80 to 100-year-old Douglas-fir and western hemlock dominated stands. Approximately 85% of the watershed is in mid seral stands. An estimated 15% of the watershed has areas with known infections of laminated root disease. Only a small percentage (7%) of the watershed consists of late seral stands. These older stands now occur in narrow patches along streams, and in larger blocks near Cool Creek.

Stands located within Still Creek's eastern portion are in poor forest health. In this area, many trees have reduced crown size and vigor, needle loss and discoloration, and are experiencing mortality. Several factors attribute to these conditions, including: offsite seed sources, poor soil conditions inherent from repeated fire activity, and infestation of spruce budworm and Douglas-fir beetle.

Aquatic

The watershed supports both anadromous (sea-run forms) and resident species salmonids. Primary fisheries include summer steelhead and resident rainbow and cutthroat trout. The watershed also supports winter steelhead, coho and spring chinook salmon -- contributing significantly to downstream fisheries in the lower Sandy River. Healthy populations of dace, whitefish and sculpin are also present. Higher up in the watershed, several small lakes and ponds support popular fisheries with cutthroat, rainbow and brook trout. The watershed's high mountain lakes include: Enid, Mirror, Wind, Veda, Hidden, Devils and Five lakes.

Habitat conditions for salmonids range from low to high quality within the watershed. Habitat surveys have identified a wide diversity of habitat types, ranging from low-gradient, wide meandering river channels to small, high-gradient glacier-fed creeks.

In some areas within the watershed, fish habitat has been degraded. Large floods in 1964 and 1970s scoured channels and swept much of the large woody material out of the system. In the aftermath of these floods, the U.S. Army Corps of Engineers, Forest Service, other public agencies, and private individuals removed any remaining large logs and boulders from sections of Still Creek, Camp Creek and the Zigzag River.

Throughout the Zigzag Watershed, moderate water quality concerns with turbidity, sediment, erosion and stream structure exist. For the most part, these concerns are associated with glacial runoff, unstable channels, sediment from road sanding, and stream cleanout after the 1964 Flood.

Special Habitats and Species of Concern

The Zigzag Watershed includes habitat for several "species of concern," all of which are tied to either the Endangered Species Act, National Forest Management Act (NFMA) regulations, or Forest Service policy.

The watershed also supports several sensitive plants (Regional Forester's Sensitive Species List), including: ground cedar (its largest population in the state is located on Tom, Dick and Harry Mountain in the Ski Bowl ski area); fir clubmoss (four sites are known along Still Creek, and two sites are located on Hunchback's north side); bog clubmoss (Multorpor Fen is one of only two sites in which it occurs within the entire Mt. Hood National Forest); and lesser bladderwort (which grows within Enid Lake's drawdown zones).

In addition, two of Still Creek's tributaries have confirmed occurrences of Cope's giant salamander, another Regional Forester's Sensitive Species. The watershed also supports two known northern spotted owl pairs. This species is listed as Threatened by the U.S. Fish and Wildlife Service, and is protected under the Endangered Species Act.

The watershed includes approximately 3,000 acres of special habitats, including: wetlands, rock outcrops, talus slopes, cliffs and bridges. In some cases, species of concern utilize these various special habitats.

Cliff sites within the watershed are potential habitat for Peregrine falcons, listed by the U.S. Fish and Wildlife Service as an Endangered species. Tom, Dick and Harry Mountain has been identified as a site with high potential for peregrine falcon habitat. A peregrine falcon hacking site was located there from 1990 to 1994.

Various types of wetlands also occupy the watershed, including wet meadows with and without ponds, forested wetlands, and several high mountain lakes. Multorpor Fen represents an excellent example of a subalpine mire. It contains several rare plants.

Social/Economic

Historically, the watershed has been used by American Indians for hunting, fishing, and providing other foods such as huckleberries and white bark pine nuts. Pioneers passed through the watershed on the historically significant Barlow Road on their way to the Willamette Valley in the mid to late 1800's. The watershed's ongoing importance in providing a wide variety of recreational opportunities started in the late 1800s. In 1926, the Secretary of Agriculture designated the land to the south of Mt. Hood and the Mt. Hood Loop Road (a portion of which is now U.S. Highway 26) as the Mt. Hood Recreational area, further highlighting the area's importance for recreation.

The Zigzag Watershed provides a wide variety of recreational opportunities. Activities range from more primitive types of recreation, such as hiking, fishing, and backpacking, to more developed facilities such as ski areas, motels and other facilities to meet the needs of recreationists. The watershed's proximity to Mount Hood and its variety of recreational opportunities contribute to its popularity, particularly for residents of the nearby Portland metropolitan area.

Recreational facilities on National Forest lands include: three ski areas, 557 Recreational Residences, three developed campgrounds, six Organization Camps (for non-profit organizations), and a variety of hiking trails. The Mt. Hood Wilderness, encompassing 30% of the watershed, receives heavy use along the Pacific Crest National Scenic Trail and other access trails. Elsewhere, use in the wilderness is low, most likely due to the extremely rugged terrain on the slopes of Zigzag Mountain.

U.S. Highway 26, a major travel route between Portland and central Oregon, dissects and serves as primary access to the watershed. Because of its heavy use and traffic congestion, the highway is currently being evaluated for expansion to provide more capacity and to correct identified safety problems.

Private lands within the watershed include the communities of Government Camp, Rhododendron and the Faubion/Zigzag areas. Many of the full-time residents of the watershed either work locally or commute into the Portland metropolitan. Many homes in the area serve as vacation retreats by part-time residents.

Much of the economic environment within the watershed is dependent upon tourism. Local communities are increasingly providing a variety of recreational facilities and services such as motels, stores and restaurants to meet the needs of the area's visitors and its permanent and part-time residents. Harvest of timber and other forest products has played a minor role in meeting the economic needs of the area.

Land ownership in the Zigzag Watershed is 97% Forest Service and 3% private.

"Pulse" Large-Scale Analysis

In January and February of 1994, the Mt. Hood National Forest completed a large-scale analysis of the Forest coined "Pulse," implying a short, dynamic burst of energy. Information about the Forest was assembled, analyzed and synthesized at a Forest-level scale. Because provincial level planning has not yet been completed, Pulse provides information about the context, both ecological and human, of watersheds within the overall forest.

Information from Pulse was reviewed by the Zigzag Watershed Analysis Team. Applicable points were then incorporated into Chapter 4, Current Conditions and Trends. Until additional larger-scale planning is completed, Pulse will continue to provide larger-scale information about processes, patterns, and uses that will meet objectives of provincial-level planning.

Chapter 2 - Desired Conditons

Chapter 2 - Desired Conditions

The desired conditions for National Forest lands in the watershed are taken from existing management plans. These are derived from merging the land allocations from the Record of Decision of the Northwest Forest Plan (ROD) and the Mt. Hood Forest Land and Resource Management Plan (LRMP).

The ROD amends existing plans with additional land allocations and standards and guidelines. For acreage and display purposes, the following land allocation hierarchy is used: 1) Congressionally Reserved Areas, 2) Late Successional Reserves, 3) Riparian Reserves, 4) Administratively Withdrawn Areas, and 5) Matrix.

The standards and guidelines of the LRMP still apply where they are more restrictive or provide greater benefits to late successional forest-related species. In Matrix lands, management direction from the LRMP will generally apply, as well as direction from the ROD that applies to all land allocations.

On non-federal lands, state and county land management regulations apply.

Table 2-1 summarizes acres by land allocation. National Forest land allocations are based on the hierarchy described on the previous page.

Table 2-1 -- Acres by Land Allocation

LAND ALLOCATIONS	ACRES IN ALLOCATION
Wilderness (A2)	11,216
Late Successional Reserves (LSR)	5,375
Riparian Reserves	7,082
Winter Recreation (A11)	3,165
Unroaded Recreation (A5)	2,901
Special Interest Area (A4)	951
Developed Recreation Sites (A10)	205
Scenic Viewshed (B2)	2,612
Special Emphasis Watershed (B6)	2,491
Roaded Recreation (B3)	588
Backcountry Lakes (B12)	156
Private Land	988
Total acres -	37,730

Figure 2-1(on next page) displays Congressionally Reserved Areas, Late Successional Reserves and Riparian Reserves on National Forest Lands. Figure 2-2 displays all National Forest Land Allocations. Mapping is based on the same hierarchy used in the land allocation table above.

Key aspects of the desired conditions by land allocation are summarized in the pages following this two maps. Further detail is described in the existing Northwest Forest Plan and Mt. Hood Forest Land and Resource Management Plan.

Figure 2-1 -- Congressionally Reserved Areas, Late Successional Reserves and Riparian Reserves

(Note, there are private inholdings within the watershed boundary below and total approximately 988 acres. Although mapped within National Forest land allocations, these areas are regulated by State and local laws.)

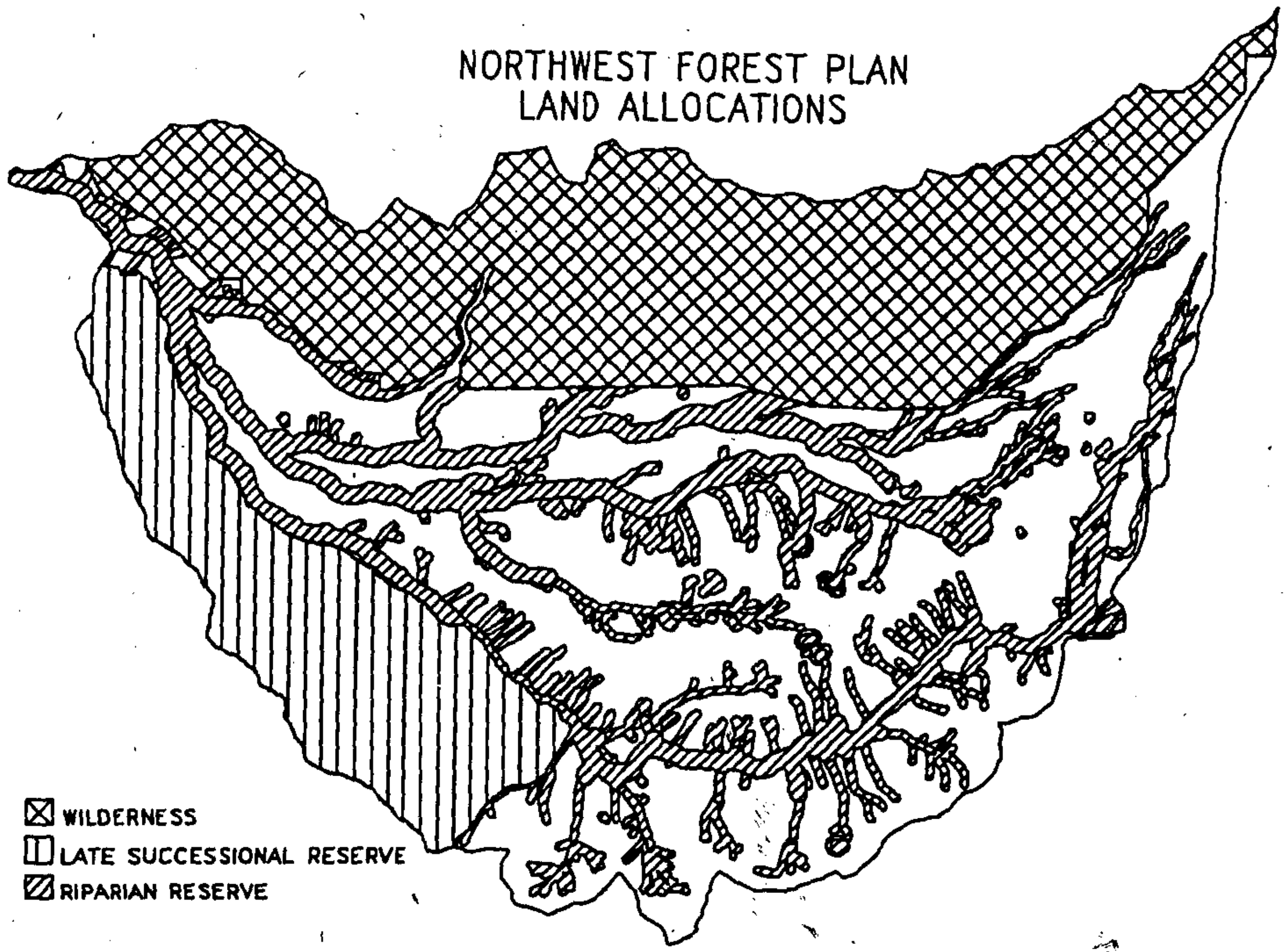
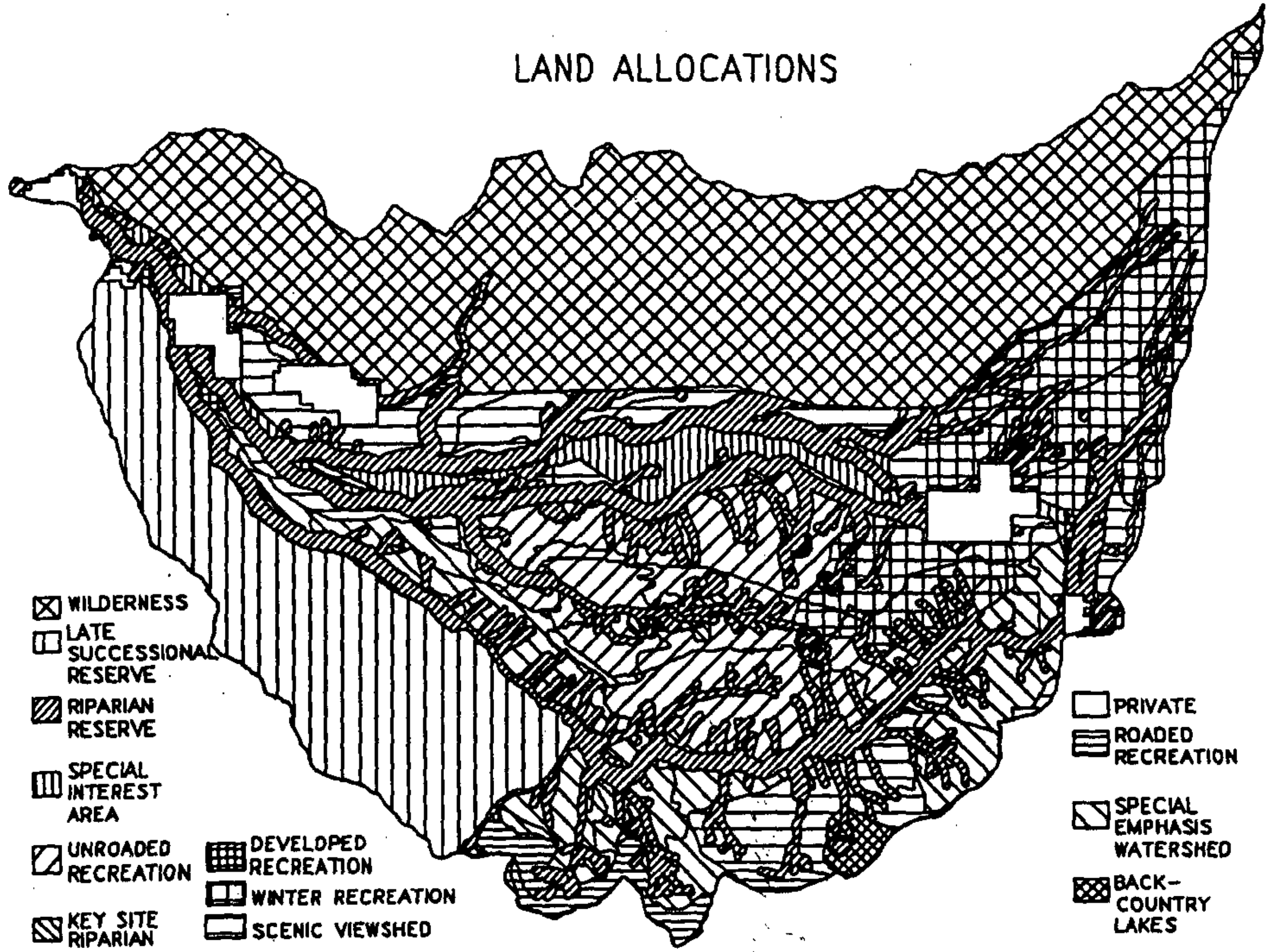


Figure 2-2 -- National Forest Land Allocations



Land Allocations

Congressionally Reserved Areas

These lands have been reserved by act of Congress for specific land allocation purposes. For the Zigzag Watershed, this includes the Mt. Hood Wilderness.

Mt. Hood Wilderness (A2)

The goal of Wilderness areas are to promote, perpetuate and preserve the wilderness character of the land; protect watersheds and wildlife habitat; preserve scenic and historic resources; and promote scientific research, primitive recreation, solitude, physical and mental challenge, and inspiration. Motorized or mechanical equipment is not allowed within Wilderness boundaries.

Late Successional Reserves (LSR)

Desired condition for these reserves (in combination with the other allocations and standards and guidelines):

- To maintain a functional, interacting, late successional and old-growth forest ecosystem.
- To serve as habitat for late successional and old-growth related species, including the northern spotted owl.
- To maintain natural ecosystem processes and functions (ROD B-1 and B-4).

In addition to the mapped LSRs (shown on Alt. 9 Map for the Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl), 100-acre LSRs are to be designated around each known (as of Jan. 1, 1994) spotted owl activity center not already protected by another reserve (ROD C-10). Because no known owl activity centers occur in Matrix lands within the Zigzag Watershed, this allocation does not apply.

Management assessments are to be prepared for each LSR before habitat manipulation activities are designed or implemented. The watershed analysis provides information that will be important for the overall LSR assessment.

Riparian Reserves

As a key element of the Aquatic Conservation Strategy, the Riparian Reserves provide an area along all streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis. Riparian Reserves are also important to the terrestrial ecosystem.

Desired conditions for Riparian Reserves:

- To attain a fully functional aquatic and riparian habitat area that meets the needs of riparian-dependent species.
- To serve as dispersal corridors for many terrestrial animals and plants.
- To enhance habitat for species that depend on the transition zone between upslope and riparian areas.
- To maintain and restore riparian structure and function of intermittent streams.
- To provide greater connectivity within the watershed and among LSRs.

Direction for designating Riparian Reserve widths is stated in the ROD (Standards and Guidelines, pages C-30 and C-31). For the Zigzag Watershed Analysis, measured site-potential tree heights within major vegetative zones were used to delineate the interim Riparian Reserve widths. (See Chapter 7 for detailed information on the assumptions used for developing the interim Riparian Reserve widths.)

The following is a summary of the interim Riparian Reserve widths used in this analysis.. For the purpose of mapping, horizontal distances were used. On most lands (except steep slopes), the difference between slope and horizontal distance is minimal.

Major vegetative zones and their measured site-potential tree heights:

- Western Hemlock Zone -- Douglas-fir measured tree height 210'
- Pacific Silver Fir Zone -- Douglas-fir measured tree height 170'
- Mountain Hemlock Zone -- Use defaults from the ROD.

Unstable and potentially unstable areas should be field verified during project planning, and delineated by a soil scientist or geologist. Final location of all Riparian Reserves will be based on site-specific analysis.

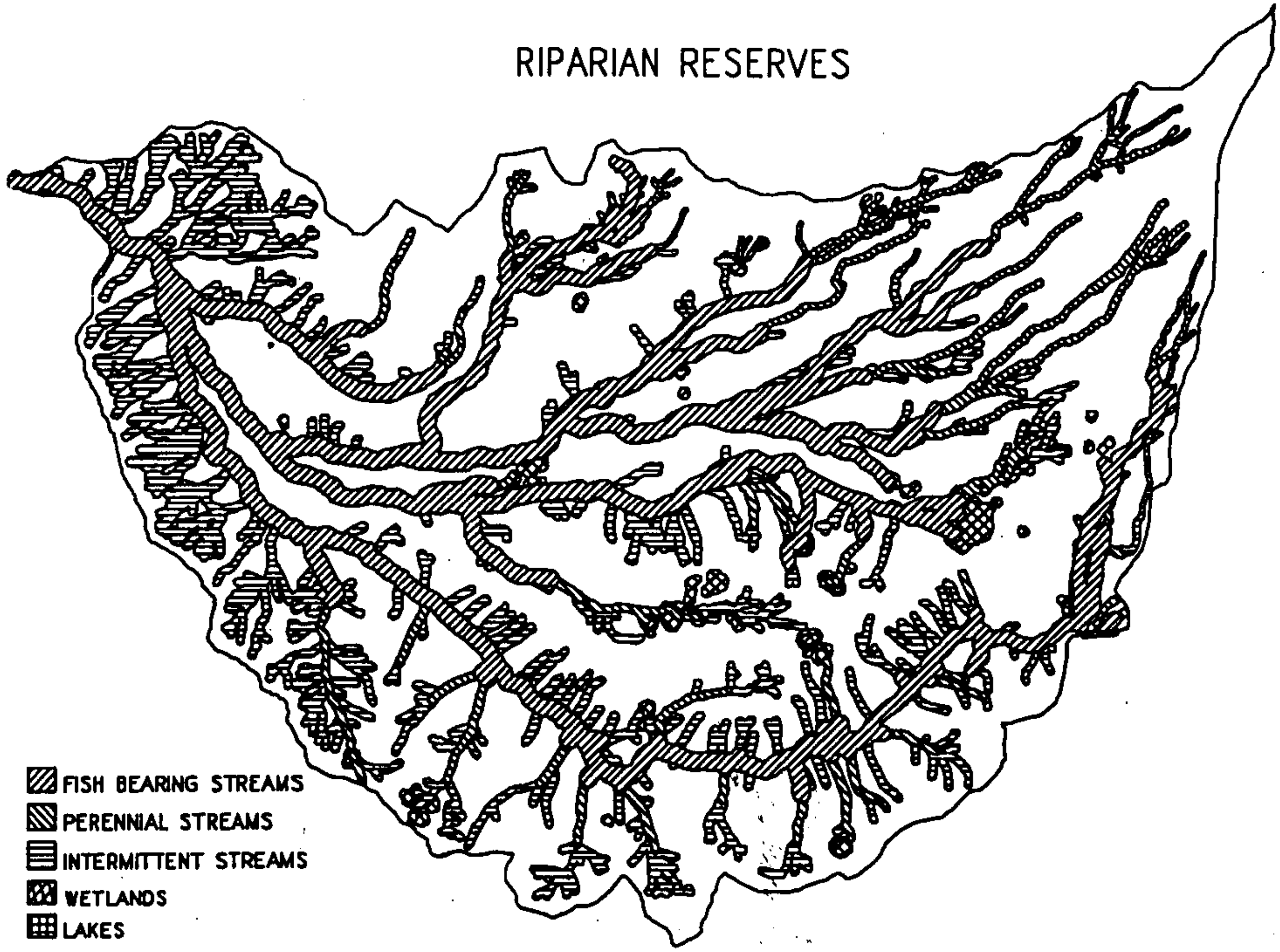
Table 2-2 -- Interim Riparian Reserve Widths

STREAM/RIPARIAN ZONE TYPE	WESTERN HEMLOCK ZONE	PACIFIC SILVER FIR ZONE	MOUNTAIN HEMLOCK ZONE
Fish bearing streams (uses 2 site-potential tree heights)	420'/side 840' total	340'/side 680' total	300'/side 600' total
Non-fish bearing, permanently flowing streams (uses 1 site-potential tree height)	210'/side 420' total	170'/side 340' total	150'/side 300' total
Seasonally flowing or intermittent streams (uses 1 site potential tree height)	210'/side 420' total	170'/side 340' total	100'/side 200' total
Lakes and natural ponds (uses 2 site potential tree heights)	420' surrounding	340' surrounding	300' surrounding
Wetlands (uses 1 site-potential tree height)	210' surrounding	170' surrounding	150' surrounding
Unstable and potentially unstable areas (uses 1 site-potential tree height)	210' surrounding	170' surrounding	100' surrounding
Key Site Riparian	See comment below		

Key Site Riparian (A-9)

The desired condition is to maintain or enhance the habitat and condition of these areas notable for their exceptional diversity, high quality, and their key role in helping meet the needs of riparian-dependent species. In most regions of the watershed, Riparian Reserves override the LRMP's Key Site Riparian designations. Key Site Riparian areas are thus incorporated into the Riparian Reserves network. However, 72 acres of the original Key Site Riparian allocation are wider and contain more upland forest than widths in Table 2-2. In such instances, the Riparian Reserve widths (as displayed in Table 2-2) would be increased to include these additional acres.

Figure 2-3 -- Riparian Reserves within the Zigzag Watershed



Administratively Withdrawn Areas

Administratively Withdrawn Areas are identified from the LRMP. These include recreation and visual areas, back country, and other areas where management emphasis precludes scheduled timber harvest.

A11 Winter Recreation Areas

The desired condition is to provide high quality winter recreation (and associated summer) opportunities including: downhill skiing, Nordic skiing, and snowplay within a naturally-appearing forest environment.

Within the watershed, Multorpor Ski Bowl, Summit, and Timberline ski areas, provide important developed alpine (downhill) winter recreation opportunities. Other areas of the watershed also provide important Nordic (cross-country) skiing opportunities.

A5 Unroaded Recreation

These areas provide a variety of year-round unroaded recreation opportunities in a semi-primitive, non-motorized and undeveloped environment. They are generally accessed by trails suitable for foot or horseback use.

A4 Special Interest Area

Special Interest Areas protect, and where appropriate, foster public recreational use and enjoyment of important historic, cultural, and natural aspects of our national heritage. The Barlow Road Historical Travel Route is located within this allocation. It includes all known traces of this wagon road and its associated features.

A10 Developed Recreation Sites

The goal of developed recreation sites is to provide a range of high-quality outdoor recreational opportunities for concentrated recreational use at readily accessible, appropriately-designed developed sites. Included in these management areas within the Zigzag Watershed: Recreational Residences, Organization Camps, and Tollgate, Camp Creek and Still Creek campgrounds.

Matrix

The Matrix consists of federal lands outside the categories of the previously listed designated areas. Within Matrix lands, management direction from the LRMP will therefore generally apply, along with direction from the ROD that applies to all land allocations.

The following land allocations are within the Matrix:

B2 Scenic Viewshed

Scenic viewsheds are intended to provide attractive, visually appealing forest scenery with a wide variety of natural-appearing landscape features. Vegetation management activities are used to create and maintain desired landscape character. The visual character of the landscape results from prescribed visual quality objectives within distance zones from selected view points.

Primary view positions: Timberline Lodge, Timberline Road, and U.S. Highway 26.

B6 Special Emphasis Watershed

The goal of this allocation is to maintain or improve watershed riparian and aquatic habitat conditions, as well as water quality for municipal uses and/or long-term fish production. A secondary goal is to maintain a healthy forest condition through a variety of timber management practices.

B3 Roaded Recreation

This land allocation applies to the portion of the watershed on the north side of the ridge from Sherar Burn Road #2613. (The road is actually located in Salmon River Watershed.) The desired condition is to provide a variety of year-round recreation opportunities in natural-appearing roaded settings and, secondarily, to maintain a healthy forest condition through a variety of timber management practices.

B12 Backcountry Lakes

This allocation is used to protect or enhance the recreation, fish and wildlife, and scenic values of designated lakes. A secondary goal is to maintain a healthy forest condition through a variety of timber management practices. Veda Lake is included in this allocation, as well as an area surrounding Kinzel Lake -- although the actual lake is located in the Salmon River Watershed.

Aquatic Conservation Strategy

In addition to land allocations, the Aquatic Conservation Strategy (ACS) focuses on maintaining and restoring ecosystem health at watershed and landscape scales to protect fish habitat and other riparian-dependent resources. The strategy consists of four components: Key Watersheds, Riparian Reserves, Watershed Restoration, and Watershed Analysis. These components provide the land management agencies with the tools to maintain and restore the productivity and resiliency of riparian and aquatic ecosystems. The objectives of the Aquatic Conservation Strategy are listed in the ROD, page B-11. The Zigzag Watershed is not designated a Key Watershed.

Chapter 3 - Key Question Development

Chapter 3 - Key Question Development

One of the first steps in the watershed analysis process is to focus on the watershed's key attributes most relevant to management questions, human values, or resource conditions within the watershed. These identified attributes are then formulated into questions. These Key Questions are answered in the analysis, based on indicators most commonly used to measure or interpret processes and conditions for ecosystem elements. To facilitate synthesis, processes and conditions are analyzed and presented under the same Key Question.

A key attribute was identified as:

- Having a stature in the watershed that cannot be ignored.
- An item of administrative or legislative significance (i.e. species addressed under the Endangered Species Act).
- Tied to the Northwest Forest Plan.
- Distinct or unique at the watershed, basin or provincial scale.

Key Questions and Rationale

Once the key attributes were identified, they were restructured into question format. The rationale for selection accompanies each Key Question. Consideration of past, present and future temporal scales is implied by "conditions."

Key Question #1:

How do conditions of the watershed contribute to habitat needs for species of concern associated with aquatic, riparian, terrestrial, and special habitats?

RATIONALE: The ROD (page B1) states one of its goals is to maintain late successional and old-growth habitat and ecosystems on federal lands. The Aquatic Conservation Strategy Objectives 1, 2, 8, 9 (ROD page B-11) address species in riparian and aquatic habitats. Finer-scale attention was also deemed necessary in the Northwest Forest Plan's Final Supplemental Environmental Impact Statement (FSEIS) for some species and ecosystem issues. Species which were outside the scope of the FSEIS and deemed to be at risk were also considered. Species of concern are tied to the Endangered Species Act, National Forest Management Act (NFMA) regulations, and Forest Service policy.

Key Question #2:

How do conditions of the watershed affect the ability to meet the Aquatic Conservation Strategy objectives?

RATIONALE: The ROD states: watershed analysis will develop the baseline from which to assess maintaining or restoring the watershed's existing condition (page B-10); and watershed analysis provides the basis for monitoring and restoration programs, as well as the foundation from which Riparian Reserves can be determined (page B-12).

Key Question #3:

How do conditions of the watershed affect opportunities for development within the ski areas, Recreational Residences, Organization Camps, and private lands?

RATIONALE: The Zigzag Watershed is unique in containing three developed ski areas (Multorpor Ski Bowl, Summit and Timberline) which offer recreation activities throughout the year. Within the watershed, there are also 557 Recreational Residences and 7 organizational Camps, both having administrative significance. Private lands include the villages of Government Camp and Rhododendron.

Key Question #4:

How do conditions of the watershed affect the availability of forest products such as timber and other wood products, plant materials, huckleberries, and minerals?

RATIONALE: The ROD (Page E-9) requires that predictable levels of timber and non-timber resources be available and produced within the watershed, including: livestock grazing, special forest products, and mineral extraction.

Key Question #5:

How do conditions of the watershed affect the maintenance and development of U.S. Highway 26?

RATIONALE: Highway 26 is a major recreational and commercial travel corridor which bisects the watershed. It connects the Portland metropolitan area with recreational sites within the watershed, and serves as a high-use, regional travel corridor to central Oregon. Highway 26 is distinct at the basin scale and as an interface with the forest environment. It also has important stature at the watershed scale.

Key Question #6:

How do conditions of the watershed affect the inventoried roadless areas?

RATIONALE: Three large areas of inventoried roadless lands exist within the watershed. These include the Mt. Hood Additions and Wind Creek roadless areas, as well as portions of the Salmon-Huckleberry roadless area. The ROD (pages A-7, B-19) states: "Watershed analysis must be conducted in all non-Key Watersheds that contain roadless areas before any management activities can occur within these roadless areas."

Chapter 4 - Current Conditions and Trends

Chapter 4 - Current Conditions and Trends

Introduction

Chapter 4 describes the condition of the watershed in terms of processes and functions that are critical to addressing the Key Questions. Included is a description of the existing condition, the range of natural variation, and trends based on current management direction. How conditions have changed over time as a result of human influence and natural disturbances is also documented.

Results of the analysis were often complex and lengthy. Additional information is therefore presented in this document's analysis file. Other important products of the watershed analysis includes maps, spatial data summaries, and databases. Most of the maps displayed within this document are available at 2.64 inches per mile. Data layers reside in electronic format in MOSS. Hand-drawn maps summarize additional information. All of these materials provide a foundation for future management in the Zigzag Watershed.

Geology

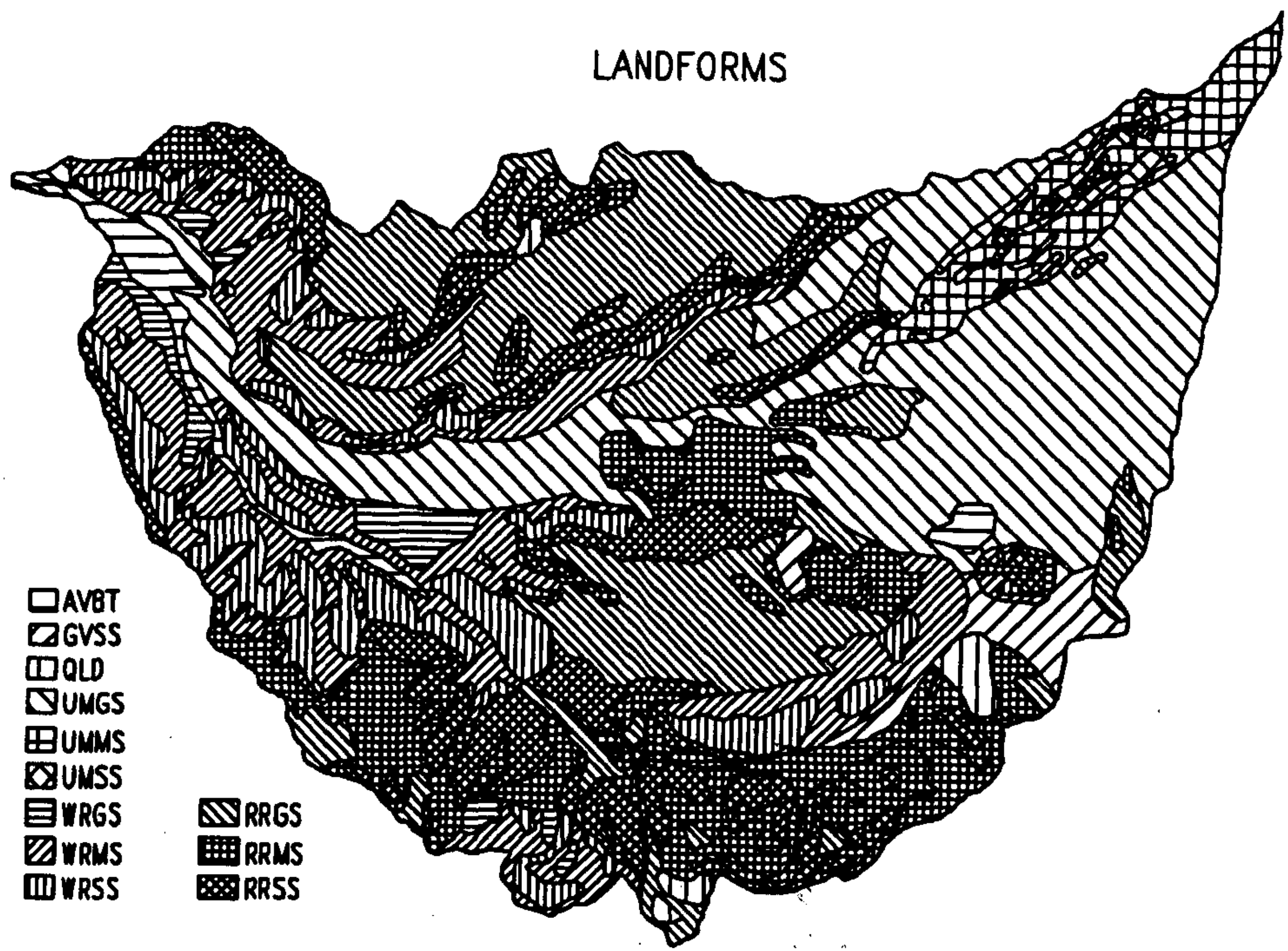
The western portion of the Zigzag Watershed is largely underlain by older, weak, andesitic tuff breccias of the Western Cascades geologic province. These volcanic deposits originated mainly as pyroclastic flows and lahars. They are found along the toeslopes of the Zigzag River and western Still Creek, and sideslopes of northeastern Still Creek. Some layers of weak, pyroclastic rock also outcrop on Eureka Peak and Wolf Camp Butte. Where the weak geologic formations occur on steep slopes within the watershed (such as Wolf Camp Butte, Hunchback, West Zigzag and Multorpor mountains), the hillsides are subject to debris slides and flows. Soils forming in this rock type are quite variable. Where the slopes are steep, soil development has been limited and soils are often extremely rocky. On the moderate and gentle slopes, the soils have developed more fines and contain occasional large rock fragments. Rock outcrops, talus slopes, and felsenmeers are common (see Figure 4-1 on the following page).

The more resistant lava flows of the High Cascades geologic province cap the weaker tuff breccia. The resistant rocks -- basalts and andesites -- are expressed on the sideslopes and ridgetops throughout the western and central watershed. Where the resistant rock forms steep hillslopes, such as along the northern aspects in Still Creek, debris slides and avalanches are common. Soils forming in this geologic type are generally quite rocky and, in some cases, shallow in depth. Rock outcrops, talus slopes, and felsenmeers are quite common.

On Mt. Hood's upper flanks, Quaternary volcanic and glacial deposits shape the hillslopes. Here, young pyroclastic flows, debris flows, and glacial till deposits form unconsolidated materials of the high mountain slopes. Resistant rock occasionally outcrops within these deposits. The unconsolidated materials are rapidly eroded by water, as evidenced by the remarkable stream dissection within Zigzag Canyon. Soils on these surfaces are poorly developed with coarse textures, low moisture holding capacity, and low fertility.

Lahars as young as 200 years of age cover the valley bottom along the Zigzag River's mainstem. Pyroclastic debris from the Old Maid eruptive period (180-270 years before present), the Zigzag eruptive period (400-600 years before present), and Timberline eruptive period (1,400-1,800 years before present), combine to shape the landscape of the valley of the Zigzag, Little Zigzag and Sandy rivers. Soils on these juvenile landforms are young and poorly developed. They are also coarse textured with low moisture holding capacity and low fertility.

Figure 4-1 -- Zigzag Watershed Landforms



Quaternary landslide deposits and glaciated valley sideslopes are also found within the watershed. The glaciated valley sideslopes occur at elevations above 3,000 feet in the eastern portion of the Still Creek subwatershed, and also within Mirror Lake Basin. Quaternary landslide deposits are found below Wolf Camp Butte and Eureka Peak.

Landforms

The previously described broad geologic units have been grouped into 12 landform types, based primarily on slope angle, drainage density, and susceptibility to landsliding. Landforms and geologic type are summarized in Table 4-1.

Table 4-1 -- Landform Characteristics

LANDFORM UNIT	GEOLOGIC TYPE	PHYSICAL CHARACTERISTICS	SEDIMENT DELIVERY MECHANISMS
Resistant rock, steep slopes (RRSS)	Basalt and andesitic flows; porphyritic lava with minor flow breccia; intrusions	Slope angles typically exceed 50%. Occurs throughout watershed, but most common in Still Creek valley	Inner gorge failures, debris flows and slides, surface erosion creep
Resistant rock, moderate slopes (RRMS)	Basalt and andesitic flows; porphyritic lava with minor flow breccia; intrusions	Slopes range from 30-50%. Found mostly in the north-central part of the watershed.	Inner gorge failures, debris flows and slides, surface erosion creep
Resistant rock, gentle slopes (RRGS)	Basalt and andesitic flows; porphyritic lava with minor flow breccia; intrusions	Slopes range from 10-40%. Found throughout the watershed.	Inner gorge failures, debris flows and slides, surface erosion creep
Weak rock, steep slopes (WRSS)	Andesitic tuff breccia; fluvial volcaniclastic sandstone and siltstone; propylite	Slopes regularly exceed 70%, seldom less than 50%. Found mostly in the lower 1/3 of the watershed.	Inner gorge failures, debris flows and slides, slumps, minor earthflows, surface erosion, creep
Weak rock, moderate slopes (WRMS)	Andesitic tuff breccia; fluvial volcaniclastic sandstone and siltstone; propylite	Slopes range from 30-50%.	Inner gorge failures, debris flows and slides, slumps, minor earthflows, surface erosion, creep
Weak rock, moderate slopes (WRMS)	Andesitic tuff breccia; fluvial volcaniclastic sandstone and siltstone; propylite	Slope angles 30-50%. Commonly found in the western portion of the watershed .	Inner gorge failures, debris flows and slides, slumps, minor earthflows, surface erosion, creep
Weak rock, gentle slopes (WRGS)	Andesitic tuff breccia; fluvial volcaniclastic sandstone and siltstone; propylite	Occurs in the western portion of the watershed on slopes that seldom exceed 30%.	Inner gorge failures, debris flows and slides, slumps, minor earthflows, surface erosion, creep
Alluvial valley bottoms, terraces (AVBT)	Generally sorted deposits of sand, gravel, and reworked ash	Slopes 10-30%. Occurs near Multorpor Mtn. and lower reaches of Still Creek and ZigZag River	Streambank failures, surface erosion
Glaciated valley side slopes (GVSS)	Generally unsorted compacted deposits of detritus, from silt to boulder	Slope angles generally less than 30%. Occurs in the southeastern portion of the watershed at elevations above 3,000 feet.	Streambank failures, debris slides and flows, erosion, creep
Unconsolidated material, steep slopes (UMSS)	Dacite pebbles, cobbles and boulders in sand matrix with silt and sand interbeds.	Slope angles exceed 50-70%. Occurs in the higher elevations of the watershed	Inner gorge failures, debris slides, surface erosion, dry ravel
Unconsolidated material, moderate slopes (UMMS)	Dacite pebbles, cobbles and boulders in sand matrix with silt and sand interbeds.	Slope angles 30-50%. Occurs in the higher elevations of the watershed.	Inner gorge failures, debris slides, surface erosion, dry ravel
Unconsolidated material, gentle slopes (UMGS)	Dacite pebbles and cobbles, boulders in sand matrix with silt and sand interbeds	Slopes angles less than 30%. Found in the eastern portion of the watershed.	Inner gorge failures, debris slides, surface erosion, dry ravel

Landsliding

Table 4-2 and Table 4-3 summarize the watershed's landslide potentials. Mass wasting is generally confined to slopes in excess of 50% on these landforms. Approximately 20% of the watershed is within this slope class. From the landform map and summary of landslide potential, it appears concentrated areas of high landslide potential exists near Zigzag and Hunchback mountains. Pockets of unstable lands can be found throughout all of the subwatersheds. The landform map can be used as a guide to predict where landslides may be a concern to management. Unstable lands were not included in the Riparian Reserve network for the watershed analysis. Rather, unstable lands should be added to the Riparian Reserve network following site-specific field evaluation. The geologic report contained in the analysis file lists several additional signs of slope instability which require field investigation.

A landslide inventory completed for the watershed analysis sampled a subset of the landforms within the watershed. It identified 77 landslides originating since 1958. Of the landslides identified, 15 were associated with roads, 4 with clearcuts, 1 with roads or clearcuts, and 57 within mature forest or non-forested land. Many landforms in the watershed are more broadly defined with medium landslide potential and sediment delivery ratings. At least 25 of the landslides identified appear to be associated with the 100 year storm that occurred in 1964, 63 appear to have delivered sediment to waterways, and at least 12 are actively eroding.

The majority of the landslides associated with the 1964 storm are debris flows. Most of these occurred in the western portion of the watershed, originating either from Zigzag or Hunchback mountains. Camp Creek and Still Creek subwatersheds are reported to have readily transported debris during more recent high-intensity storms.

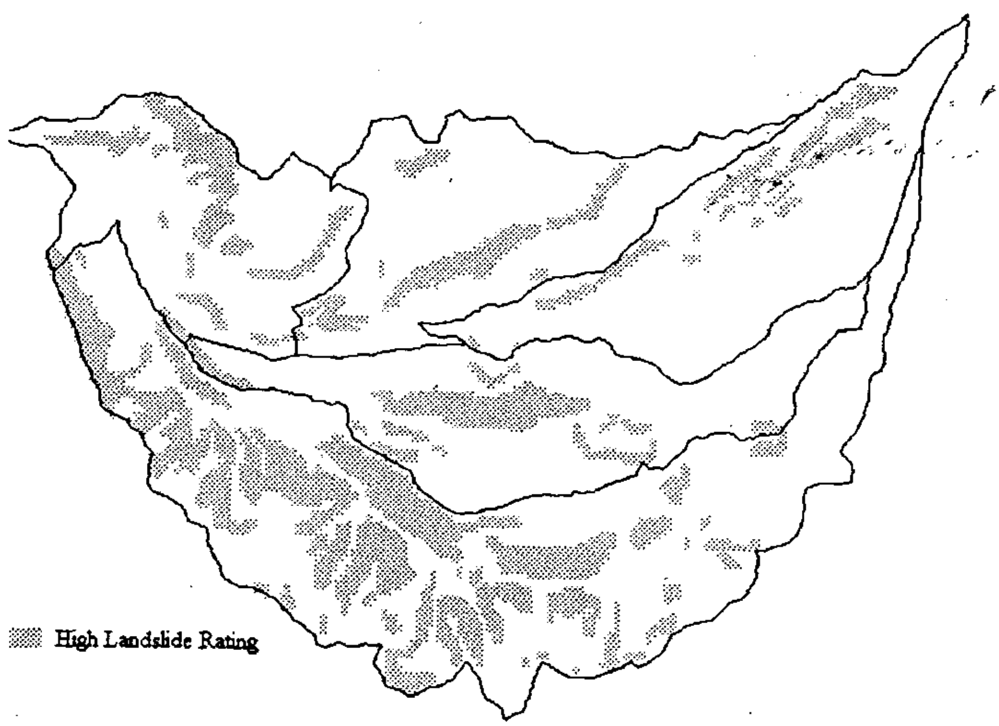
Table 4-2 -- Landslide and Sediment Delivery Potential

LANDFORM UNIT	LANDSLIDE POTENTIAL	SEDIMENT DELIVERY	PERCENT OF WATERSHED	ACREAGE IN WATERSHED
RRSS	HIGH	HIGH	10	3687
RRMS	MEDIUM	MEDIUM	15	5706
RRGS	LOW	LOW	20	7443
WRSS	HIGH	HIGH	9	3294
WRMS	MEDIUM	MEDIUM	13	5009
WRGS	LOW	MEDIUM	2	704
AVBT	LOW	LOW	2	672
GVSS	MEDIUM	MEDIUM	2	756
QLD	MEDIUM	MEDIUM	1	326
TALUS				
UMSS	HIGH	HIGH	1	403
UMMS	MEDIUM	HIGH	3	1282
UMGS	LOW	MEDIUM	22	8419

Table 4-3 -- Landslide Potential by Subwatershed

SUBWATERSHED	TOTAL ACRES	HIGH ACRES/PERCENT	MEDIUM ACRES/PERCENT	LOW ACRES/PERCENT
Still Creek	14411	4322 / 30	7213 / 50	2857 / 20
Henry/ZigZag	4994	942 / 19	1792 / 36	2261 / 45
Devil/Lady	5708	610 / 11	1028 / 18	4070 / 71
Camp Creek	6225	932 / 15	1389 / 22	3904 / 63
ZigZag/Little ZigZag	6390	578 / 9	1658 / 26	4146 / 65

Figure 4-2 -- High Landslide Rating



Soils

The relatively young geologic surfaces within the watershed provide the base for its soil formation. In addition, vegetation and organic matter and climate and topography combine to shape soil development. Soil conditions that most influence site productivity within the Zigzag Watershed include organic matter, soil depth, rock content, and mean annual moisture and temperature. Large areas of talus, rock outcrop and soil-rock complexes exist throughout the watershed. Soils that have formed contain large amounts of sands and gravels and are relatively low in organic matter. The most productive soils are limited to gently sloping ridgetops in the Wind Lakes Basin and small areas of upper Still Creek. (Table 4-4 summarizes the general soil types within the Zigzag Watershed.)

Fire has played an important role in soil development within the Zigzag Watershed. Since the turn of the century, fire has burned several areas within the watershed. Some of these areas have burned more than once. Intense heat has consumed large woody debris and duff. Loss of soil organic matter following fires is thought to have negatively affected soil nutrition. Loss of mineral soil from post-fire erosion is thought to have contributed to additional reductions in soil nutrition.

For the Zigzag Watershed Analysis, soil properties such as mineral soil texture and depth and rock content were examined to estimate soil productive capabilities and limitations. The soil properties were used to determine limits to rooting and tree growth, surface erosion potential, and soil droughtiness/wetness. For expediency, only soils on lands available for timber harvest (B lands) were evaluated for soil capabilities and limitations. Results revealed that more than two-thirds of the B lands may have some limitations to productivity due to soil characteristics. Figure 4-3 illustrates the location of these soils. A list of the soils and their potential limitations is included in the analysis file. Some of the lands containing limiting soils are mapped as unsuitable for timber production (LRMP suitability screens 1, 3 or 4). Suitability mapping for the watershed was completed in 1989 and is shown below in Figure 4-3. During project planning, it is recommended that site-specific soil investigations take place to validate potential soil limitations and suitability.

Figure 4-3 -- B Land Allocations With Potential Soil Limitations

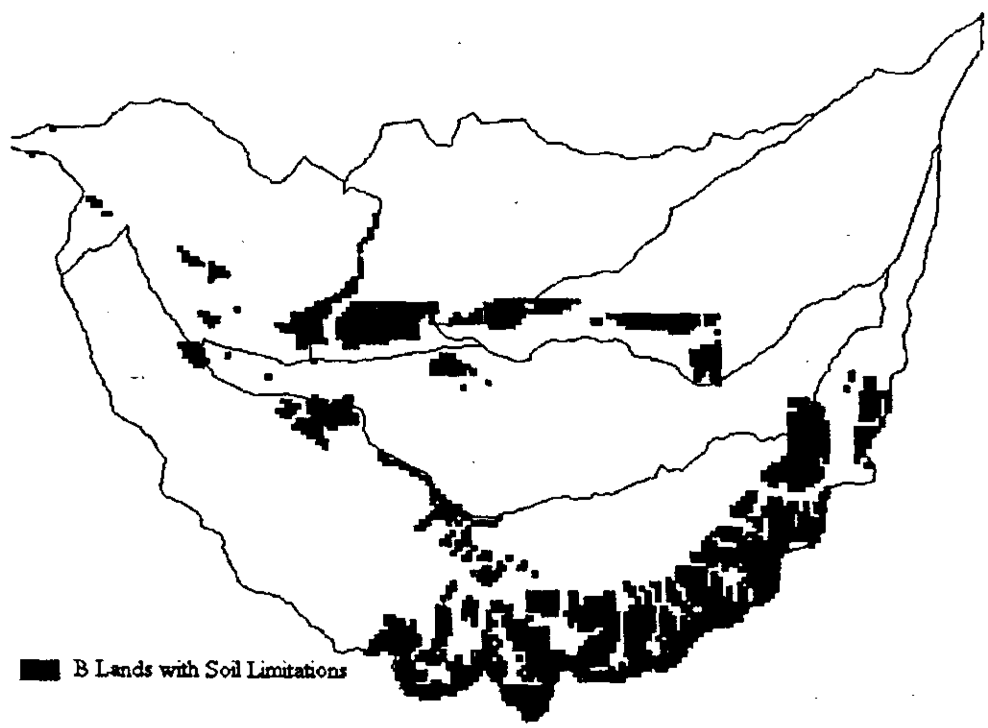


Figure 4-4 -- Suitability Mapping, Zigzag Watershed

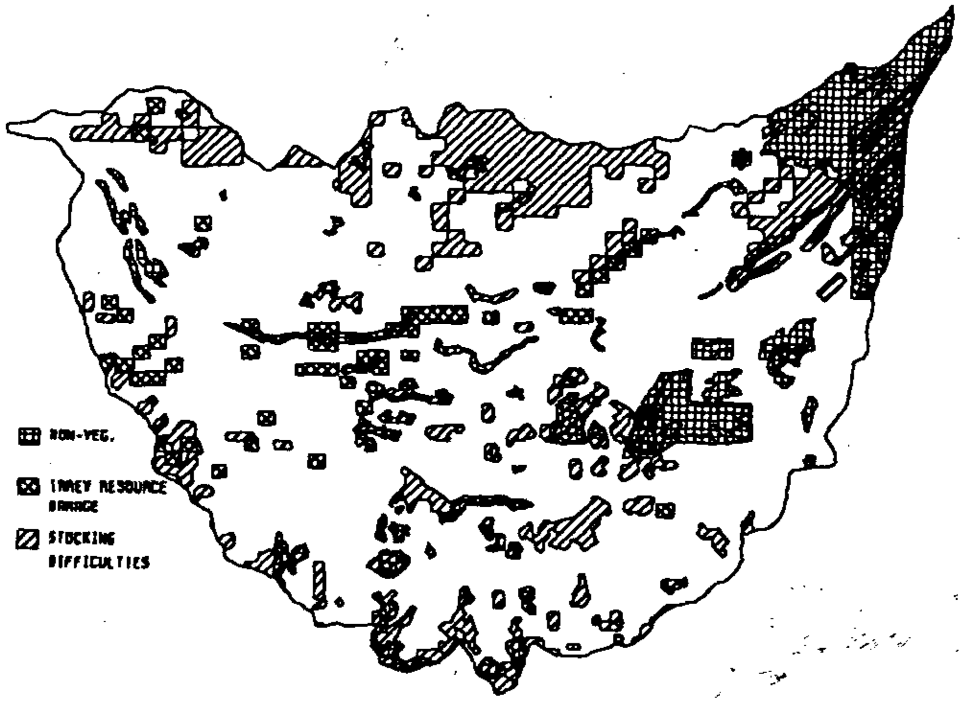


Table 4-4 -- Zigzag Watershed General Soil Types

SUBWATERSHED	GENERAL SOIL TYPES	APPROX ACRES	PERCENT OF SUBWATERSHED
STILL CREEK	unvegetated talus and rubbleland, igneous rock outcrop, wet talus, felsenmeer slopes, glacially scoured cirques and talus-extremely gravelly loam complexes	4772	33
	moderately deep, very gravelly and extremely gravelly loams forming in glacial till deposits	4300	30
	shallow, very gravely sandy loams and silt loams forming in glacial till deposits	1860	13
HENRY CREEK & /ZIGZAG RIVER	moderately deep, very gravelly and extremely gravelly loams forming in glacial till deposits	3530	71
DEVIL & LADY CREEKS	moderately deep, very gravelly and extremely gravelly loams forming in glacial till deposits	2090	37
	igneous rock outcrop, unvegetated talus and rubbleland, felsenmeer slopes, alluvial and poorly drained forested bottomlands, talus-soil complexes	1984	35
	moderately deep very gravelly and very cobbly loams forming in subalpine plant communities on glacial till	1122	20
CAMP CREEK	wet talus, felsenmeer slopes, unvegetated talus and rubbleland, igneous rock outcrop, glacially scoured cirques	2200	35
	moderately deep, very gravelly and extremely gravelly loams forming in glacial till deposits	1025	16
	shallow, very gravely sandy loams and silt loams forming in glacial till deposits	1080	17
	moderately deep very gravelly loams forming in subalpine plant communities on glacial till	644	10
ZIGZAG/LITTLE ZIGZAG	moderately deep very gravelly and very cobbly loams forming in subalpine plant communities on glacial till	3250	51
	unweathered sands and gravels, felsenmeer slopes, unvegetated talus and rubbleland, wet talus, igneous rock outcrops, soil-rock outcrop complexes	2500	39
	deep, sandy and loamy skeletal soils forming in glacial till and outwash	635	10

Fire

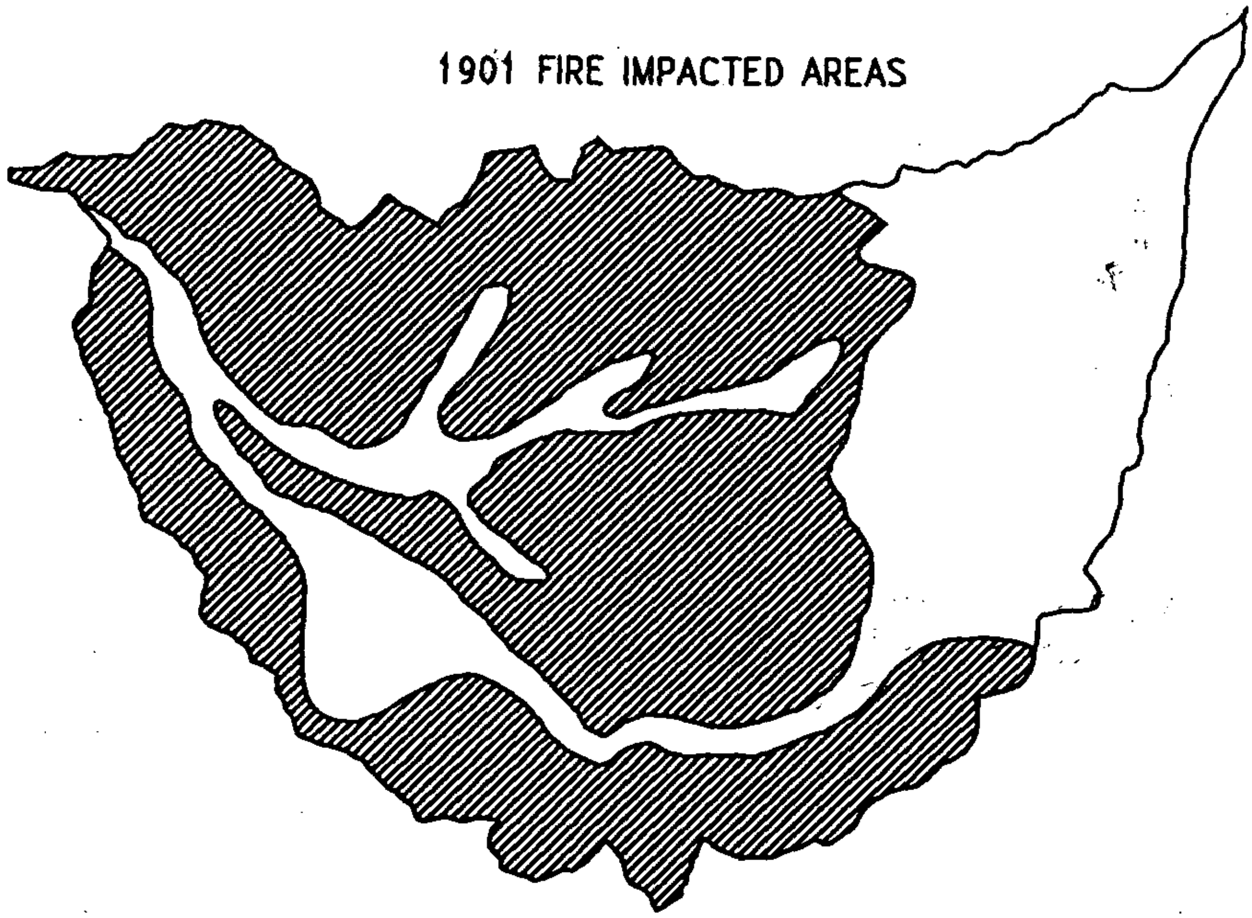
Fire History

Fire has been a major influence within the Zigzag Watershed. At least four significant fires of 1,000 acres or more have occurred within the watershed within the last century. From the available documentation, the earliest recorded forest fires occurred around 1852 and burned over an area near Government Camp. The largest fire recorded covered 10,000 acres in August, 1917. The most recent significant fire, the Zigzag Burn, occurred in October, 1952, and burned over 1,000 acres.

Historical fire occurrence records for the Mt. Hood National Forest consist of documented fires for the periods of 1924-1930 and 1960-1994. The Mt. Hood National Forest has kept fire records since 1960. Fire occurrence records prior to 1960 consist of a narrative survey of the Cascade Range Forest Reserve conducted in 1901-1903, fire atlas records from 1908-1920, and fire lookout panoramic photos taken in 1933-1934. The available historic information reveals fire has burned over much of the Zigzag Watershed and surrounding (Eagle, Roaring River, and Salmon River) watersheds.

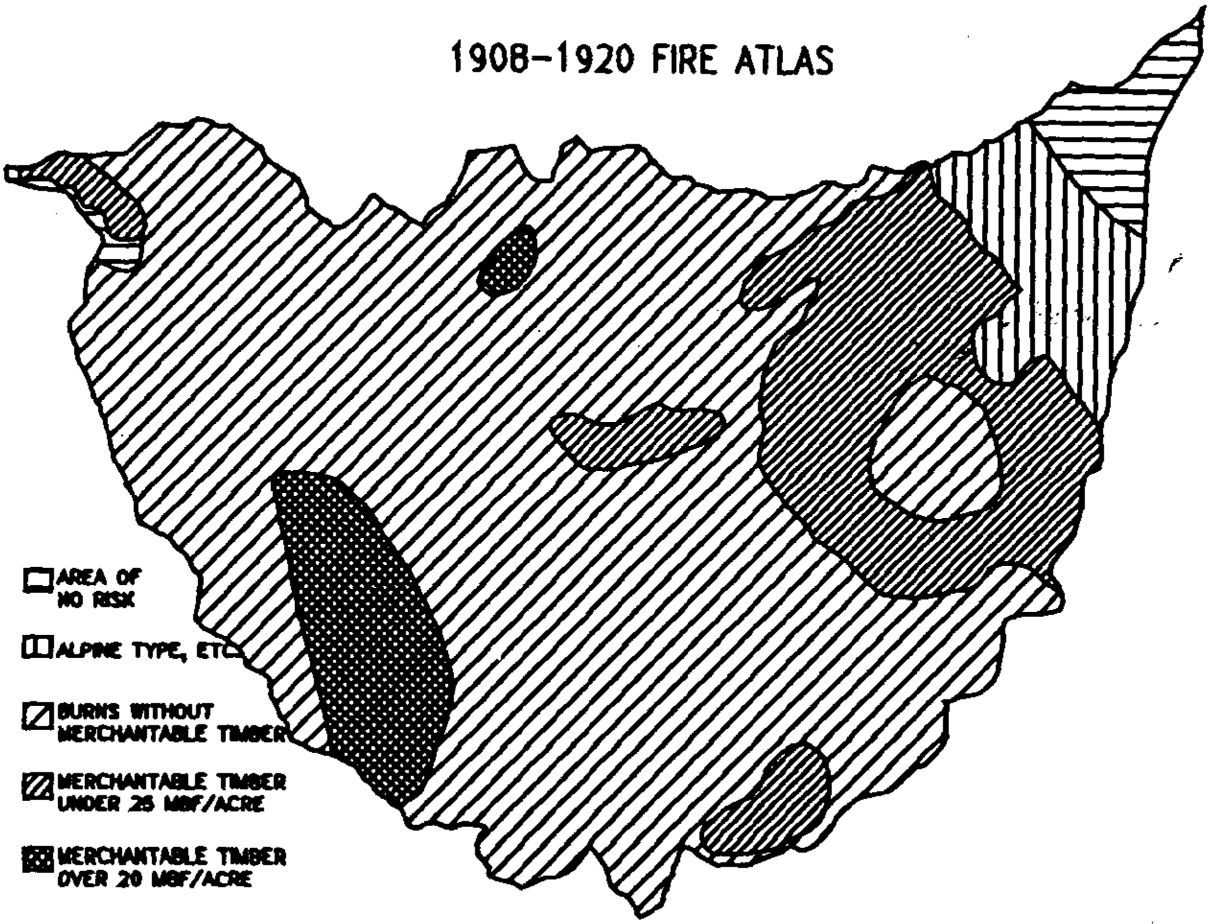
As documented in the survey of the Cascade Range Forest Reserve in 1901, fires burned throughout most of the watershed with little or no human effort to suppress them. It is believed that many of the fires were intentionally set by sheepherders (to increase acreage of range land), by hunters (to drive game animals into traps), or were started unintentionally by unattended campfires. American Indians are also believed to have intentionally set fires to improve berry picking fields and increase forage for animals. The following map displays areas impacted by fire in 1901.

Figure 4-5-- 1901 Fire Impacted Areas



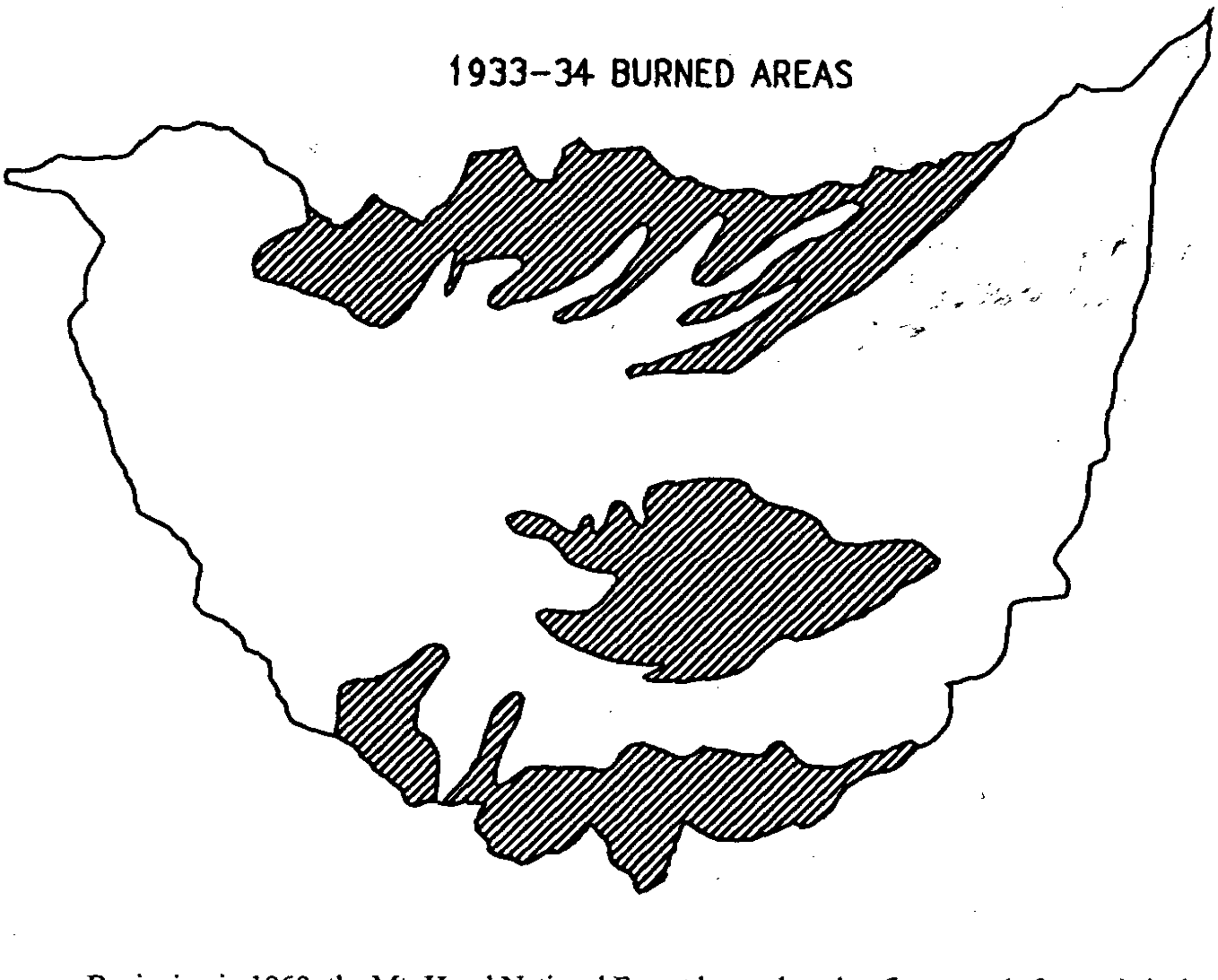
The next documented fire activity, according to the Oregon National Forest fire atlas, occurred from 1908-1920 and 1924-1930. The fire atlas and survey map lists 89 fires during 1908-1930 within the Zigzag Watershed. This includes the Sherar Burn in 1915 which started in the Salmon Watershed and burned into the Zigzag Watershed. Three significant fires occurred within the Zigzag Watershed during this period: 1908 (1,920 acres) surrounding Eureka Peak; 1910 (2,650 acres) surrounding West Zigzag Mountain; and 1917 (10,000 acres) including Tom, Dick and Harry Mountain, Mirror Lake, and Eureka Peak. The largest of these wildfires, 10,000 acres, was started by an escaped campfire.

Figure 4-6 -- 1908 - 1920 Fire Atlas



Panoramic photos taken from fire lookouts during 1933-34 further display the historical fire occurrence throughout much of the Zigzag Watershed. These photos provide evidence of more recent fires in the Tom, Dick and Harry Mountain area, as well as along the north and south divides of the watershed. Due to a lack of old downed woody material and snags apparent in these photos, additional fires have obviously burned within these areas.

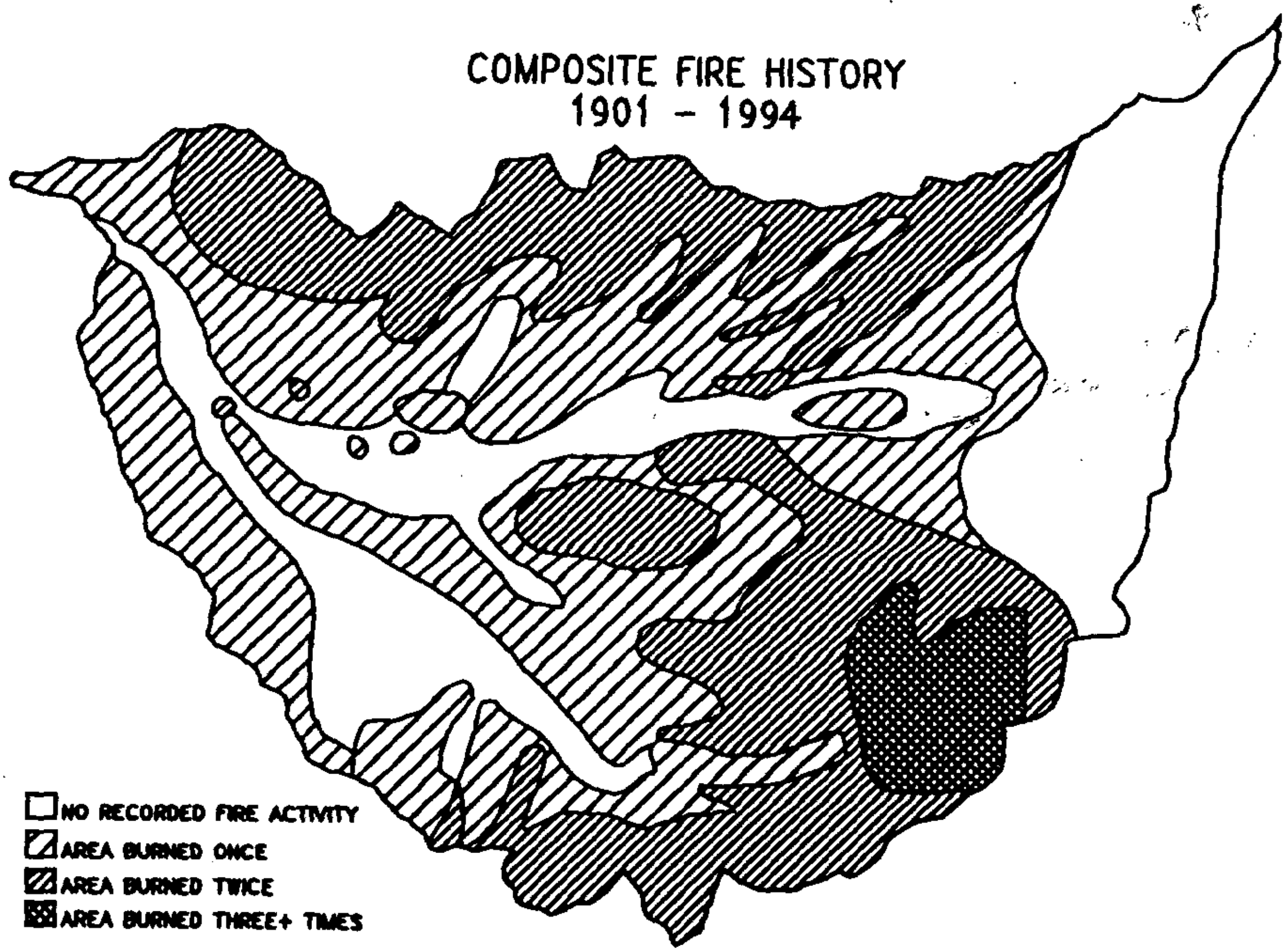
Figure 4-7 -- 1933-34 Burned Areas



Beginning in 1960, the Mt. Hood National Forest began keeping fire records for statistical wildfires. (A statistical wildfire is a fire that burns uncontrolled in vegetative or associated flammable material and requires suppression action to protect natural resources or values associated with natural resources, or is destructive to natural resources.) The records have been transposed and are kept in a personal computer (PC) database located at the Mt. Hood National Forest Supervisor's Office. From 1960-1994, 121 statistical fires have occurred within the Zigzag Watershed. All were less than 100 acres.

The following 1901-1994 Composite Fire History map is composed of the previous three maps. It indicates areas where fire has burned within the Zigzag Watershed during the past century. The map indicates areas that have burned once, twice, and three or more times since record keeping started here in 1901. Eureka Peak and the surrounding area has the highest repeated incidence of fire.

Figure 4-8 -- Composite Fire History 1901-1994



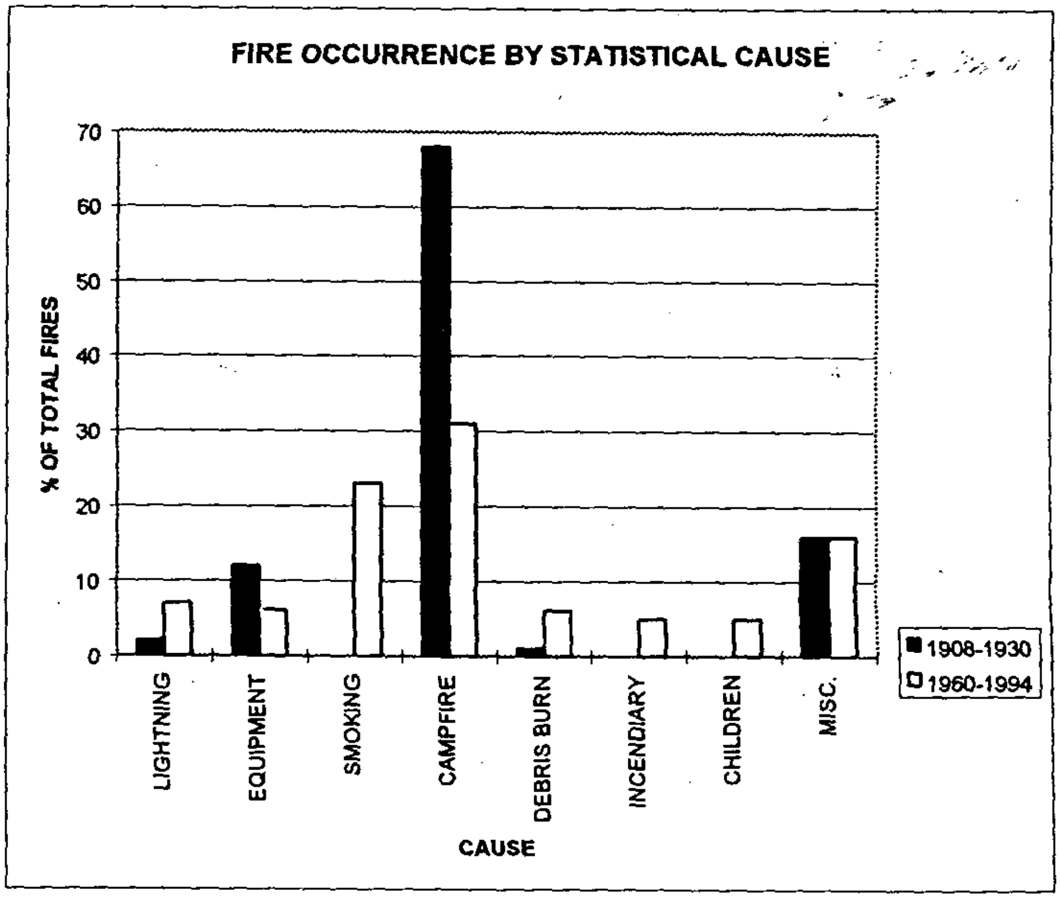
The significance of repeated fire occurrence is important. There is a high probability of organic matter consumption from repeated fires which result in lower nutrient status of soils. Loss of mineral soil from post-fire erosion on steeper slopes leads to shallow soils or bare exposed rock. Loss of above ground organics in the form of snags, downed wood and live trees further decreases soil nutrient input.

Current stands express these conditions through poor regeneration or physiologically stressed trees that are more prone to disturbances such as insect attack. Diminished numbers of snags and downed wood may result in decreased habitat for some wildlife species. In conclusion, the Composite Fire History map can be used to indicate areas with probable resource concerns and priority for restoration.

Fire Occurrence by Statistical Cause

Since 1908, a total of approximately 210 statistical wildfires have occurred within the Zigzag Watershed. These fires range in size from Class A (<.25 acre) to Class G (5,000+ acres). The following table displays the fires by ignition source (lightning, smoking, equipment, etc.) for the two time periods with recorded information: 1908-1930 and 1960-1994.

Figure 4-9 -- Fire Occurrence by Statistical Cause

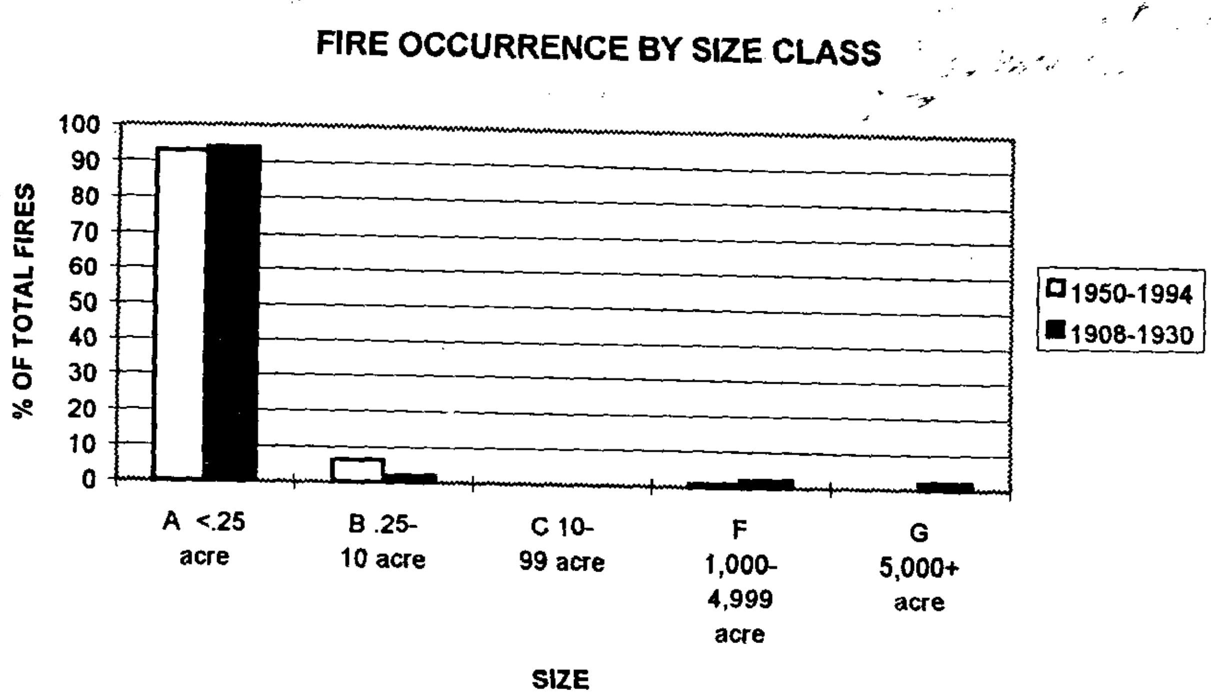


Of the 121 fires from 1960-1994, 70% were human caused (escaped campfires/smoking/children/incendiary/debris burning) and 7% were lightning caused. Of the 89 documented fires from 1908-1930, 68% were human caused (as described above) and only 2% were caused from lightning. The remaining 30% were from equipment or unknown causes.

In 1994, a national air tanker study was conducted to determine the past, present, and proposed most efficient use of air tankers for fire suppression. One of the products of the study was an analysis of the numbers and types of fires that occurred during the past 25 years in the Pacific Northwest. The study showed that 75% of all fires were caused by lightning. In contrast, in the last 35 years, only 7% of the fires in the Zigzag Watershed were lightning starts.

In conclusion, the percentage of human caused fires has been relatively constant since 1908. However, the amount of human caused fires, as opposed to lightning starts, has been much higher for the Zigzag Watershed than the average for the Pacific Northwest.

Figure 4-10 -- Fire Occurrence by Size Class



This graphic (Figure 4-10) displays a total of 210 Zigzag Watershed fires by size for two time periods. More than 90% of the statistical fires are less than .25 acre in size. With the exception of the 1952 Zigzag Burn, no fire documentation exists from 1930 to 1960. Therefore, Zigzag Burn data is included in the table with the 1960-1994 information.

The fire occurrence rate from 1960 to present for the Zigzag Watershed is .092 fires/1,000 acres/year. This occurrence rate translates into approximately 3.5 fires per year. Comparatively, the rate for 1908-1930 is 0.13 fires/1,000 acres/year which equals approximately 4.9 fires/year. Both the rate of fires and the size of fires has decreased in the more recent time period. Furthermore, the amount of fires caused by campfires has decreased by approximately 40%. This may be due in part to fire prevention and Smokey Bear campaigns which started in the 1940s and emphasized extinguishing campfires. Also, there are currently more developed recreation sites versus dispersed sites. This has most likely helped the reduction in escaped campfires. Prevention activities affect the rate of fires, whereas fire suppression in recent decades most likely helped decrease fire sizes.

A plotting of fire locations for the 1960-1994 period indicates that approximately 78% of all statistical fires occurred along Highway 26 in or near the communities of Zigzag, Rhododendron, and Government Camp. The remaining 22% of fires could be associated with lightning, dispersed campsites, or existing road/trail systems.

Fire Regimes

In 1994, a group of fire specialists developed a draft report entitled Fire Ecology of the Mid-Columbia (Evers et al., 1994) which summarizes the most current available fire ecology and management information that applies to the Mid-Columbia area of Oregon and Washington, including the Mt. Hood National Forest. Fire Groups were developed based on plant associations and species response to fire, as well as the roles these species take during succession.

Each Fire Group includes specific information concerning:

- Plant association comprising the fire group, including ecoclass and elevation range (if available).
- Vegetation overstory and understory type, including climax and seral species.
- Forest fuels (kind and amount of dead and downed woody material) likely to be present.
- Role of fire in the pre-settlement era in shaping the vegetation composition.
- Forest succession of ecological groups as influenced by fire regimes.
- Fire management considerations (suggestions) that resource managers may consider for incorporation into land management objectives for a particular site.

There are four dominant fire groups within the Zigzag Watershed which closely approximate the major vegetation zones. These are summarized in the analysis file, they can be used to describe and predict the influence of fire. In some cases, however, existing conditions within the watershed do not entirely fit these descriptions. Therefore, existing conditions must be taken into consideration when using these Fire Groups for predictions or for management recommendations.

Fire Management Direction

Fires are an inherent part of the disturbance and recovery patterns to which native species have adapted. In significantly altered ecosystems, natural disturbance processes may no longer be operating within historical ranges of variability. Their effects may be as foreign to the functioning of the ecosystem as are human activities. Consideration of fire as a natural process should be taken into account with all fuel and fire activities. However, the wildland-urban interface is an area where fire is not allowed to perform its natural function due to the need for protection of life and property.

Fire and fuels management direction vary by land allocation and are described in the analysis file. In general, the watershed includes State of Oregon protected land, wildland-urban interface lands, general forest land, and land within the Mt. Hood Wilderness. Fire suppression direction for National Forest lands, in order of priority, is: protection of life, property, and natural resources. Therefore, areas within the wildland-urban interface would require immediate wildfire suppression action.

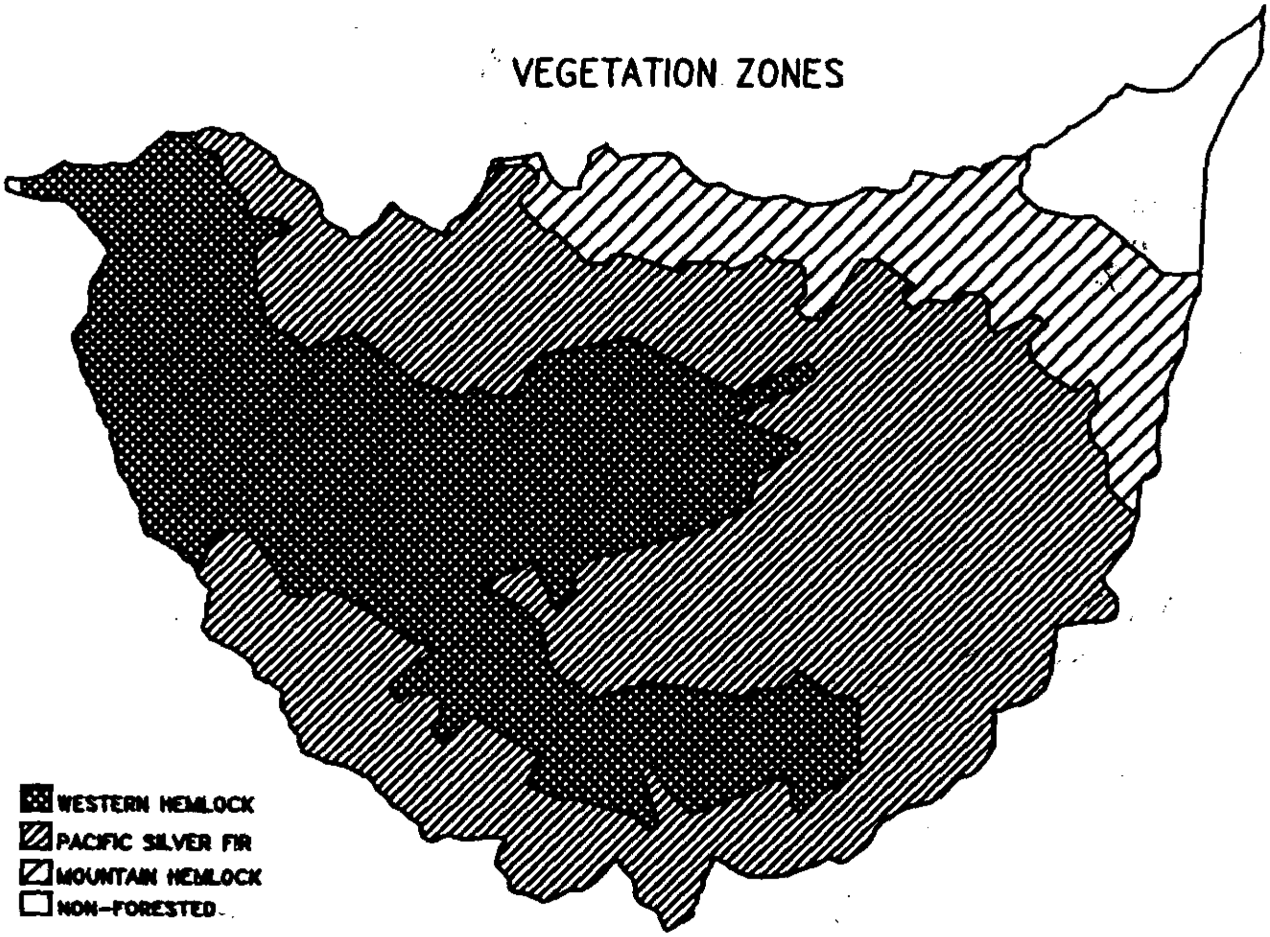
Intensity and severity of wildfire effects can be reduced through stand density reduction (increased crown spacing).

Vegetation

Ecological Vegetation Zones

There are three main vegetation zones within the watershed: Western Hemlock, Pacific Silver Fir, and Mountain Hemlock. Near timberline, there are small areas of Subalpine and Alpine Zones. These zones represent sets of ecological conditions that shape the type of forest projected to dominate a particular area.

Figure 4-11 -- Vegetation Zones



The Western Hemlock Zone occurs at lower to mid elevations up to approximately 3,400 feet. This zone reflects moderate sites without season-long snowpacks and abundant moisture. Western hemlock is the dominant species in climax stands, rarely found due to fire. Douglas-fir is dominant in early successional stands and co-dominant with hemlock in late successional stands. These are high biomass, diverse, productive forests. Approximately 33% of the watershed is within this zone.

The majority of the watershed, 51%, is within the Pacific Silver Fir Zone, found at moderate elevations, from 3,000 to 4,000 feet. This zone is characterized by a high diversity of tree species, including western hemlock, Douglas-fir, true firs, western red cedar, and western larch in the transition zone of the Cascades. Pacific silver fir is the climax dominant, but this condition rarely occurs. Cool, moist conditions are representative, with season-long snowpacks only at the upper elevations. Growing-season frost is likely.

The Mountain Hemlock Zone represents approximately 11% of the watershed in the higher elevations near timberline and East Zigzag Mountain. Mountain hemlock dominates mid and late successional stands, but western hemlock, true firs, western white pine and Douglas-fir are also common. After fire, lodgepole pine is a common pioneer due to its tolerance of growing-season frost. These are cold, moist environments with deep winter snowpacks and short summers.

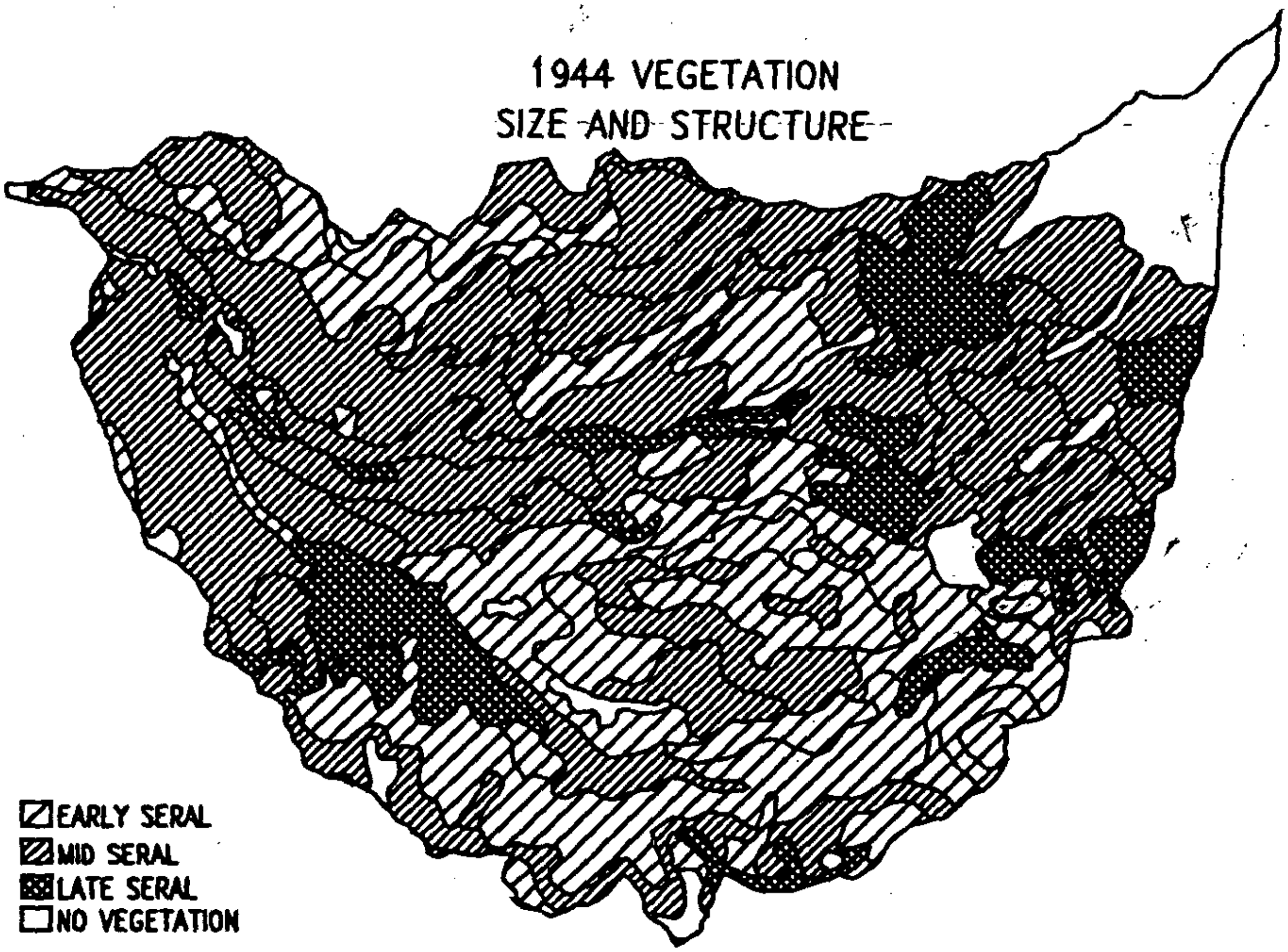
Approximately 5% of the watershed is mapped as Alpine Zone, which includes vegetation at the highest elevations just below timberline, and the non-vegetated portion above timberline. Mountain hemlock and subalpine fir predominate. White bark pine may be present in small amounts. Even harsher than the Mountain Hemlock Zone, these environments are cold and moist with deep winter snowpacks.

Vegetation Size and Structure

Along with the ecological factors described above, the nature of the forests within the watershed were largely determined by the frequency, intensity and extent of past fires (described in previous section). The following map, produced from the 1944 county survey historical database (PNW 1944 database), displays the size and structure of vegetation that followed the stand replacing fire events. This database also portrays the watershed prior to most of its timber harvest.

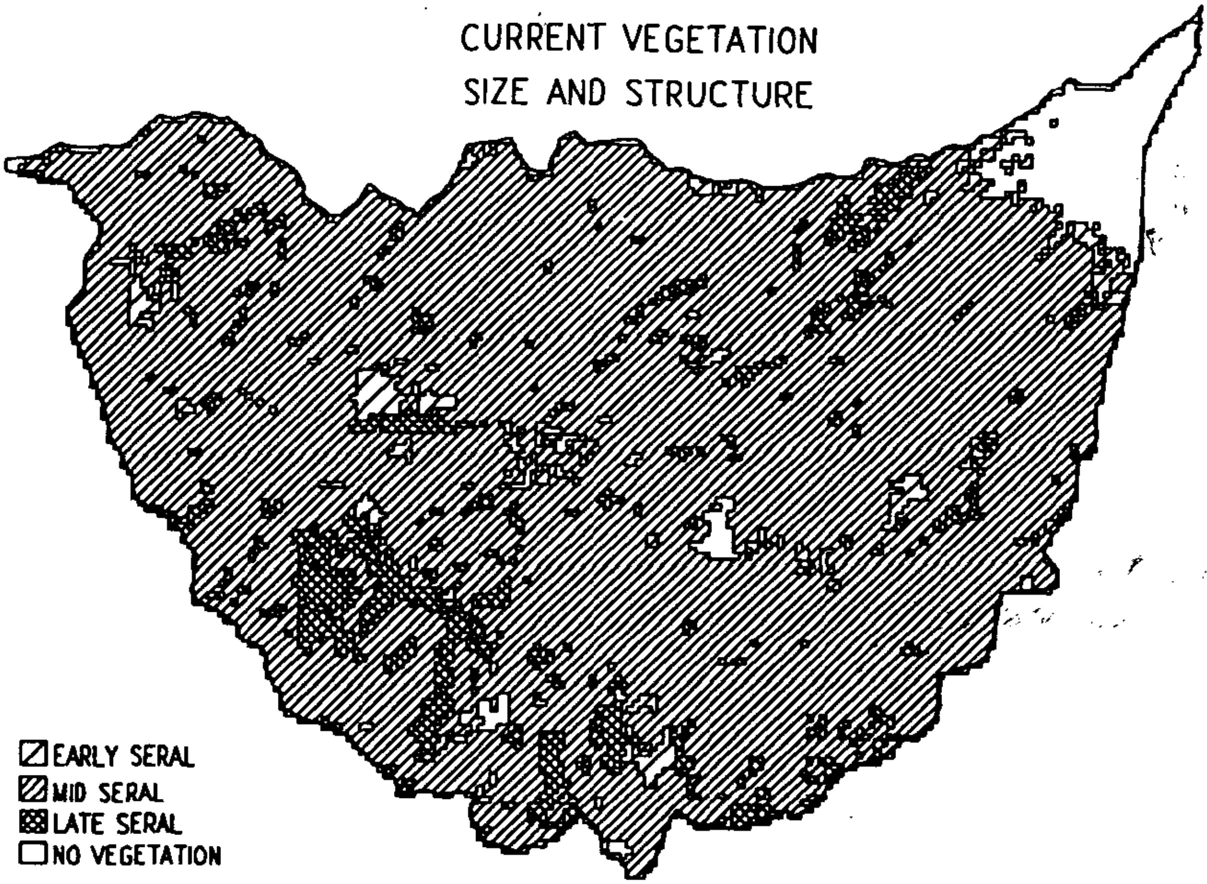
Stands are classified and referred to by seral stage. Early seral reflects an intent to portray acres of forest that function as openings. It includes grass/forb/shrub/seedling and open sapling/pole classifications. Late seral is based on large size class and more than one layer. It includes closed and open large conifer classifications. Mid seral generally includes closed and open small conifer stands and closed sapling/pole stands.

Figure 4-12 -- 1944 Historic Vegetation Size and Structure



In 1944, the majority of the Zigzag Watershed, or 52%, was composed of closed, small conifer stands (mid seral) resulting from fires during the early part of the century. Approximately 30% of the land base, mainly in the central and lower parts of the watershed, were early seral stands composed of grasses, shrubs, forbs and seedlings which came in after the fires in the 1920s and 1930s. Only 12% of the watershed was composed of late seral or closed large conifer stands. Late seral stands that escaped burning are located mainly in narrow areas along streams, with some larger contiguous areas near Cool Creek and northwest of Zigzag Canyon.

Figure 4-13 -- Current Vegetation Size and Structure



The current vegetative condition of the Zigzag Watershed is mainly of even aged, moderately dense stocked stands of 80 to 100-year-old Douglas-fir and western hemlock dominated stands. A large majority, 85%, of the watershed is composed of these mid seral stands. These stand conditions are contributing to laminated root disease (*Phellinus weirii*) and insect infestations (discussed later in this section).

Only a small percentage of the watershed, 7%, consists of late seral stands. As with the vegetation in 1944, these older stands occur in narrow patches along streams and in larger blocks near Cool Creek. Since there has been little harvest activity or recent disturbances, only 4% of the watershed is currently in early seral stands. It is likely, however, that the smaller root disease pockets were not included in this figure.

Within the Still Creek LSR, in the southwest part of the watershed, there are 78% mid seral stands, 18% late seral stands, 3% early seral, and 1% non-vegetated.

Stands within the eastern portion of the Still Creek subwatershed are in poor forest health. Many trees have reduced crown size and vigor, needle loss and discoloration, or are experiencing mortality. This is due to several factors, including offsite seed sources, poor soil conditions inherent on the site or from repeated fire activity, and infestation of spruce budworm and bark beetles.

Trends

Overall, the most significant trend has been the large increase in mid seral stands, and a corresponding decrease in early seral stands as these younger forests matured. There has been a small decrease in closed and open large conifer stands. Since there has been little harvest activity or other development in these older stands, most of the difference is likely due to an overestimation in 1944. It is to be noted that some differences in acreages exist in these comparisons due to differences in definitions and methodology between the two databases.

Table 4-5 – Vegetation Structure Comparison, Historic (1944) v.s. Current

SIZE STRUCTURE	ACRES IN 1944	ACRES IN 1995
Closed and open large conifer	4,483	2,639
Closed small conifer	19,256	25,934
Open small conifer	not included	5,997
Open sapling pole	not included	237
Grass forb shrub (includes meadow, alpine)	11,206	297
Rock, water, non-veg	2,489	1,675
Hardwood	230	not separated
TOTAL	37,664	37,730

Comparing broad species composition of current stands to 1944 stands shows little change. Because the 1944 database is by species groups, and the current database is by dominant species, there is some difficulty in comparing these two databases. However, comparing "groups" of species such as Douglas-fir/western hemlock or true fir/mixed conifer associations, little change is indicated. Anecdotal information suggests a decrease in western red cedar and whitebark pine. There is also a likely decrease in western white pine. This decrease is due to blister rust disease which was introduced around 1910 and caused mortality to many of the existing white pine. It also has prevented many white pine seedlings from maturing on sites with blister rust disease present.

Seral Stage Analysis

Seral stage affects, and is affected by, a variety of ecosystem functions, including: wildlife species use and migration, hydrologic function, production of snags and coarse woody debris, nutrient cycling, and disturbance processes such as fire, insects and disease. The Range of Natural Conditions (RNC) for seral stages is based on the Regional Ecosystem Assessment Project (REAP), scaled down to the watershed level. REAP determined pre-European management conditions at a landscape level and determined a RNC for the time period of 1750-1930. Current conditions are based on corrected 1995 vegetation data.

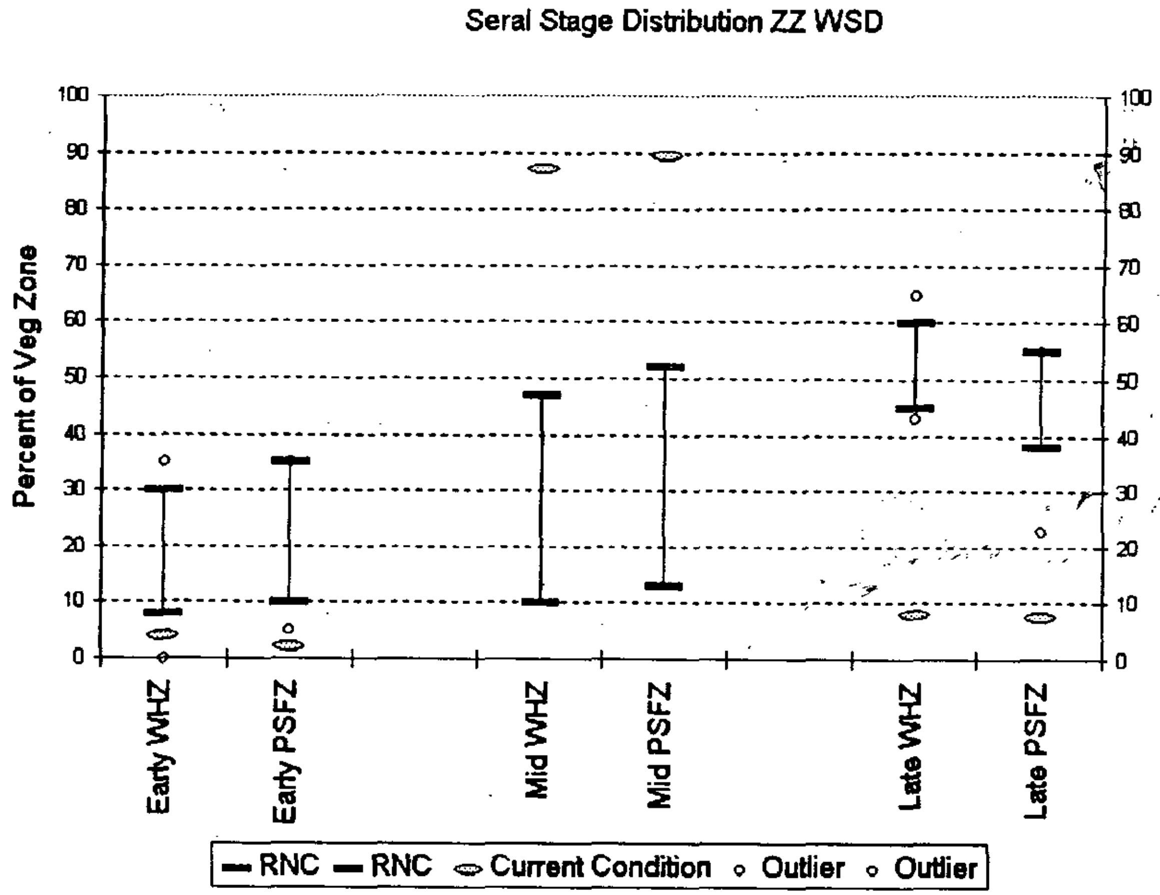
REAP used the following assumptions in defining the Range of Natural Conditions:

- Stand age data was used to "zero" back stands and determine the time period for RNC.
- Fire activity was not significantly controlled by management activities prior to 1930.
- Fire was the disturbance causing stands or areas to revert to early seral.
- Timber harvest was not a significant factor prior to 1930, and all early seral acres from 1900 to 1930 were late seral prior to becoming early seral.

The following table compares current seral stages by vegetative zone against the RNC. Outlying data is displayed as well, but has a lower confidence level. As defined earlier, early seral reflects an intent to portray acres of forest that function as openings. It includes grass/forb/shrub and open sapling/pole classifications. Late seral is based on large size class and more than one layer. It includes closed and open large conifer classifications. Mid seral generally includes closed and open small conifer stands and closed sapling/pole stands. Overall, 7% of the watershed is in late seral, 85% in mid seral, 4% in early seral, and 4% in non-vegetated areas..

In watersheds with less than 15% late seral forest, all late seral patches should be retained, regardless of land allocations (ROD C-44). Protection of these stands could be modified when reserved areas have reached late successional conditions. This standard and guideline has important application to the Zigzag Watershed because its late seral forest is currently at 7%. All late seral forest should therefore be retained until the reserves mature. This standard affects 563 acres of late seral stands in the B allocations, which allow some level of timber harvest. The rest of the acreage is in reserved allocations.

Figure 4-14-- Comparison of Seral Stage, by Vegetation Zone, with Range of Natural Conditions



Late seral forest, for both the Western Hemlock Zone (WHZ) and Pacific Silver Fir Zone (PSFZ), are well below the RNC. Early seral forest is also below RNC for both zones, but not by as great of margin. These decreases in early and late seral forest are reflected in the large increase in mid seral forest. Current mid seral forest is well above RNC in both zones. Other comments regarding the RNC:

- Large fires in the early part of this century decreased the late seral stage and account for the higher mid seral stage.
- Wilderness, roadless areas, and other land allocations have limited timber harvest, thus little early seral stage.

Landscape Pattern

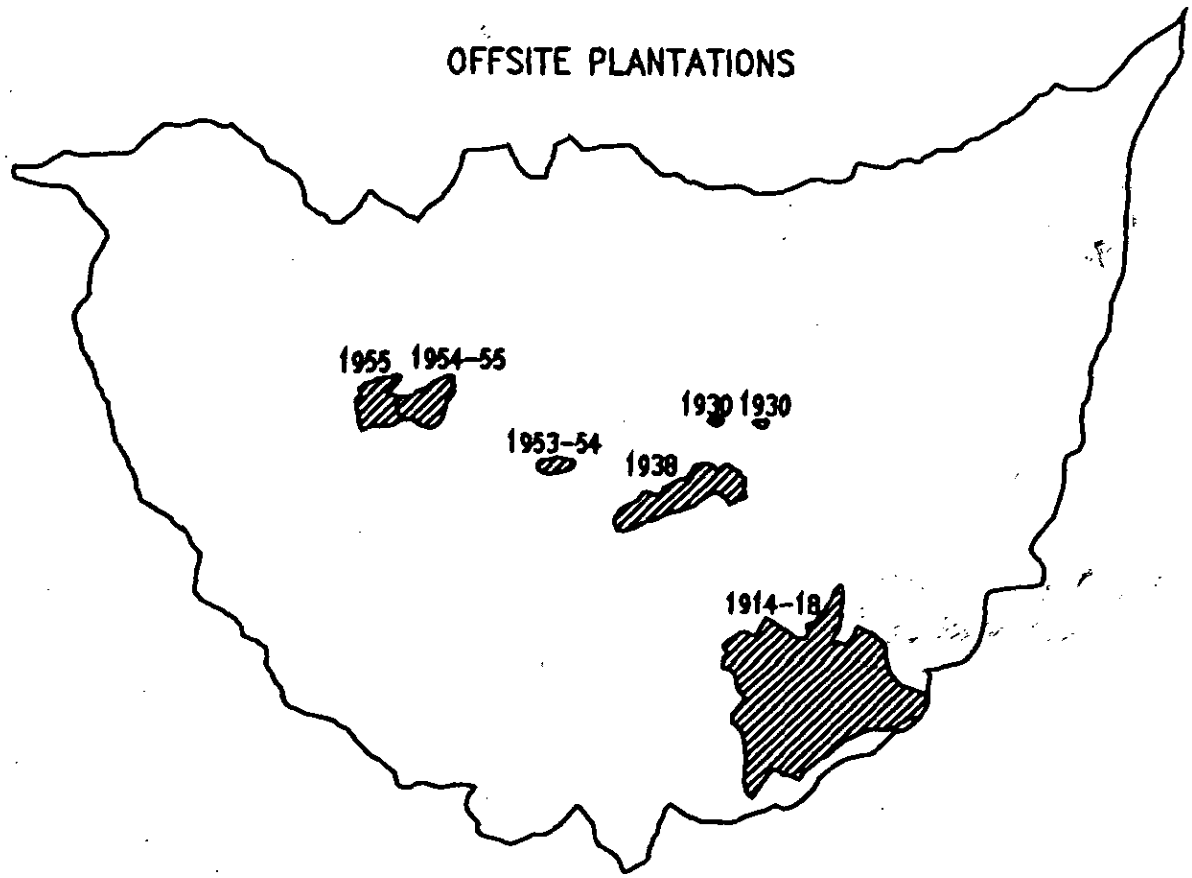
In the historic landscape, large patches dominated. These large patches were either late, mid, or early seral patches at any given point in time as dictated primarily by fire occurrence. The shapes of the forested patches were irregular, with edges of low contrast and boundaries following topography and landform.

In the current landscape, this same pattern holds true for a large portion of the watershed within Wilderness and roadless areas. However, the developed areas of Rhododendron, Government Camp, Highway 26, and the three ski areas have altered this landscape pattern. The patterns of these managed landscapes are very different from the historic landscapes.

Offsite Plantations

At least 1,952 acres of offsite plantations have been planted or seeded within the Zigzag Watershed. Information on these plantations was collected from the Zigzag Ranger District Reforestation Log, historical records including the "1938 Survival Study of the Still Creek Plantation," and aerial photographs. These offsite plantations are roughly mapped in the following figure.

Figure 4-15 -- Offsite Plantations



An offsite stand is one in which the seed used on the site for artificial seeding or for the planting stock was derived from a distant location or from a different elevation than the planting site. Seed sources for the offsite plantations in the Zigzag Watershed include the Gifford-Pinchot, Olympic, and Mt. Baker-Snoqualmie national forests.

These plantations were established between 1914 and 1955 before the importance of matching the seed source to the site was well understood or appreciated. Due to a lack of local seed, portions of the Zigzag Burn in 1953-1955 may have been reforested with non-local seed sources. Records indicate that Mt. Hood sources were used as planting stock starting in 1955, although elevations of seed source were not always recorded.

The significance of offsite stands is that physiological processes of trees, including phenology, are closely related to local conditions. As an example, offsite trees may break bud too early, subjecting them to frost damage, or set buds too late, also subjecting them to frost. Offsite stands are also less resilient than native stands to climatic events and other disturbances such as insect attack. Furthermore, many stands show decreased growth rate or stagnated conditions. Silvicultural treatments to keep stands healthy and vigorous may help reduce effects of offsite plantings by increasing vigor, and therefore resilience.

The largest area of offsite trees is the Still Creek Plantation, located in the southeast portion of the Still Creek subwatershed. Many of its "corn rows" are currently visible. The reforestation log maps this area at approximately 1,435 acres. The 1938 survival study reports it as 1,842 acres, but the mapping was estimated by vantage points on either side of Still Creek. Excerpts from Land Classification of the Oregon National Forest (R.S. Shelley, 1914) describe Forest Service efforts to reforest burns in the watershed. The Still Creek area is described as: "a vast burn, part of which has restocked or is restocking and the remainder is to be reforested by artificial means. Planting operations are already under way on Still Creek and seedlings have been set out or seed sown on several thousand acres of burn which border it on either side." Acreage is therefore approximate.

The Still Creek Plantations were planted in 1914, 1915, 1918, and 1919 with Douglas-fir, western white pine, and noble fir, either in pure stands or in mixtures, and partly reforested by direct seeding (as previously described). The 1938 survival study describes poor stocking on shale rock sites or slide areas. It also describes a high mortality rate of Douglas-fir "probably from having planted stock from low altitude seed at too high an elevation." Noble fir survival was reported at approximately 50%, and remaining trees with slow growth rates. The white pine plantations were described as having up to 80% of trees infected with blister rust. Currently, there are portions of these plantations that have non-stocked or poorly stocked areas, and areas with diminished growth rates and "ratty" crowns.

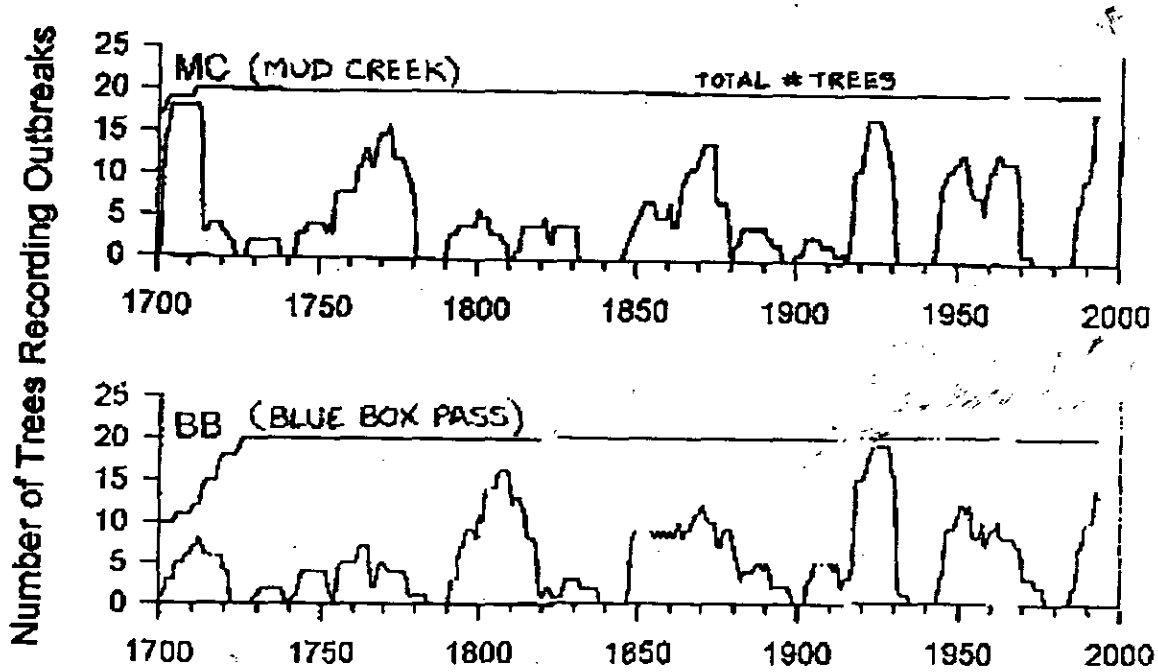
Disturbance from Insects and Disease

Western Spruce Budworm

Western spruce budworm (*Choristoneura occidentalis*) has been the major defoliator in recent decades. Budworm larvae feed during late spring and early summer, predominantly on current year's buds and foliage. Effects of defoliation are decreased growth, top killing, tree deformity, and sometimes, whole tree mortality. Four to five years of successive, intense defoliation results in nearly complete defoliation of individual trees. Epidemics often occur over extensive areas, but significant amounts of budworm-caused tree mortality generally occurs only in 10-20% of the outbreak area. Bark beetle populations sometimes increase in defoliated stands and cause additional mortality of stressed trees.

Recent dendrochronology studies have documented the occurrence of numerous western spruce budworm outbreaks over the past three centuries. These long-term reconstructions provide historical reference on the range of natural variability. Data from the Mud Creek area in the adjacent Salmon River Watershed and data from Blue Box Pass, located southeast of the Zigzag Watershed (from Swetnam and Wickman et al., 1994), is displayed in Figure 4-16. The left hand scale displays the number of trees recording outbreaks from sample sets on each site.

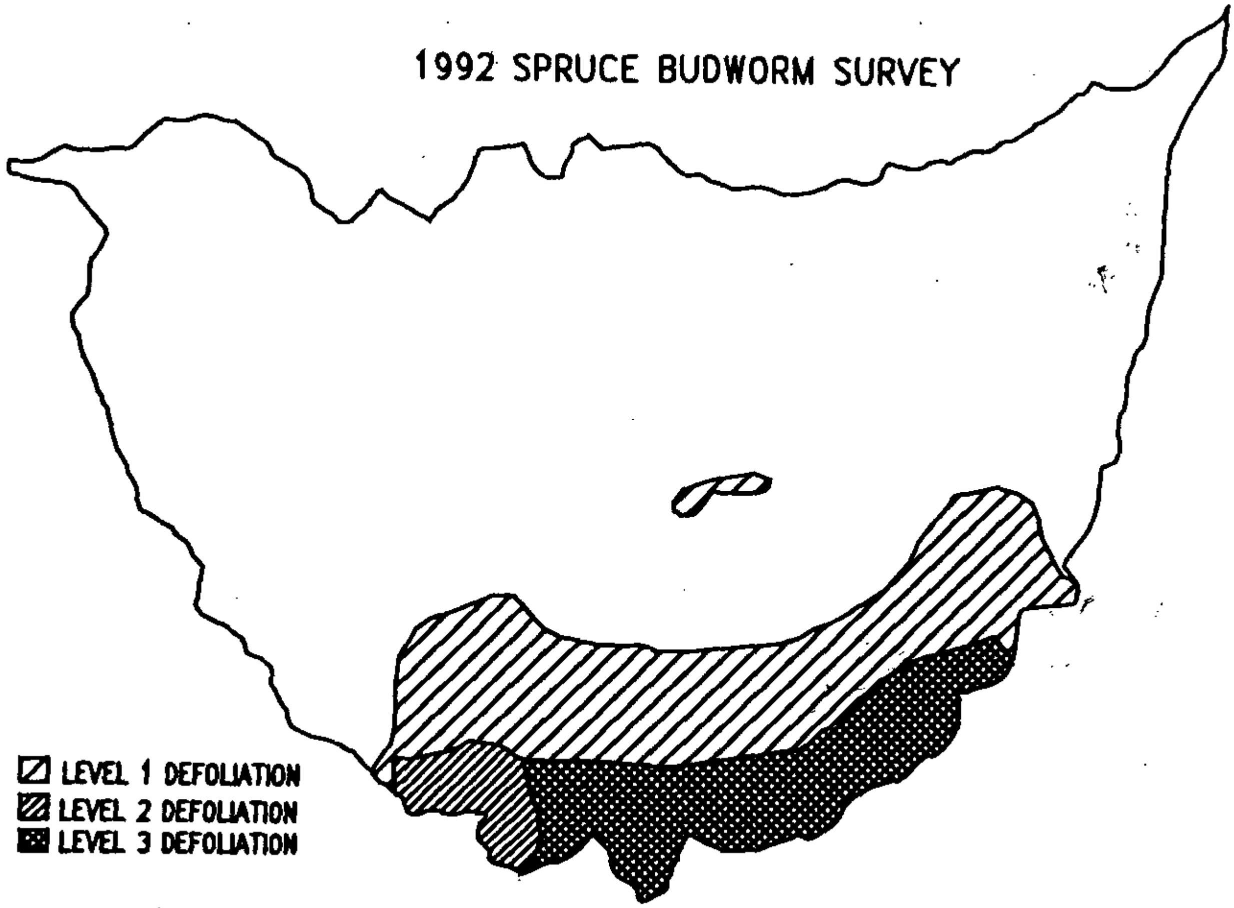
Figure 4-16 -- Historic Spruce Budworm Outbreaks



Compilations of the numbers of trees recording outbreaks within Mt. Hood National Forest reveal a strong pattern of repeated outbreaks over the past several centuries. Many of the peaks span 20 to 30 years or more. Average budworm outbreak duration recorded within individual trees was approximately 12 to 14 years, and average periodic growth reduction during these periods was approximately 20 to 30 percent of expected growth (Swetnam and Wickman et al., 1994).

During the 1992 annual aerial sketch map survey, visible current defoliation was detected throughout most of the southern portion of the watershed within the Still Creek subwatershed. These areas had been treated in 1988 with the biological insecticide Bt (*Bacillus thuringiensis*).

Figure 4-17 -- 1992 Spruce Budworm Infestation



Defoliation Intensity:

Level 1 = current year's defoliation is visible from the air
Level 2 = current year's defoliation is visible from the air with some bare tops (very little gray)
Level 3 = current year's defoliation is visible from the air with many bare tops visible (some gray with some foliage)
Level 4 = current year's defoliation is visible from the air with some bare crowns (very gray, no visible green foliage in tree)

Within the Zigzag Watershed, the 1992 aerial survey detected: 5,085 acres with Level 1 defoliation intensity, 689 acres with Level 2 defoliation, and 2,713 acres with Level 3 defoliation. The first visible defoliation occurred in 1984. The defoliation threshold peaked around 1992. Populations have been declining ever since. Therefore, the length of the present infestation in this watershed has been approximately 11 years.

Spruce budworm is endemic to the area. The size of this most recent outbreak was likely within the range of historic conditions. However, the effects of the spruce budworm population were probably more severe due to offsite plantings, poor stand conditions, and dense stand structure in the Still Creek area. These factors cause stressed and less resilient stands, therefore increasing defoliation effects. Offsite stands were heavily impacted, whereas nearby native stands were lightly impacted (Dick Scott, past silviculturist, pers comm.).

Douglas-fir Beetle

The Douglas-fir beetle (*Dendroctonus pseudotsugae*) is another endemic insect that normally breeds in felled, injured, or diseased trees. The resulting endemic mortality can be large in amount and widely scattered (Furniss and Carolin, 1977). At times, the Douglas-fir beetle becomes epidemic and kills apparently healthy trees over extensive areas. The outbreaks are usually sporadic and of short duration, developing after extensive windthrow or large fires.

In the Zigzag Watershed, Douglas-fir beetles have infested trees inside the Still Creek subwatershed that had been previously defoliated by the western spruce budworm. This is causing pockets of tree mortality. Although mortality of budworm affected trees may continue, it is unlikely that the bark beetles will kill significant numbers of trees in adjacent stands (Bruce Hostetler, entomologist Westside Insect and Disease Technical Center, pers comm.).

Root diseased trees provide a continuous source of favorable host material for beetles between those times when conditions are favorable for epidemics. Laminated root disease, described in the next subsection, is a particularly significant predisposing agent which helps maintain endemic populations of Douglas-fir beetle in the ecosystem and watershed.

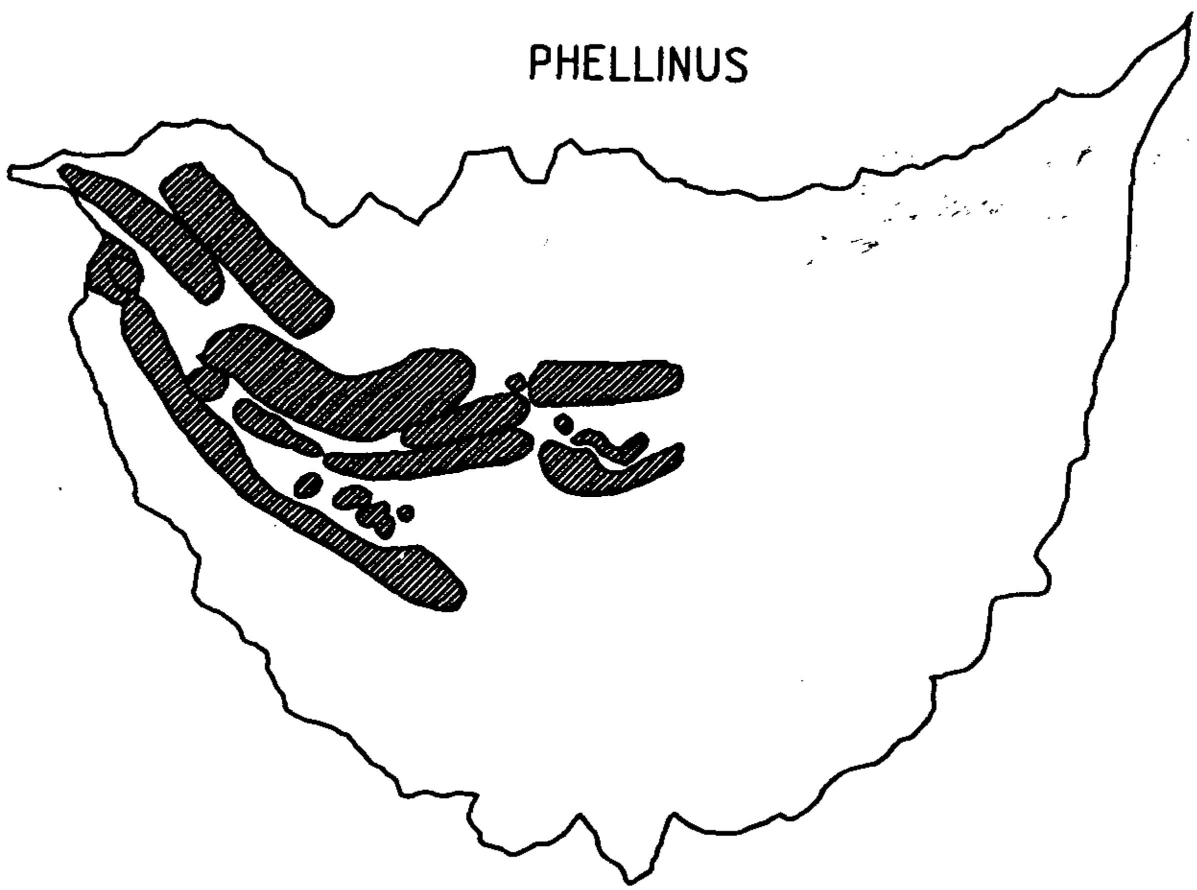
Laminated Root Disease

Laminated root disease, caused by the fungus *Phellinus weirii,* is widespread throughout forested areas of the northwest. *P. weirii,* like many other tree root pathogens, is believed to have co-evolved with its hosts and thus is a natural, and perhaps even necessary, part of many forest ecosystems (Thies and Sturrock, 1995). Whether the effects of laminated root disease are considered beneficial or detrimental depends on management objectives for the site. For example, laminated root disease reduces timber volume and may cause trees to be a safety hazard near recreational sites or residences. On the other hand, it may be desirable in creating openings with diverse plant communities, or increasing large woody debris for wildlife habitat.

Approximately 15% of the Zigzag Watershed is comprised of known infections of laminated root disease. These areas with known infections are broadly mapped in the following figure and are concentrated in the Enola Hill, Cool Creek, and west end of Still

Creek areas. Within these broadly mapped areas are pockets of infection, identified by visual symptoms or mortality. Some infection centers are several acres in size. For the most part, infection centers have been identified through project planning such as the Enola Timber Sale. Therefore, the level of infection in non-project areas is unknown. While the Mt. Hood Wilderness has not been surveyed for laminated root disease, infections have been identified north, south and west of its boundaries. The disease, therefore, is likely to occur within the Mt. Hood Wilderness. The westside regional average for laminated root disease infection in Douglas-fir types is approximately 20-25% of the total area. Actual infection in the Zigzag Watershed is most likely similar.

Figure 4-18 -- Laminated Root Disease Infections



The primary host types for laminated root disease are Douglas-fir, western hemlock, and true firs. Tolerant and resistant species include lodgepole pine, western white pine, and western red cedar. Hardwoods are considered immune. A listing of species' susceptibility to laminated root disease is included in the analysis file. Approximately 84% of the watershed is composed of highly susceptible or intermediately susceptible host species.

Root disease infection centers or "pockets" may be identified by openings in stands with characteristically dead or dying host trees at their margins. Another distinguishing characteristic is criss-crossed or jack-strawed fallen trees. These fallen trees tend to occur in a random pattern of crossed stems or leaning trees -- unlike storm blowdown, where trees usually fall in one direction, all at approximately the same time. Large centers may be occupied by tolerant conifers, shrub species, and hardwoods.

Visible crown symptoms are variable and usually develop only after the fungus has killed and decayed a major portion of the root system. Reduced terminal and lateral growth are usually the first crown symptoms, accompanied by loss of needles, which gives the crown an increased transparency. Off-color foliage, yellow or pale green, and distress crops of smallish cones are other visual symptoms. Crown symptoms are likely to be expressed earlier on a poor site than on a more productive site.

Small trees usually die soon after showing the first signs of infection, whereas larger trees live an average of 10 years after onset of crown symptoms. Trees that decline for many years typically develop a rounded or dome shaped top, and branches may appear brush-like with most needles near branch ends. Some infected trees are windthrown before obvious crown symptoms develop.

Laminated root disease begins in a stand when uninfected roots of a susceptible tree grow into contact with infested stumps or roots left from a previous stand and are colonized by *P. weirii*. Infected stumps or trees serve as a long-lived inoculum that enables the fungus to remain on the site and initiate the disease in the next stand. *P. weirii* requires organic matter in which to live. The fungus can stay in the ground in large, deep roots for as long as 50 years, and in relatively small diameter roots for at least 8 years.

Usually, there is a latent infection of symptomless trees in a 30-50' radius from infected trees with visible symptoms. The literature rate of spread is an average of one foot per year, usually in a radial pattern. Most of the Zigzag Watershed is composed of highly susceptible host types of Douglas-fir, western hemlock, and true firs in mid seral, even aged, closed canopy stands. Assuming that crown width equals root area, a closed canopy forest would have a high level of root-to-root contact. Under these conditions, the rate of spread would be at least one foot per year, and likely even higher.

The pattern of the disease on the landscape matches the pattern of the host. The fire history of the Zigzag Watershed has affected the amount and density of the host which, in turn, has facilitated the spread of the fungus.

Laminated root disease contributes greatly to the presence of snags and down woody debris. However, snags are less stable and inevitably windthrown. The biology of *P.weirii* does not contribute to rot high up in the tree. Therefore these snags may not be good habitat for cavity nesters.

Laminated Root Disease: Conclusions

The trend for the spread of laminated root disease is an exponential increase within the watershed. This is due to the level of known infections, and large contiguous acres of highly susceptible host types in even aged, closed canopy stands with high root-to-root contact. The rate of spread is at least one foot per year. Infections usually can be found in healthy appearing trees 30-50' from visible symptoms. Further analysis, using the Western Root Disease Model (a subroutine of the Forest Vegetation Simulator) can predict spread of the disease and tree mortality on a stand-by-stand basis.

Visual symptoms may be used to estimate areas at risk to the disease; with existing known infection centers having the highest risk. Most of the watershed is at some level of risk because vegetation is similar throughout the watershed and is comprised mainly of the Douglas-fir host type.

There will be an increasing impact on Douglas-fir and other hosts, including growth loss, windthrow and mortality. These areas will also remain "out of production" for host conifers since new seedlings will be infected. However, areas may be restocked, naturally or artificially, with resistant conifers or hardwoods.

Laminated root disease is a disturbance agent that generally increases ecosystem diversity. It selectively kills susceptible conifers and thus provides growing space for less susceptible conifers and immune hardwoods and shrubs. The disease causes openings in stands, develops areas of unique stand structure, and contributes to the presence of snags and down woody debris.

Huckleberry Fields

Historic wildfires and burning by American Indians frequently created open, tree-free environments above 3,000 feet that were suitable for the growth and development of wild huckleberries. American Indians also used fire to maintain historic fields.

The Zigzag Mountain area, post fire, was used as an historic huckleberry picking area by American Indians. West Leg Road also has been a favorite berry picking area. The southern portion of Hunchback Mountain ridge that divides the Zigzag and Salmon River watersheds has had extensive huckleberry use south of the ridge, but less use on the north.

With fire suppression, trees eventually encroach on the huckleberry fields -- crowding and shading the shrubs and eventually eliminating huckleberry production. To maintain fields in the absence of fire, some form of overstory control is necessary. While there has not been active huckleberry management within the Zigzag Watershed, opportunities for management exist within the appropriate vegetation types.

Several field plots were installed in the Wolf Camp Butte area in the adjacent Salmon River Watershed in 1972 as part of a huckleberry ecology and management research project (Minore, Smart and Dubrasich, 1979). The project determined that berry production can be very high and huckleberry fields are culturally, recreationally and economically important. The project concluded with several management recommendations that still warrant consideration. Included in these recommendations are overstory control by individual tree girdling, and nitrogen fertilization of berry plants.

Special Habitats

The Zigzag Watershed includes almost 3,000 acres of special habitats. Examples include wetlands, rock outcrops, talus slopes, cliffs and bridges. Table 4-6 lists these habitats, approximate acres, and species of concern using habitat types. A list of wildlife species that are potentially found within the Zigzag Watershed in these special habitats is located in the analysis file. Figure 4-19 shows the distribution of these habitats across the watershed. Each habitat is also briefly discussed. (Further discussions of individual species are included in the botany, wildlife, and fisheries subsections in this chapter.)

Table 4-6 -- Special Habitat Types and Species of Concern

Special Habitat	Acreage	Species of Concern (D=documented, P=potential)
Talus	2182	Larch Mtn. salamander (P), fir clubmoss (D), rare lichens and bryophytes (P)
Rock/cliff	378	peregrine falcon (P), Howell's daisy (P), rare lichens and bryophytes (P)
wetland	301	bog clubmoss (D), stiff clubmoss (D), wild cranberry (D), lesser bladderwort (D), three-leaf goldthread (P), pale sedge (P), scheuchzeria (P), indian rice (P)
alpine	40	black rosy finch (P)
riparian wetland	24	fir clubmoss (D), grape ferns (P), tall bugbane (P)
grass meadow	17	Brewer's reedgrass (P)
bridges	8 bridges	long-legged myotis (P), long-eared myotis (P), Townsend's big-eared bat (P)
springs	10	Mt. Hood primitive caddisfly (P), Mt. Hood farulan caddisfly (P), cold-water corydalis (P)

Figure 4-19 -- Special Habitats

The most common habitat type in the watershed is talus (2,182 acres). These piles of boulders and rocks can be vegetated or unvegetated, wet or dry. Pikas and other small mammals use the spaces as homes and cover. Some plants such as parsley fern, selaginella, and sedums are associated with talus. Two sensitive species, fir clubmoss and the Larch Mountain salamander, can be found in moist talus.

Rock (378 acres) is the second most common type and includes bedrock and cliffs. Peregrine falcons, listed by the U.S. Fish and Wildlife Service as an Endangered species, use cliffs for preferred nesting and roosting. Howell's daisy grows on rock outcrops near Devil's Peak on the Salmon River side of the ridge, and may also occur in the Zigzag Watershed. Some Northwest Forest Plan "survey and manage" lichen species are specific to rock (including talus) and have potential to occur in this watershed.

Various types of wetlands are scattered throughout the watershed, including wet meadows with and without ponds, and forested wetlands. The National Wetlands Inventory Map was used as a base layer to create the special habitat map. It can be viewed for more detailed locations of wetland types. 301 acres of "wetland" and 24 acres of riparian wetland were identified.

Wetlands are extremely important areas of biological and hydrological diversity. Multorpor Fen, the largest wetland in the watershed, is presently owned by the Nature Conservancy. This fen is an excellent example of a North Cascades subalpine mire (Seyer 1983). Though called a "fen," this wetland actually encompasses six unique types of plant communities, including the fen type. Three uncommon plants are also documented from Multorpor Fen: stiff clubmoss, bog clubmoss and wild cranberry. Alaskan yellow cedar, nearing its geographical southern limit, also lines the perimeter of the fen. Alaskan yellow cedar grows in only two areas of the Mt. Hood NF, near Government Camp and the Multorpor Fen, and in the Collowash drainage of the Clackamas River. (A detailed report entitled "Ecological Analysis: Multorpor Fen Preserve, Oregon" [Seyer 1983] is included in the analysis file.)

Other important wetland areas include the Still Creek Key Site Riparian area, Wind Lake Basin, and Devils Lake area. Further survey work is needed to document their communities.

Springs provide water at a constant temperature, flow and quality. They may serve as homes to organisms that require consistency in their lives. Rare caddisflies, tiny snails, and cold-water corydalis are potential inhabitants of springs in this watershed.

Less than 5% of the watershed is in the alpine zone of Mt. Hood. Conditions here are extremely harsh. Long snowpacks, intense sun and wind and drought require plants and animals to have special survival strategies. Unique species include whitebark pine, heather, partridgefoot and Newberry's knotweed.

Grass meadows are an uncommon habitat type in western Cascade temperate rainforest. These meadows are created and/or maintained by disturbance and soils. Only 17 acres of natural grass meadows were mapped in the watershed. Some of the largest are in the subalpine/alpine zone. The south side of Zigzag Mountain also has large meadow areas. Grassy ski runs can function as meadows, although large areas of the ski runs have been seeded with non-native species.

Bats utilize bridges both day and night. Of the eight bridges in the watershed, some may provide roosting sites for: the long-legged and long-eared myotis, two of several bats of concern in the Northwest Forest Plan; and the Townsend's big eared bat, a Regional Forester's sensitive species.

There are several high mountain lakes that create a special habitat within the Zigzag Watershed. They include: Enid, Collins, Mirror, Wind, Veda, Hidden, Devils, and Five Lakes. These lake basins may provide excellent forage areas for a variety of songbirds, raptors, bears, and deer. Pond-dwelling amphibians may also inhabit these areas. Introduction of brook trout (non-native) has competed with the native amphibian population and may have changed the ecosystem within that microhabitat, affecting both plant and animal populations. The level of human interaction around these high mountain lakes could also affect this microhabitat by impacting surrounding vegetation and water quality within the lakes.

Botany

Plant Biodiversity

The diverse habitats in the Zigzag Watershed are homes to 581 vascular plant species (SCCA Database, 1994). 49 species, or about 8%, are not native to the Pacific Northwest. Since knowledge of fungi, lichen and bryophyte distribution is not well known, there are no species estimates for these groups.

The ecology and status of important species of concern are discussed below. Included in this group are Survey and Manage Species, Regional Forester's Sensitive Species, Mt. Hood NF Inventory Species, Riparian Species and Noxious Weeds. (Complete lists for these different groups of plants and their status in the Zigzag Watershed are available in the analysis file.)

Survey And Manage Species

The Northwest Forest Plan lists fungi, lichens, bryophytes and vascular plants that are to be protected through survey and management standards and guidelines (ROD C4 - C6. Listed in the Appendix, Table C-3.) There are four survey strategy ratings which apply to C-3 species:

1. Manage known sites (beginning in 1995).
2. Survey prior to ground-disturbing activities and manage newly discovered sites (for 1999 project implementation and beyond).
3. Conduct extensive surveys for the species to find high priority sites for species management.
4. Conduct general regional surveys to acquire additional information and to determine necessary levels of protection.

Species with survey strategy ratings 1 and 2 demand the most immediate attention. Guidelines for survey and management species with ratings 1 and 2 were due from the Regional Executive Office, (REO) in June 1995. Upon receipt of these guidelines, recommendations for fungi, lichens, bryophytes and vascular plants documented within the Zigzag Watershed could change.

Fungi

Out of 234 fungi species listed in Table C-3 of the Northwest Forest Plan, four rare, false truffles are documented in the watershed: *Octavianina macrospora, Rhizopogon brunneiniger, Alpova alexsmithii*, and *Rhizopogon evadens var. subalpinus*, as well as one gilled mushroom, Pholiota albivelata. Many other fungi have been seen but not specifically documented. These include favorite edibles such as chantrelles and boletes. Quite a few others have potential habitat. (For complete listings, refer to botany section in the analysis file.)

Octavianina macrospora is an extremely rare endemic false truffle known only from a 1930s type locality collection at the former Twin Bridges Forest Camp (now Twin Bridges Campground). This truffle is thought to be ectomycorrhizal with mature to old growth Douglas-fir and western hemlock. Since no other sites are presently known, more specific comments cannot be made on its habitat requirements. As a strategy 1, 3 species, this location must be protected from disturbances such as logging.

Rhizopogon brunneiniger also has a type locality in the watershed at the former Barlow Forest Camp (now Kiwanis Camp). There are four more widely dispersed sites known in the Pacific Northwest, which may indicate that this species is more abundant than presently known. All sites are in mature to old growth conifer forest. Logging could be a factor in impacting or restricting its distribution. This is also a strategy 1, 3 fungus and the type locality needs to be protected from disturbances such as logging.

Two other rare false truffles grow at Still Creek Campground, *Alpova alexsmithii* and *Rhizpogon evadens var. subalpinus*. Both of these truffles are probably ectomycorrhizal with mature to old-growth mountain hemlock, true firs, and other conifers that grow at upper mid-elevations. Six other sites are known for *A. alexsmithii* in the Pacific Northwest, including another site on the Mt. Hood NF at Olallie Lake Scenic Area. *R. evadens var. subalpinus* is more widely distributed, but still rare. Because its habitat is fairly common, further surveys could easily reduce its rarity. Both truffles have strategy 1, 3 ratings, requiring their locations be protected from impacts such as logging or intense recreation.

Pholiota albivelata is a recent addition to Table C-3 and is not described in Appendix J-2. This gilled mushroom belongs to a group of brown spored wood-rotting fungi that often appear in Pacific Northwest conifer forests. *P. albivelata* has been given strategy 1, 3 ratings. In the Zigzag Watershed it is documented from Camp Creek Campground. More specific information is not presently available.

Lichens

26 out of 81 listed lichens have been reported in the Zigzag Watershed. Currently, legal descriptions are only available for two: *Bryoria subcana* and *Loxospora sp. nova "coraliferra."* Both are found near the southeastern portion of the Recreational Residence tracts, and are strategy 1, 3 species.

Bryoria subcana is listed as a rare, oceanic influenced lichen. It grows as a black stringy clump on conifer trunks. Members of this genus are commonly called "horsehair." *Loxospora sp. nova "coraliferra"* is a more common oceanic influenced lichen which also grows on conifer trunks. Both are described as being restricted to the coast. The sites within the Zigzag Watershed are inland extensions of their distribution. Frequent fog and moderate temperatures are habitat features important on the coast. Both lichens are sensitive to air pollution.

Most of the other lichens have a strategy 4 rating. Many of the common nitrogen-fixing lichens are included in this group. The arboreal lichens favor large diameter trees which are often asymmetrical and have large lateral branches and/or emergent crowns. Aquatic lichens need good water quality. Specific microclimates are important for riparian, rock and ground species. Foggy ridgetops are also home to some species. (Refer to survey and manage table in this analysis's analysis file, also in Appendix J-2 of the ROD).

Bryophytes (Mosses And Liverworts)

No survey and manage species of mosses or liverworts are documented in this watershed. Potential habitat exists for many of the 23 species listed in moist mature to old growth forests and streamsides. Surveys are needed by knowledgeable persons to confirm the presence of these species.

Vascular Plants

Habitat exists for five of the seventeen vascular plant species listed in Table C-3 in the Northwest Forest Plan Appendix: *Allotropa virgata, Botrychium minganese/B. montanum, Corydalis aquae-gelidae,* and *Coptis trifolia.* All have strategy 1, 2 ratings.

Allotropa virgata, sugarstick, has been observed but not documented in the Recreational Residences area. Habitat characteristics include an undisturbed mesic forest floor with well-drained soils, developed humus layer, and coarse woody debris. Logging and fire suppression may affect sugar stick.

None of the other four species have been observed in the watershed. *B. minganese/B. montanum*, grapeferns, grow in wet cedar areas such as those near Multorpor Fen. *C. aquae-gelidae*, cold-water corydalis, is an endemic riparian species. Optimum habitat for this species is provided in streams and seeps with cold water (average 10°C), and in substrates with >50% gravel and coarse sand, perennial flow and high canopy. *C. trifolia*, three-leaf goldthread, grows at the brushy, shaded edges of wet meadows. Multorpor Fen, Wind Lake Basin and Devils Lake may have potential habitat.

Regional Forester's Sensitive Plant Species List

21 vascular plants are either documented or suspected to occur in the Zigzag Watershed. The following is a discussion of the four documented species. Information on the other 17 suspected species is available in this analysis's analysis file and in the Mt. Hood NF Sensitive Plant Handbook. Four suspected species, also listed in the Northwest Forest Plan, were discussed in the previous section.

Diaphasiastrum complanatum (=Lycopodium complanatum), ground cedar, is listed as sensitive because it is at the southern edge of its range in Oregon. There are only seven known sites in the state, four within the Zigzag Ranger District. Two of the seven sites have disappeared, including one near Burnt Lake in the Sandy Watershed. The largest population in Oregon grows on Tom, Dick and Harry Mountain in the Ski Bowl ski area. A small population grows in a brushy area near Veda Lake. Ground cedar favors shrubby areas with northern aspects at upper mid-elevations. Its life history appears to be associated with hot fires (Eames, 1942) or other disturbances that expose mineral soil. A 1930s fire lookout photo series shows every site had been burned within the Zigzag Ranger District. In Canada and Alaska, ground cedar can be found along road shoulders and cutbanks. Competition from surrounding vegetation appears to cause its decline. About 60% of the plants on Tom, Dick and Harry Mountain grow in ski runs at Ski Bowl. Routine slope brushing keeps the vegetation in an early seral stage and may enhance habitat for ground cedar.

Huperzia occidentale (=Lycopodium selago), fir clubmoss, is circumboreal in its distribution and nears the southern end of its range on the Mt. Hood NF. It is well distributed on the west side of the Forest, though not common. Four sites are known along Still Creek, and two sites in wet vegetated talus on the north side of Hunchback Mountain. Historically, it may have been more abundant. Fir clubmoss favors mature old-growth riparian forest, and prefers an undisturbed forest floor/streamside with well developed humus layer and woody debris. The extensive fire history of the watershed, in combination with logging, may have altered riparian forest that could have provided beneficial habitat.

Lycopodiella inundata, bog clubmoss, is a rare inhabitant of fens and bogs. It is interruptedly circumboreal and reaches to northwest California on the Pacific Coast. Only two sites are known from the Mt. Hood NF area, one in the Multorpor Fen in the Zigzag Watershed, and one in Big Bend RNA in the Bull Run Watershed. Both locations are classified as subalpine mires and are not common habitats in the Northern Cascades province (Seyer, 1983). Within these mires, bog clubmoss inhabits the muddy, peaty depressions where little vegetation grows. Changes in the hydrology or water quality of Multorpor Fen may have adverse impacts on this little clubmoss.

Utricularia minor, lesser bladderwort, is a carnivorous floating aquatic plant. At Enid Lake it grows along the lake's margins in the drawdown zone. On the Forest it can also be found in Redtop Meadows in the Salmon River Watershed and Bear Springs and Clackamas ranger districts. Its distribution is listed as circumboreal and is not common in Oregon. General habitat requirements include quiet, shallow waters that are often acidic and that draw down in the summer. Flowering is infrequent and vegetative propagules are probably dispersed by waterfowl. Visitors to Enid Lake often trample the shoreline near the Camptown-Crosstown Trail where lesser bladderwort is usually found.

Mt. Hood N.F. Inventory Plant Species

Unlike Regional Forester's Sensitive Species, Mt. Hood Inventory Species do not require any protection or mitigation. These plants are on an Oregon Natural Heritage Program review or watch list, and are recorded when found. Many were once classified as Sensitive Plants. (A complete list can be found in the analysis file.)

Lycopodium annotinum, stiff clubmoss, can be found growing in or near bogs, swamps, marshes, meadows or springs across the Forest. It is present at Multorpor Fen but may also grow in other wet meadows within the watershed.

Poa laxiflora, loose-flowered bluegrass, is a well-distributed but not common riparian grass. It grows at moist sites, often under alders, where some disturbance has occurred. Several sites are known along Still and Camp creeks.

Vaccinium oxycoccus, wild cranberry, is locally abundant on the Mt. Hood NF but uncommon in Oregon. Wild cranberry can be found on sphagnum hummocks in bogs and fens. In this watershed, one site exists at Multorpor Fen. Potential habitat may also be present in the Wind Lake Basin and Devils Lake area.

Riparian Species

A list of species that are known or could potentially occur in riparian areas within the Zigzag Watershed is included in the analysis file. Little is known about the ecology of most species of bryophytes, lichens and fungi. Therefore, recommended Riparian Reserve widths should be maintained. Some vascular plant species, such as the grapeferns, are strongly associated with the Riparian Reserve areas of the watershed.

Noxious Weeds

Invasive, non-native plants are one of the biggest threats to natural biodiversity. In the Zigzag Watershed, six species on the Mt. Hood NF Noxious Weed list are present:

- *Centaurea diffusa*, diffuse knapweed
- *Centaurea maculosa*, spotted knapweed
- *Cirsium arvense*, Canada thistle
- *Cytisus scoparius*, Scotch broom
- *Hypericum perforatum*, St. Johnswort
- *Senecio jacobaea*, tansy ragwort

Generally, noxious weeds in the Zigzag Watershed grow in high traffic areas along roadsides and on disturbed ground, particularly in intensively managed areas. Highway 26 provides a good corridor for the east-west movement of weeds through the northern Oregon Cascades.

The knapweeds have become established along Highway 26, particularly to the east of Laurel Hill. These weeds are classified as "New Invaders" in the Mt. Hood Noxious Weed Management Plan and are targeted for priority control work. Sites between Laurel Hill and the west end of Government Camp were selected for treatment with herbicides. Applications began in 1994 and have been highly effective. Without a focused management effort, knapweeds could become highly invasive on the west side of the Forest. (More detailed information on the history of knapweeds in the watershed can be found in the analysis file.)

Canada thistle, Scotch broom, St. Johnswort and tansy ragwort are classified as "Established Infestations." These weeds are much more abundant than knapweeds. Preventing their spread to new areas of the watershed is the primary management strategy. Further discussion of these weeds can also be found in the analysis file.

Invasive Non-Native Species

Thus far, only *Hedera helix*, English ivy, threatens to be a problem in the Recreational Residence tracts area. Dense patches covering trees and the forest floor will exclude native species and reduce tree vigor. Forest Park in Portland is a good example of a severe infestation. The Zigzag Watershed's Recreational Residence tracts area has a similar potential for the continued spread of English ivy.

Another concern is the amount of non-native grasses and forbs at Multorpor Ski Bowl and Summit Ski Area due to years of seeding with non-native mixes. Orchard and timothy grasses can form long-lived stands. White clover is also extremely persistent. It is not clear whether a native plant community could withstand the impacts associated with ski areas, nor what the value of soil protection is by non-native species relative to a decrease in native biodiversity.

Wildlife

Late Successional Reserves and Riparian Reserves were designated with the objective of providing both for aquatic habitat conditions and for terrestrial species that inhabit the riparian habitats. Despite this extensive reserve system, future outcomes were considered uncertain for more than 300 terrestrial plant and animal species. As a result, the agencies are to survey for these species and manage sites where they are located. Additional standards and guidelines were prescribed for Matrix lands as well, to provide for needs of some terrestrial species. This assembly of reserves and standards and guidelines creates a terrestrial ecosystem management strategy analogous to the objectives of the Aquatic Conservation Strategy (Mellen, Huff, and Hagestedt, 1995).

The approach for wildlife discussions in this analysis is to look at species of concern where finer scale attention was deemed necessary in the Northwest Forest Plan. These include C-3 species, threatened or endangered species, and protection buffer species in the Matrix. Furthermore, species which were outside the scope of the Northwest Forest Plan and which are deemed to be at risk, or sensitive, are considered. Species with potential habitat within the Zigzag Watershed are also identified for use as indicators of biodiversity.

Wildlife Biodiversity

Currently, 231 species of terrestrial and aquatic amphibian species have potential habitat within the watershed. Of these, 6 are listed as threatened, endangered or sensitive, 12 are FEMAT species of concern, 49 are snag dependent species, 62 are log dependent, and 7 are introduced species. In this chapter, these species are discussed either individually or by guilds.

Threatened and Endangered Species

Peregrine Falcon, *Falco peregrinus anatum*

The peregrine falcon, rare to uncommon in Oregon, is listed by the U.S. Fish and Wildlife Service as an Endangered species. The species is particularly dependent on cliff habitat. Cliffs are preferred for nesting and roosting since the height of cliffs aids hunting by providing a larger field of view, as well as predictable updrafts and thermal currents for soaring. They feed almost exclusively on birds, many of which are associated with riparian zones and wetlands.

Peregrine falcons are sensitive to human disturbance. Protection of aeries (nests) from management activities and recreational use between April 1 and July 31 is critical for successful reproduction. The home range for a peregrine falcon is 7.5 mile radius of the nest, territory size is a minimum of 100 ft. radius of nest, and minimum habitat per pair is .5 mile of cliff (Brown, 1985).

The type of parent material in a cliff formation and the size and number of fractures, pockets and ledges formed on the cliff face are all important factors in determining the value of cliffs for wildlife. Volcanic activity in the Cascade Mountains has formed many cliffs of igneous material, highly resistant to erosion. This type of material has long-lasting ledges and fractures which provide high quality breeding sites for peregrines (Brown, 1985).

Elevation also governs the use of cliffs by wildlife. Those cliffs below 5,000 feet offer potential for nesting, while heavy snowpacks and short growing seasons at higher elevations limit the forage base for wildlife (Brown, 1985).

A review of potential cliff sites was completed on the Mt. Hood NF through photo-interpretation, topographic map review, and a helicopter flight (Pagel, Kott, Huff, 1994). A map of cliff sites and their likelihood of supporting nesting peregrines identified the following four sites within the Zigzag Watershed as moderate to high, or high potential:

Zigzag Mountain, Tom Dick and Harry Mountain above Mirror Lake, and two sites in the mid-portion of Still Creek between Devil's Peak and Wolf Camp Butte. The Tom Dick and Harry Mountain and Still Creek sites were included in a 1995 field survey searching for peregrine aeries across the Forest. No peregrines were found at the survey sites.

A peregrine hacking site was located at the Tom, Dick, and Harry Mountian location from 1990-94. (Hacking is the release of young raptors by humans during the development period between fledging from the nest and total independence from the parent.) During this five-year period, more than 25 birds were released from this site. Zigzag Mountain is another potential site. It has been identified as a potential reintroduction site in the Enola Timber Sale Environmental Analysis. However, no future plans to release birds have been developed.

The Special Habitats map displays potential cliff sites (mapped as rock). These cliffs are generally below 5,000' in elevation and composed of andesite or basaltic andesite. Andesite and basaltic andesite are resistant rock which weather slowly and produce angular horizontal and vertical fractures conducive to forming ledges and small openings. The cliff sites within the Zigzag Watershed are therefore high quality potential habitat for peregrines.

The Mt. Hood Land and Resource Management Plan (LRMP) identifies a large portion of the watershed as a potential peregrine falcon recovery area. The Recovery Plan for Peregrine Falcons does not specifically identify the Zigzag Watershed in the recovery of the species, yet this area is identified within the larger Pacific States and Nevada Region. The original plan (1982) was revised in 1984 and an addendum was completed in January 1991. New recovery objectives and recommendations were identified in each revision, incorporating more recent information of the species in the Western United States. Currently, there are about 141 known pairs. Recovery objectives and recommendations for the Pacific States and Nevada is to change the status from endangered to threatened. For full de-listing, 180 or more known pairs would need to be identified. In Region Six the trend is strongly upward (less than 5 known pairs to 141 in 20 years). Number of pairs in Oregon (about 18) are increasing.

Bald Eagle, *Haliaeetus leucocephalus*

Bald eagles are classified as a threatened species in Oregon by the U.S. Fish and Wildlife Service. They are protected at the federal level by the Endangered Species Act of 1973 (ESA), the Bald and Golden Eagle Protection Act, and the Migratory Bird Treaty. They are also protected by state law in Washington and Oregon.

Bald eagles inhabit the forests of Oregon during both the wintering and nesting seasons. They are most abundant in winter when there is an influx from the north. Most of their historic range in the northwest is still occupied, but populations have been steadily declining for many years (Brown, 1985). Recently, that decline has slowed or stopped.

Eagles have fared better in Oregon and Washington than in most areas, and substantial populations still exist within these two states. Recent surveys indicate that more than 100 breeding pairs and approximately 600 wintering birds occur in Oregon, with the largest concentration in the Klamath Basin.

Nesting, perching, roosting, and foraging habitats are all important components determining suitability of an area. Bald eagles exhibit a strong preference for large, dominant or co-dominant trees in a heterogeneous stand of mature or old-growth conifers near large bodies of water. This allows easy access to their preferred diet of fish.

The Zigzag Watershed does not provide a large enough body of water to provide suitable nesting, perching or foraging habitat. Even so, bald eagles may be seen migrating through the area. The LRMP does not identify the watershed as a potential recovery area for bald eagles, nor does the recovery plan for bald eagles recognize it as crucial in assisting in the recovery of the species.

Northern Spotted Owl, *Strix occidentalis caurina*

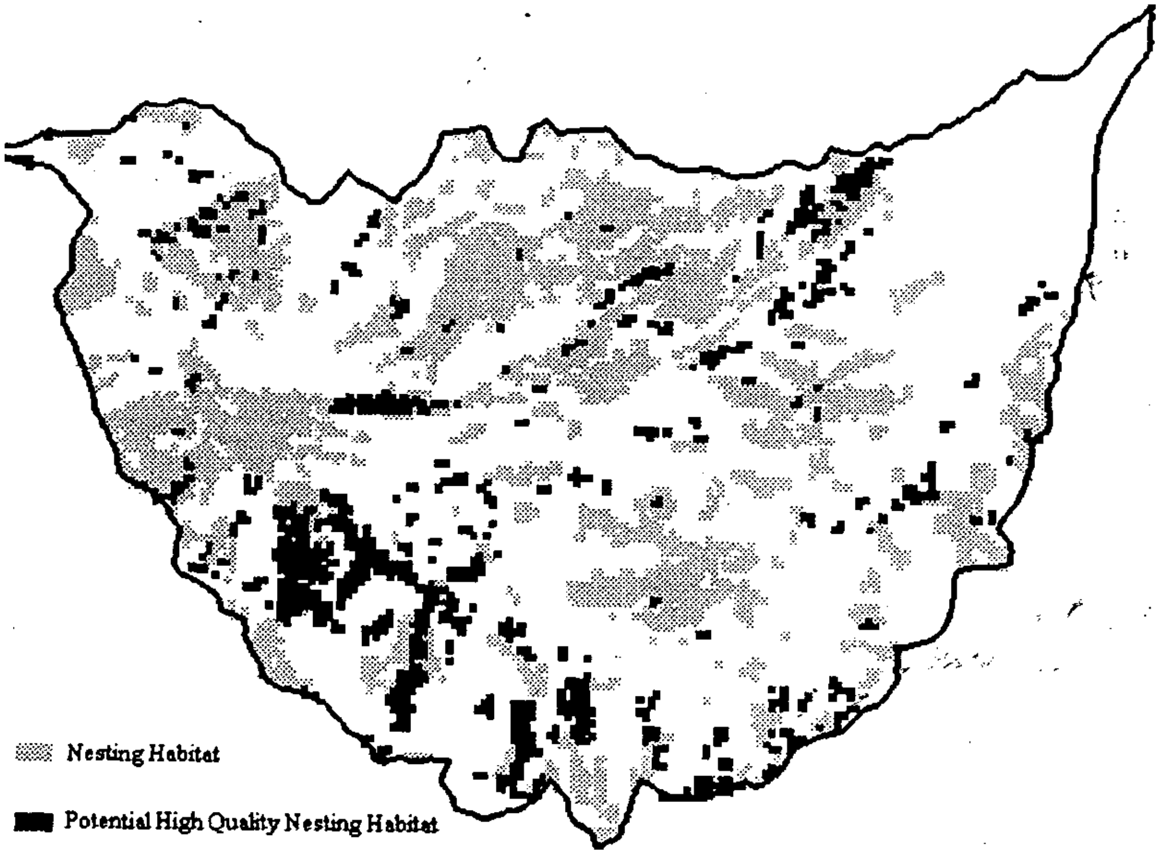
Northern spotted owls are listed as a threatened species by the U.S. Fish and Wildlife Service. They are protected under the Endangered Species Act of 1973. When listed as a threatened species in 1990, the USFWS identified Critical Habitat as required by the ESA. No Critical Habitat Units are located within the Zigzag Watershed.

Spotted owls are closely associated with old growth stand conditions in the temperate and high temperate conifer forest plant communities (Forsman, 1976, USDI, FSW, 1982). Multi-layered old-growth forests are the preferred nesting habitat of spotted owls in Oregon. Furthermore, it appears to be the most consistent feature of forests occupied by spotted owls. Mature and second growth stands with scattered old-growth trees or broken-topped trees provide suitable nesting sites for owls. Canopy closure averages 70% at most nest sites. In addition to suitable nest sites, roosting, foraging and dispersal habitat are all crucial elements to spotted owl viability (Brown, 1985).

Roosting habitat encompasses the area within several hundred yards of the nest and includes trees low in the forest understory during warm or hot weather, and high up in old growth or mature trees during cold, wet weather. Foraging habitat would include areas with large amounts of large woody debris and snags, providing adequate amounts of prey species (flying squirrel, red tree voles, and other small mammals). Dispersal habitat is defined as a stand of trees with an average diameter at breast height of 11" and average canopy closure of 40%.

The Zigzag Watershed contains approximately 10,821 acres of potential nesting habitat and 18,980 acres of dispersal habitat. Potential nesting habitat has not been field verified, yet preliminary analysis indicates 2,639 acres of the potential nesting habitat may be high quality. Much of this high quality nesting habitat is scattered throughout the watershed, but appears to be concentrated on its west end.

Figure 4-20 – Potential Spotted Owl Nesting Habitat



The Northwest Forest Plan identifies the lower portion of the Still Creek drainage as Late-Successional Reserve (LSR). 5,375 acres of LSR are within the Zigzag Watershed. The objective of LSRs is to protect and enhance conditions of late-successional and old growth forest ecosystems which serve as habitat for late-successional and old-growth related species, including the northern spotted owl (ROD C-9). Currently, the LSR contains only 18% late seral habitat. The majority, 78%, is mid seral. A summary of the LSR and recommendations is included in Chapter 7.

The LSR contains 2,152 acres of potential nesting habitat, 944 acres of which may be high quality. It currently supports one known spotted owl pair that has been located annually since 1981. This LSR would not likely support more than one pair until additional late-seral habitat develops. The watershed outside of the Late-Successional Reserve (LSR) supports one known pair, located within the Mt. Hood Wilderness.

Regional Forester's Sensitive Species List (with known occurrence in Zigzag Watershed)

Cope's giant salamander, *Dicamptodon copei*

Cope's giant salamander inhabit fast flowing 1st to 3rd order streams with clear cold water and streamside forest. Water temperatures usually range from 8 to 14 degrees centigrade (46.4 to 57.2 degrees fahrenheit) and are seldom higher than 18 degrees centigrade (64.4 degrees fahrenheit). Recent data identifies that Cope's occurrences have been found in water temperatures not exceeding 10 degrees centigrade (50 degrees fahrenheit) (Corkran, pers. comm., 8/28/95). Stream substrate consists of cobble and small boulders, some large logs and no silt. They occasionally occur in clear, cold mountain lakes and ponds. The elevational range is from sea level up to about 1,350 m (4,400 ft.) (Nussbaum, 1983 & Corkran, Thoms, 1994). More recent data collected by Corkran, 1994, identifies their elevation limit to be 1,000 m (3,500 ft.).

Current distribution of the species is from western Washington and northwestern Oregon. It occurs in the Olympic Mountains and Willapa Hills of western Washington, the Cascade Mountains in southern Washington and northern Oregon, and in the northern Oregon Coast Range.

Surveys for Cope's giant salamander were conducted in 1995 in the Still Creek drainage of the Zigzag Watershed. Two tributaries of Still Creek have confirmed Cope's giant salamanders. Temperature data from Still Creek thermograph monitoring has identified that the main stem of Still Creek did not exceed 18 degrees centigrade during the six years it was monitored.

Camp Creek, Zigzag River, Henry Creek, Lady Creek, and Still Creek provide suitable habitat for Cope's giant salamander, yet removal of large woody debris may have degraded the effectiveness of the mainstem streams.

Cope's giant salamander are believed to be declining. The reason for the Sensitive status is restricted distribution combined with potential for habitat destruction from timber harvest, which has the potential to alter solar radiation intercepted by streams and stream temperatures. In the future, Riparian Reserve standards and guidelines should help maintain or enhance wetlands, streams, seeps, and springs; and therefore assist in protecting habitats utilized by Cope's giant salamanders.

Harlequin Duck, *Histrionicus histrionicus*

Harlequin ducks inhabit turbulent mountain streams in coniferous forests with dense shrubby streamside vegetation. Instream structures (logs, boulders) are important for providing loafing sites for the species. Slower side channels and slower moving waters are important for brood rearing. Males and females arrive in the streams of the Mt. Hood NF around March, and leave to winter at the coast around September. Nests are found on the ground near streams, in tree cavities, and cliffs.

The species range is the Pacific and Atlantic sides of North America, Greenland, Iceland, eastern Siberia, and the Kurile Islands. The species range in Oregon is along the coast in the winter, particularly along rocky shores. During the spring and summer, it nests along streams of the Cascade Range and Wallowa Mountains. A nest site was recorded on the Salmon River near Wemme in 1931, and on Clear Creek near the confluence with the Sandy River in 1991. While no nest sites are recorded within the Zigzag Watershed, the species can be sighted regularly throughout the spring and summer on Still Creek, Camp Creek, and the Zigzag River.

Surveys have not documented young on these stream systems. It is very likely they are breeding and rearing their young on these streams, but their aversion to human presence may prevent sighting the young.

The species has been and is declining. It is identified as a Sensitive species due to its breeding habitat being impacted from timber harvest, recreation increases, and degraded riparian habitats.

Regional Forester's Sensitive Species List (with potential occurrence in Zigzag Watershed)

Red-legged Frog, *Rana aurora*

The geographic distribution of the red-legged frog extends from southwest British Columbia through western Washington and Oregon into northern California. They are found throughout western Washington and Oregon at elevations ranging from sea level to 860 meters (2,830 ft.) on Mt. Rainier, and to 1,427 meters (4,680 ft.) in the Umpqua National Forest. They also occur as far east as White Salmon in the Columbia River Gorge.

Breeding habitat includes marshes, bogs, swamps, ponds, lakes and slow-moving streams. In general, breeding sites seem to require little or no flow. Outside the breeding season, they are highly terrestrial and are frequently encountered in woodlands adjacent to streams.

There are limited amounts of habitat in the Zigzag Watershed. Wetland and streamside habitats vary from poor to high quality due to human access. Soil compaction and vegetation trampling has degraded streamside/wetland habitat. Habitats without human impacts may provide high quality habitat for the red-legged frog. There are no documented sightings within the watershed.

The species is currently declining. Possible causes for this decline include: displacement by the introduced bullfrog, pesticide and herbicide runoff, and introduction of non-native fish. Future trends are likely continued declines, even with implementation of the Northwest Forest Plan. Riparian Reserves may help to maintain or enhance habitat in the future, yet impacts from bullfrogs or pesticide and herbicide runoff are out of the control of the Forest Service. The Forest Service and Oregon Department of Fish and Wildlife, currently working together on stocking of high mountain lakes, may propose to restore some of those habitats. This may improve habitat for the red-legged frog.

Townsend's big-eared bat, *Plecotus townsendii*

Townsend's big-eared bats occur in numerous plant community types, using caves, buildings, mines, and bridge undersides for nursery and hibernation purposes. These sites must meet exacting temperature, humidity, and physical requirements. Suitable undisturbed roost, nursery, and hibernaculum sites appear more important than other habitat factors in dictating presence of this species. Food consists of insects, primarily moths, and other arthropods. Besides aerial feeding, this bat gleans insects from plants.

The species range is Western North America from southern British Columbia south to southern Mexico, and east to South Dakota, Oklahoma, and Texas. A narrow range extends into the central Atlantic states. In Oregon, they are a statewide resident, but are scattered because of the fragmented nature of habitat.

No known caves or mines occur in the Zigzag Watershed. There are potential caves on West Zigzag Mountain, but specific locations are not identified and are not easily accessible.

The species is undergoing a serious decline in Oregon and other states. Populations have declined 58% west of the Cascade range since the 1975-1985 period. East of the Cascades, the decline has been 16%.

Disturbance at hibernaculum and nursery sites appears to be the main reason for their decline, yet the number of suitable caves or other structures that can support the species is limited. Disturbance interrupts their torpid state and burns fat reserves needed during periods of inactivity. Recreational use of caves and vandalism is a problem where species occur. Population declines are occurring where sites have been disturbed. Yet, where caves have been protected, populations have remained stable or increased. The species also has a low reproductive rate of one young per year, and a female produces only five to eight young in a lifetime (Marshall, 1992).

California Wolverine, *Gulo gulo luteus*

The wolverine occupies a variety of habitats, however, a general trait of areas occupied by wolverines is their remoteness from humans and human developments. Information on the habitat and population ecology of wolverines in the forests of western North America is mainly anecdotal, or not available.

The species distribution is circumpolar; it occupies tundra, taiga, and forest zones of North America and Eurasia (Wilson, 1982). Wolverines extend as far south as California and Colorado, and as far east as the coast of Labrador, although low densities are characteristic of the species.

Wolverine habitat exists within the Zigzag Watershed. The higher quality habitat would likely be the areas within the Mt. Hood Wilderness, or areas during the winter that have low human presence. While there are no documented occurrences of wolverines within the watershed, their tracks were confirmed east of the watershed in the West Fork of the Salmon River (1990).

Reasons for species decline is not completely understood, but could be due to low reproductive rates, delayed sexual maturity, high mortality from trapping (trapping only legal in Alaska and Montana), and fragmentation of large areas that are not trapped and are free from land-use impacts. Future population trends would be continued decline of the species due to impacts to their habitat, and increased recreation use.

Black Rosy Finch, *Leucosticte arctoa atrata*

The black rosy finch is listed as a Forest Service sensitive species. It is believed to be restricted to the Wallowa and Steens mountains in eastern Oregon. Rosy finches on Cascade Range peaks are members of the gray-crowned rosy finch group, but no local surveys have been conducted to confirm that black rosy finches do not occur. There is no documented presence within the watershed.

The black rosy finch is a sparrow-sized finch found in summer at high elevations at or above timberline where snow persists. They prefer habitat of snowfields and adjoining edges and rocks. They feed on seeds along the receding snowline. Breeding begins with the emergence of insects for feeding young. They nest in rocky crevices.

The status and trends of black rosy finches is unknown, particularly because of their confusing taxonomic status. Low population numbers and limited habitat are contributing to the sensitive status (Marshal, 1992).

Survey and Manage Species

Table C-3 of the Northwest Forest Plan lists 4 arthropods, 5 amphibians, 1 mammal, and 43 mollusk species having special survey and management needs. The Mt. Hood NF is outside the range for the listed arthropod species. Of the five amphibians, only one species, Larch Mountain salamander, is known to occur, or may potentially occur, on the Mt. Hood NF. The Larch Mountain salamander is also a Regional Forester's sensitive species. The red tree vole may potentially occur on the Mt. Hood NF. The list of 43 species of mollusks was interpreted by Forest wildlife biologist Robert Huff. A resulting document, dated June 14, 1994, identifies which species occur, or may potentially occur, on the Mt. Hood NF.

The terrestrial species are *Hemphillia malonei, Deroceras hesperium, Hemphillia pantherina, Prophysaon coerulem*, and *Prophysaon dubium*. These species inhabit moist forests within riparian areas and upland forests. They are often found in forest litter. The aquatic species are: *Juga (oreobasis) n. sp. 2, Lyogyrus n. sp. 1, Monadenia fedelis minor, Cryptomastix devia*, and *Cryptomastix hendersoni*. These aquatic species are found in springs, seeps and talus.

The Regional Office is compiling known site locations, population data, and management recommendations for all survey and manage species. This information has not been received yet for wildlife.

The following survey strategy "2" species require surveys to precede design of all ground-disturbing activities that will be implemented in 1997 or later: Larch Mountain salamander, red tree vole, and lynx. The Larch Mountain salamander and lynx also fall under the category of Protection Buffer Species (Northwest Forest Plan C-28 and C-47). Extensive and general regional surveys (strategies "3" and "4") are required for many other species (ROD, 1994, pg. C-4 to C-6). All amphibians, mammals and mollusks are survey strategy "1" or "2," while all arthropods are survey strategy "4". (Refer to ROD Table C-3, page C-59 and C-61 for a full listing of species.)

Red Tree Vole, *Phenacomys longicaudus*

The red tree vole spends most of its life in the canopy of coniferous trees and eats needles of conifer trees. The red tree vole is more abundant in late-successional forest than young forest, and appears to be closely associated with older forests. Because they are small and live almost exclusively in the canopy of conifers, they probably have limited dispersal capabilities.

Currently, the watershed provides only 7% of available habitat for this species (see guild discussion later in this chapter). The late-seral habitat that does occur is fragmented and scattered across the watershed. The need to maintain existing late-seral habitat is crucial for this species' presence in the watershed.

There are no documented sightings within the watershed. Surveys for the species have been initiated on the Zigzag District and will continue into 1996. There is incomplete or unknown local distribution of the species.

Larch Mountain Salamander, *Plethodon larselli*

The range for the Larch Mountain salamander is the Columbia Gorge in Washington and Oregon. The range in Oregon is the Columbia Gorge in Multnomah and Hood River counties between Bridal Veil on the west and Mitchell Point on the east. The southern edge of the range has not been identified, but has been reported from near the summit of Larch Mountain, a record which has been questioned (Marshall, 1992). The northern range has not been identified, but four populations have been found north of the Gorge near Mt. St. Helens, and just south of Mt. Rainier. They have been found to 3,400 ft. (Leonard, et. al., 1993).

Habitat for the species is small-sized angular talus slopes where the talus is kept moist by a covering of mosses and dense overstory of coniferous trees. The species is truly terrestrial and is almost never found associated with free water.

Potential habitat for Larch Mountain salamanders may exist within the watershed due to the presence of andesite and basalt rock outcrops which produce moist talus and felsenmeer slopes in angular blocky gravels.

No surveys have been conducted and no documented sightings are recorded.

Protection Buffer Species

Protection buffer species are defined as rare and local endemic species that were identified in the Scientific Analysis Team Report as species likely to be assured viability if they occur within designated areas. However, where these species occur in the Matrix, specific standards and guidelines will be applied (ROD C-45). Protection buffer species include the white-headed woodpecker, black-backed woodpecker, pygmy nuthatch, flammulated owl, and lynx.

Because they occur in ponderosa pine forests, the white-headed woodpecker, pygmy nuthatch, and flammulated owl do not occur within the Zigzag Watershed or anywhere on Zigzag District. It is also unlikely that the lynx would occur on the Mt. Hood NF, since it is rare within the range of the northern spotted owl, occurring primarily in the Okanogan area of Washington.

Winter track surveys have been conducted on the Zigzag and Columbia Gorge districts since 1990. No tracks of lynx have been identified. Only the Still Creek drainage has been surveyed through winter tracking.

The black-backed woodpecker, *Picoides arcticus*, is closely associated with pine forests but is also known to follow pest infestations. No surveys for black-backed woodpeckers have been conducted nor are any sightings documented, but it is suspected that they may occur here.

There are also protection buffer species that occur in Late Successional Reserves. Those species are great gray owls and the Shasta salamander. The Shasta salamander does not occur on the Mt. Hood National Forest. It is unlikely that the great gray owl would occur in the Zigzag Watershed, but may occur near the crest of the Cascade Range.

Species Afforded Additional Protection Within Matrix

In addition to protection buffer species, there are several bat species protected by additional standards and guidelines within Matrix lands (ROD C-43). Surveys are to be conducted of crevices in caves, mines, and bridges and buildings for presence of roosting bats. Species potentially occurring within the Zigzag Watershed include the silver-haired bat, long-eared myotis, and long-legged myotis.

Silver-haired bats, *Lasionycteris noctivagans*, are closely associated with old growth/mature forests. They roost in the fissures and grooves of bark of large trees and snags. Only 2% of the watershed provides habitat for silver-haired bats. Maintaining this existing habitat is crucial in maintaining the species across the watershed.

Long-eared myotis, *Myotis volans*, and long-legged myotis, *Myotis evotis*, use a variety of habitats. They are associated with coniferous forests and are known to use mines, bridges, and abandoned buildings. Long-legged myotis are also known to use shrub wetlands and wet meadows. (Also see discussion of snag habitat.)

Pileated Woodpecker And Pine Marten Areas (B-5)

Page C-3 of the ROD states: "Administratively Withdrawn Areas that are specified in current Forest Plans to benefit American martens, pileated woodpeckers, and other late-successional species are returned to the Matrix unless local knowledge indicates that other allocations and these standard and guidelines will not meet the objectives for these species."

A Forest-wide analysis was drafted (7/17/95) that assessed the relative importance of individual B-5 areas based on their contribution to late-seral forest conditions at the watershed level. The analysis procedure started by "screening out" any B5 area that was in reserved land allocations. The remaining areas were reviewed for their relative location to the Northwest Forest Plan land allocations. B5 areas that were immediately adjacent to late successional reserves, Congressionally reserved areas and administratively withdrawn areas, were screened out. B5 areas that entered the next screen were assessed for their proximity to Riparian Reserves, specifically stream orders "3" and "4." This screen also focused on connectivity of the B5 area to each other and other land allocations. The last screen captured existing knowledge at the field level.

At the watershed level, an analysis was completed that calculated the acreage of B5 areas outside of land allocations that allowed for late-seral habitat development (reserved areas). 207 acres of B5 areas are outside of reserved areas in the Zigzag Watershed. Those 207 acres were then reviewed for the amount and distribution of late-seral habitat in the watershed; quality of late-seral habitat within the watershed; and proximity to Riparian Reserves, 100-acres spotted owl late successional reserves, and existing late-seral habitat.

The Forest-wide analysis recommended that all B5 areas within Matrix in the Zigzag Watershed be returned to the Matrix. District biologists have concurred with that recommendation.

Snags and Coarse Woody Debris

Forty-nine wildlife species potentially occurring within the watershed are dependent on snags. Most of the primary cavity nesters are generalists and can make use of available snags in any seral condition, however, three species (black-backed woodpecker, pileated woodpecker, and three-toed woodpecker) require snag habitat in late seral forest condition. Most of the secondary cavity nesters are also generalists, however, two species (mountain bluebird and western bluebird) require snags in early seral conditions, and four species (barred owl, marten, northern flying squirrel, and northern spotted owl) use snags in late-seral conditions.

No assessment of snag habitat has been conducted for the watershed. It is likely snag levels are low due to high intensity or repeated burns (see Composite Fire History Map) and management practices. Large snags are likely most abundant within unmanaged large conifer stands, such as the Cool Creek area of the Still Creek drainage, Horseshoe Creek area in the Mt. Hood Wilderness, remnant stands in stream bottoms of lower Still Creek, and near Still Creek Campground.

Trees with laminated root disease are contributing to snag levels, but these snags are less stable and inevitably windthrown. The biology of *P. weirii* does not contribute to rot higher up in trees, and therefore may not create good habitat for cavity nesters.

The Recreational Residence tracts currently have high levels of trees infected with laminated root disease and are contributing to snag levels. However, these trees become hazards to the structures as well as visitor safety and are felled on an individual or small group basis. The trees are either left as downed woody debris, removed for fish structures, or used as firewood by Recreational Residence owners. The opportunity to top affected trees is low due to the fact that the tree could still be windthrown from decayed roots.

Western spruce budworm and Douglas-fir beetle affected trees in the Still Creek drainage could provide snag habitat, yet many of these trees are too small for habitat required by many species.

Sixty-two wildlife species potentially occurring within the watershed are downed log dependent. Coarse woody debris is important in mineral cycling, nutrient mobilization, and natural forest regeneration. It also creates a structure and diversity of habitats that are valuable to many terrestrial and aquatic wildlife species. Downed woody debris serves as sites for feeding, reproducing, and nesting. It is important for denning areas, invertebrate and vertebrate prey sources for birds and salamanders, as well as providing habitat for small mammals.

Coarse woody debris levels likely follow a similar pattern as snag levels. This is due to fire history, management practices, and development. Laminated root disease, however, contributes greatly to the presence of downed woody debris.

Over the watershed, the trend for coarse woody debris and snag levels are likely to increase due to reserve allocations, standards and guidelines, and maturation of stands. This increase in levels, however, will take time.

Life History Guilds

Besides individual species of concern, wildlife with potential occurrence in the Zigzag Watershed were addressed by their life history guild.

Wildlife species have been grouped into life history guilds based on how species are expected to respond to different amounts and distributions of habitat across the landscape (Mellen, Huff, Hagestedt, 1995). Home range size, patch configuration use, and structural stage use were used to group terrestrial species. Riparian associated species were grouped by water body, aquatic association, and structural stage. Species that require special habitats such as caves or cliffs were not grouped into guilds. The objective of the guilding approach is to predict terrestrial and amphibian occurrence relative to landscape patterns.

The following tables display the criteria used to group species by life history into guilds. The tables indicate the amount of habitat within the watershed for each guild. The amount of habitat is displayed by acres and percent of watershed, as well as the potential number of species in each guild. Those guilds with under 10% available habitat within the watershed will be discussed later as species of concern.

Guild codes refer to the grouping criteria. For example, TSPO refers to: (T) terrestrial, (S) small home range, (P) patch configuration, and (O) open structural stage.

Table 4-7 -- Criteria Used to Group Species by Life History into Guilds

TERRESTRIAL: Terrestrial habitat users (may use riparian or special habitats as well, but do not require them).

HOME RANGE:

SMALL: Home ranges less than 60 acres
MEDIUM: Home ranges 60 - 1000 acres
LARGE: Home ranges more than 1000 acres

PATCH CONFIGURATION:

PATCH: Species requiring one homogeneous patch (one structural stage) during life cycle (or breeding period for migrants).
MOSAIC: Species capable of aggregating patches of like structural stages that are dispersed in a mosaic pattern across the landscape.
CONTRAST: Species using two different major structural stages in close proximity, usually large tree and open.
GENERALIST: Species whose primary habitat is not restricted to one major structural stage.

STRUCTURAL STAGE:

OPEN: Includes grass/forb, shrub, leave tree/shelterwood, and open sapling/pole.
SMALL TREE: Includes closed sapling/pole, open small conifer (less than 21")
LARGE TREE: Includes large conifer (more than 21") and old growth.

RIPARIAN: Species that require aquatic or riparian habitats (may use terrestrial habitat if riparian habitat is nearby. May use special habitats, but do not require them).

WATER BODY:

LAKE: Aquatic/riparian obligate using only lakes.
LAKE/RIVER: Aquatic/riparian obligate using lakes or rivers or streams.
RIVER: Aquatic/riparian obligate using only rivers or streams.

AQUATIC ASSOCIATION:

A: Species use only the aquatic portion of the watershed.
AR: Species use both the aquatic and the riparian (edge or shoreline) portion of the habitat.
R: Species use only the riparian portion of the habitat.

STRUCTURAL STAGE:

OPEN: Grass/forb/shrub.
FORESTED: Hardwood sap/pole, hardwood small tree/large tree, conifer sap/pole, and conifer small tree/large tree.

SPECIAL: Species requiring special and unique habitats such as caves, cliffs, bridges, buildings, and wetlands for breeding and/or feeding.

Table 4-8 -- Amount of Habitat Available Within the Watershed for Terrestrial Guild Groups

GUILD CODE	HOME RANGE	PATCH CONFIGURATION	STRUCTURE STAGE	TOTAL ACRES	% OF WATERSHED
TSPO	Small	Patch	Open	3,257	9%
TPSPT	Small	Patch	Small Tree	0	0%
TSPLT	Small	Patch	Large Tree	7,079	7%
TSMO	Small	Mosaic	Open	1,853	5%
TSMST	Small	Mosaic	Small Tree	0	0%
TSGOS	Small	Generalist	Open/Small Tree	26,881	71%
TSGSL	Small	Generalist	Small/Large Tree	31,040	82%
TSGG	Small	Generalist	All	35,247	93%
TMPO	Medium	Patch	Open	1,077	3%
TMMO	Medium	Mosaic	Open	1,184	3%
TMMLT	Medium	Mosaic	Large Tree	3,236	9%
TMGG	Medium	Generalist	All	35,247	93%
TLMO	Large	Mosaic	Open	373	less than 1%
TLMLT	Large	Mosaic	Large Tree	5,691	7%
TLGG	Large	Generalist	All	34,550	91%
TSC	Small	Contrast	Contrast	1,042	3%
TMC	Mosaic	Contrast	Contrast	929	2%
TLC	Large	Contrast	Contrast	126	less than 1%

Table 4-9 -- Amount of Habitat Available Within the Watershed for the Aquatic/Riparian Guild Groups

GUILD CODE	WATER BODY	AQUATIC ASSOCIATION	STRUCTURE STAGE	TOTAL ACRES	% OF WATERSHED
LAKEA	Lake	Aquatic		0	0%
LAKEARO	Lake	Aquatic, riparian	Open	0	0%
LAKERO	Lake	Riparian	Open	0	0%
LKRVA	Lakes/Rivers	Aquatic		12,093	32%
LKRVARO	Lakes/Rivers	Aquatic, riparian	Open	825	2%
LKRVARF	Lakes/Rivers	Aquatic, riparian	Forested	10,921	29%
LKRVARG	Lakes/Rivers	Aquatic, riparian	All	12,093	32%
LKRVRO	Lakes/Rivers	Riparian	Open	963	3%
LKRVRG	Lakes/Rivers	Riparian	All	0	0%
RIVA	Riverine	Aquatic		12,093	32%
RIVARF	Riverine	Aquatic, riparian	Forested	10,920	29%
RIVARG	Riverine	Aquatic, riparian	All	5,795	15%
RIVRO	Riverine	Riparian	Open	336	less than 1%
RIVRF	Riverine	Riparian	Forested	5,330	14%

Of the 10 riparian/aquatic guilds, 3 guilds have less than 10% available habitat within the watershed. Of the 16 terrestrial guilds, 9 guilds have less than 10% available habitat. These figures indicate that habitat for the following species of concern is currently limited: red tree vole (TSPLT - 7%), silver-haired bat (TMC - 2%), northern spotted owl (TLMLT - 7%), and black-backed woodpecker (TMMLT - 9%). (For more information, refer to specific species discussions in this chapter.)

In addition, there is less than 1% habitat available for elk, an important game species that requires contrast habitat (TLC).

Species Of Economic Concern

Deer and elk represent a valuable recreational and economic resource both to hunters and those wishing to view the animals. Deer and elk require space, water, quality food, and cover. Areas with high quality forage and cover which is distributed to permit full use and has reasonable freedom from human disturbance, provide the most productive habitat for deer and elk. Deer and elk must have both forage and cover within their home range if they are to acquire and conserve the energy they need on a daily basis. Historically, deer and elk used naturally occurring forest openings. In the managed forest, they use forage created by clear-cut logging of units adjacent to forest stands (Brown, 1985). Based on the analysis of life history guilds, the Zigzag Watershed provides less than 1% of available habitat to elk. Approximately 93% of the watershed is available habitat for deer.

Timber practices have been limited in the watershed in the past due to low acreage of timber emphasis lands. This accounts for the low amount of habitat. The steep slopes of the watershed and its high elevations may also account for the low amount of elk habitat. To evaluate the effectiveness of local habitats, the following need to be assessed: density of roads open to motorized vehicles, sizing and spacing of forage, and cover and forage quality.

The Habitat Effectiveness Model can be run on scales smaller than the watershed for project planning. Normally, areas between 1,000 and 6,000 acres can be analyzed, but the largest analysis area should be chosen on the basis of evaluation of cumulative effects (USDA FS, 1986).

Future conditions do not appear to push toward high quality habitat for elk. Timber harvesting will occur to improve the forest health condition, yet about 90% of the watershed will develop into late-seral habitat conditions. Cover without the high quality forage will not provide effective habitat for elk.

Elk numbers appear to be declining on Zigzag District lands. Many factors may affect this, including: high human presence, low amounts of available forage, and high road densities.

Because use of roads may inhibit deer and elk use of quality foraging, rearing, and wintering areas, road densities are important. Road density by subwatershed is displayed in Table 4-11 in this chapter's hydrology section.

Forest Plan standards state: "by year 2000, roads open to motorized vehicle traffic should be reduced to not exceed 2.0 mi/sq. mile within inventoried deer and elk winter range, and 2.5 mi/sq mile within deer and elk summer range (FW-208)." Two subwatersheds exceed these standards: Henry/Zigzag, (2.59 mi/sq mi) and Camp Creek, (2.14 mi/sq mi).

The southwestern portion of the watershed is identified as severe winter range (LRMP, 1990, pg. III-70). Portions of this inventoried winter range have road densities that exceed the standard. As stated previously, road densities should not exceed 2.0 mi/sq miles. If road densities exceed these standards, management actions should be taken to reduce road densities to acceptable levels.

Hydrology

Introduction

The Zigzag Watershed consists of three distinct subwatersheds: Still Creek, Camp Creek and Zigzag River. The Zigzag River originates from Zigzag Glacier, carves its way through volcanic mudflow deposits, flows westerly through the central portion of the watershed's more recent mudflows, and terminates in alluvium near its confluence with the Sandy River. The Zigzag River is a steep gradient stream from the headwaters to the lower two miles, where it transforms to a more moderate gradient depositional area for sediment.

Still Creek originates from Palmer Glacier and a series of springs on Mt. Hood's west side. From its headwaters to Still Creek Campground, it flows through unconsolidated material from volcanic and glacial deposits (glaciated volcanics). From there, Still Creek flows through hillslopes forming in weak and resistant rock until it encounters an area of unconsolidated material near its confluence with the Zigzag River. Still Creek is a steep gradient stream from the headwaters for the first two miles, where it flattens out within the Key Site Riparian (KSR) area in an area of landslide deposits. It then becomes a steep gradient stream for another two miles. Within its last nine miles to its confluence with the Zigzag River, Still Creek is a moderate gradient sediment depositional reach.

Camp Creek originates from a series of springs and wetlands above the Government Camp area. This subwatershed includes a number of large wetlands, including the Multorpor Fen. Camp Creek originates in an area of glaciated volcanics and flows through this material from its headwaters to an area near Laurel Hill. Here, it encounters exposed resistant rock for a short period, then flows through volcanic mudflow deposits of various ages. This stream is confined by Highway 26 from the Ski Bowl parking lot to Mirror Lake Trailhead. Camp Creek is a steep gradient stream from its headwaters to the Multorpor Fen area. For the next three miles, it is a steep gradient channel, then flattens for one mile into an unstable channel in an area of volcanic mudflow depostis. From here, Camp Creek becomes a steeper gradient channel for its last half-mile before its confluence with the Zigzag River.

Figure 4-21 – Stream Network and Associated Landforms

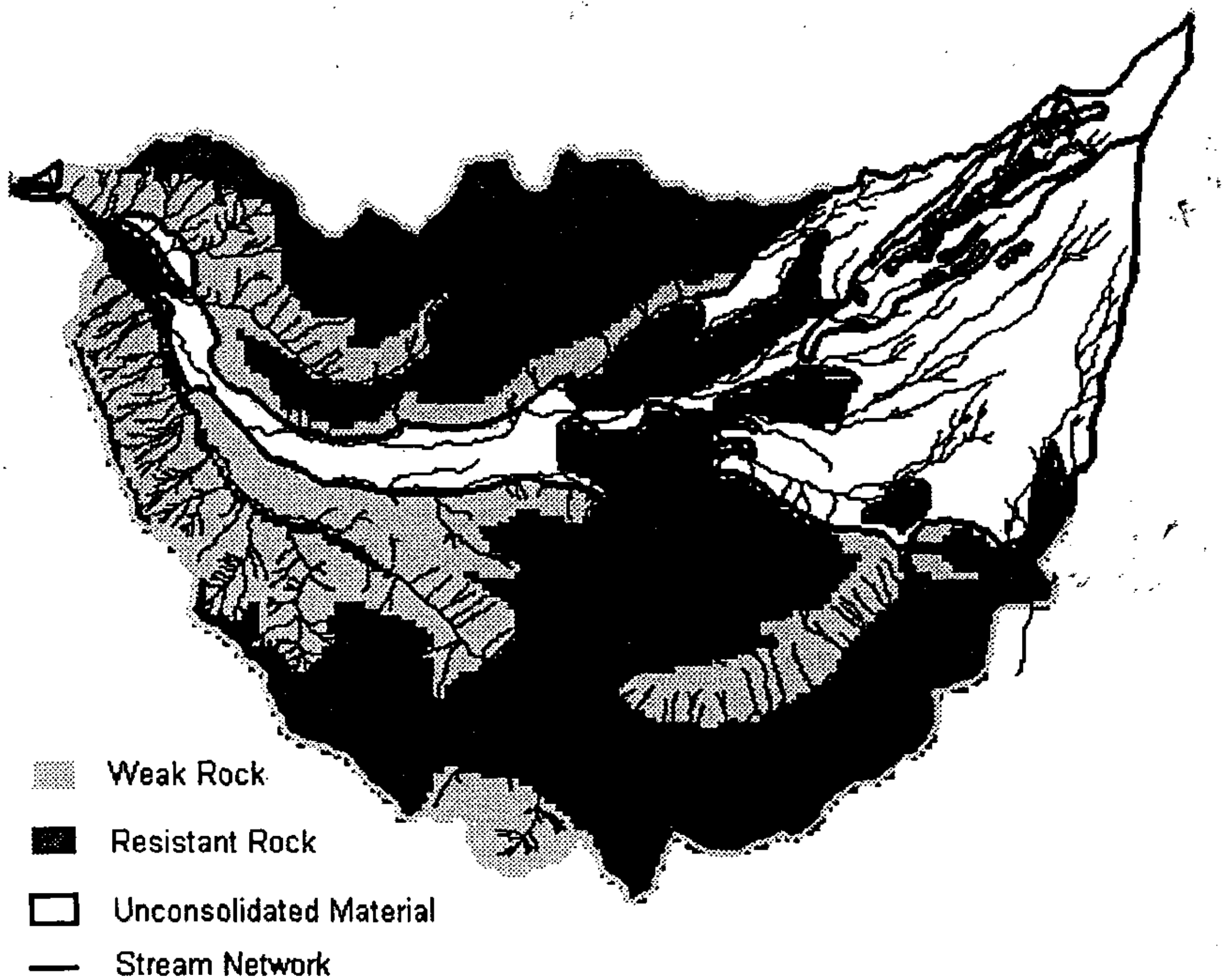
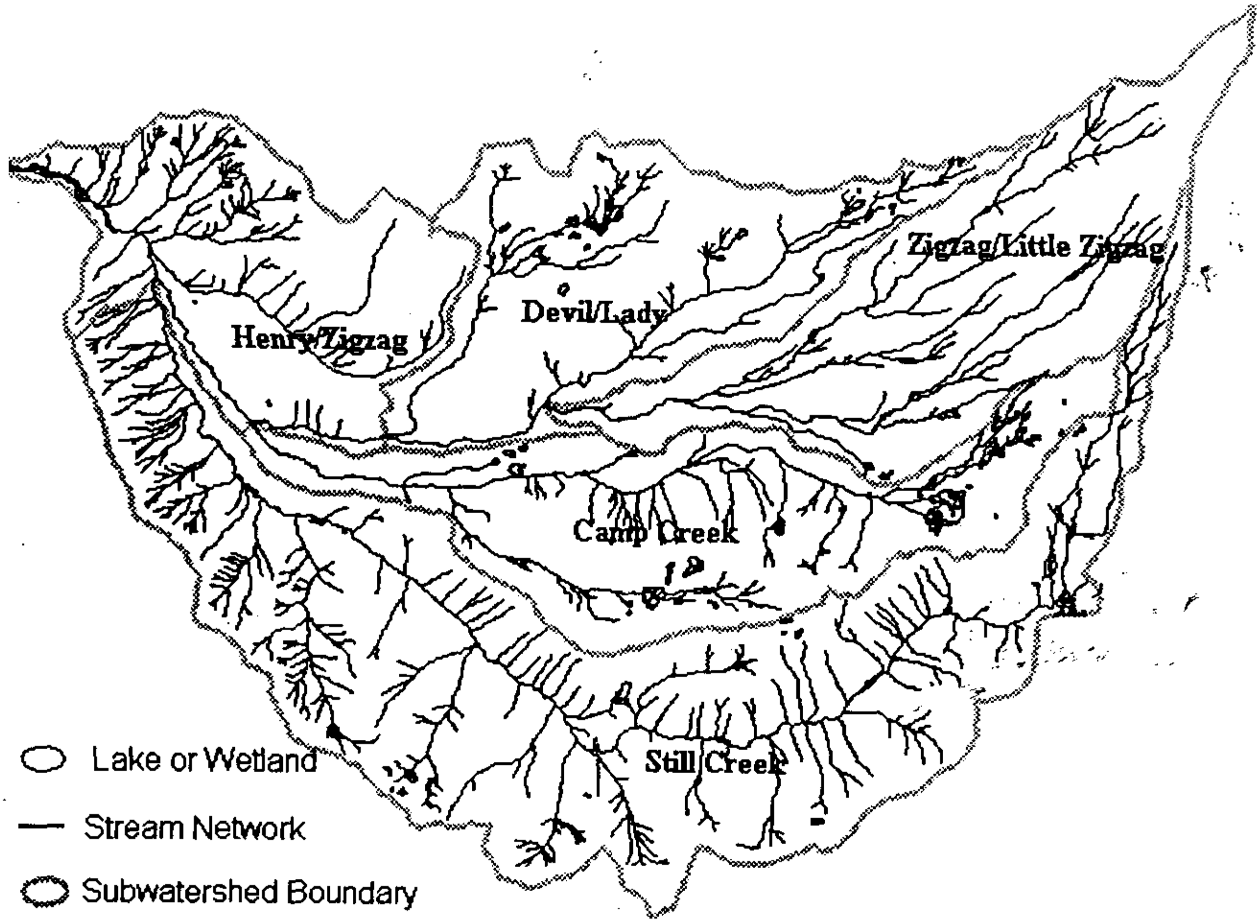


Figure 4-22 -- Stream Network and Subwatersheds



Approximate annual precipitation in the Zigzag Watershed ranges from 130 inches at its highest elevations, to 65 inches in the upper Still Creek drainage (See Figure 4-24). The greatest precipitation occurs from November through January, and the least amounts are recorded from July through August (See Figure 4-23).

Figure 4-23 -- Precipitation at Government Camp (1952-1994)

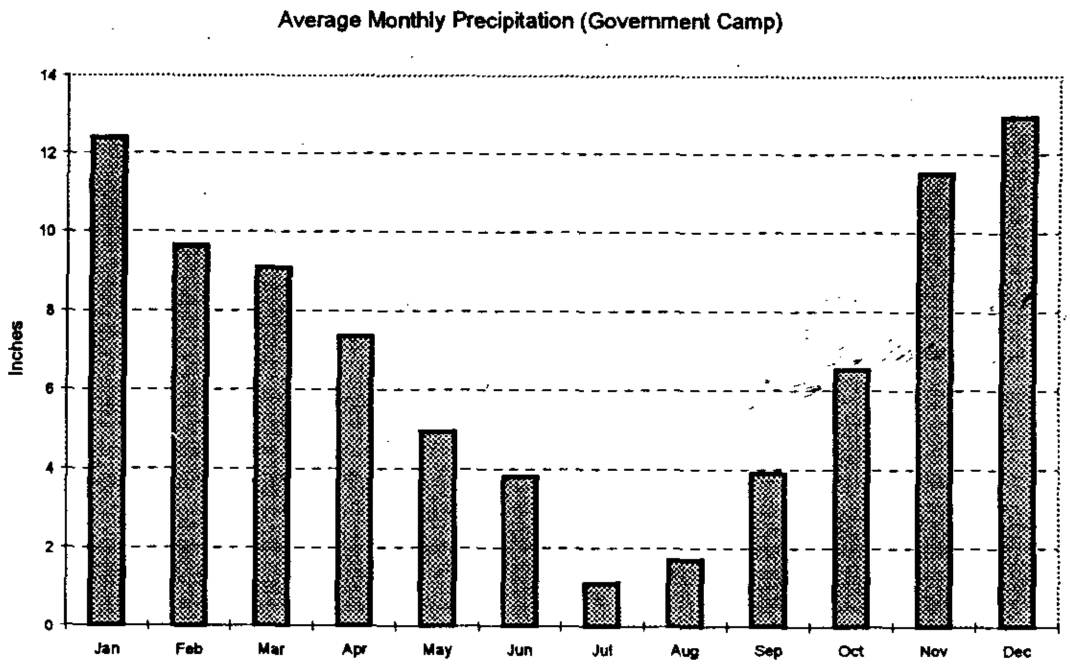
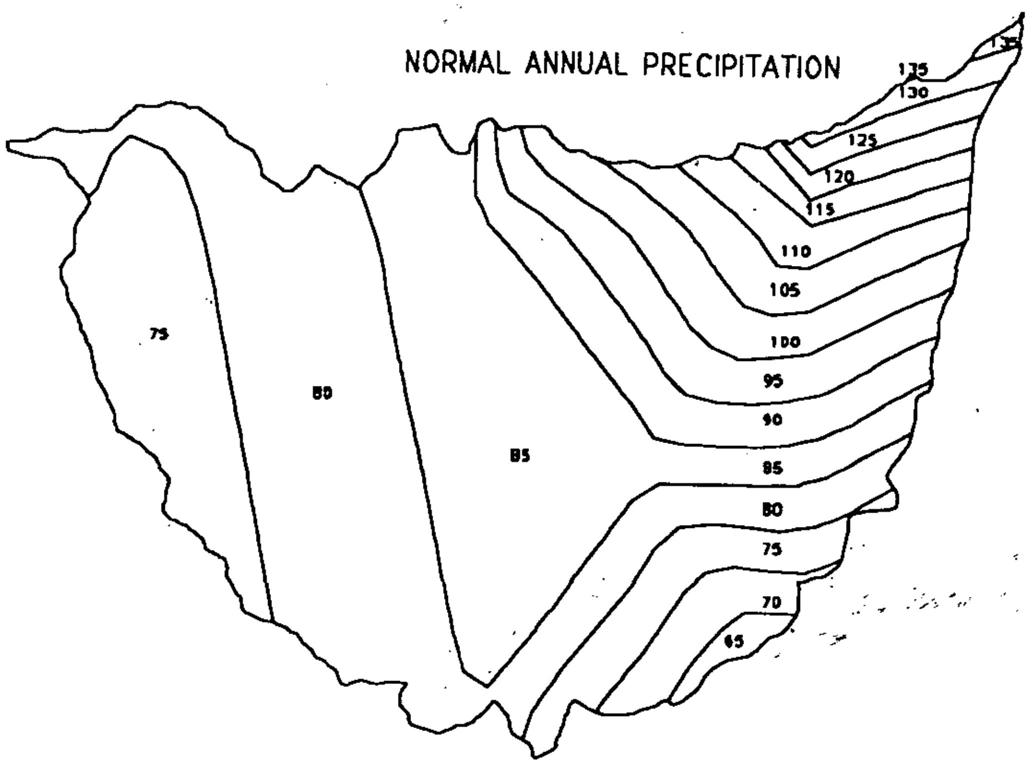
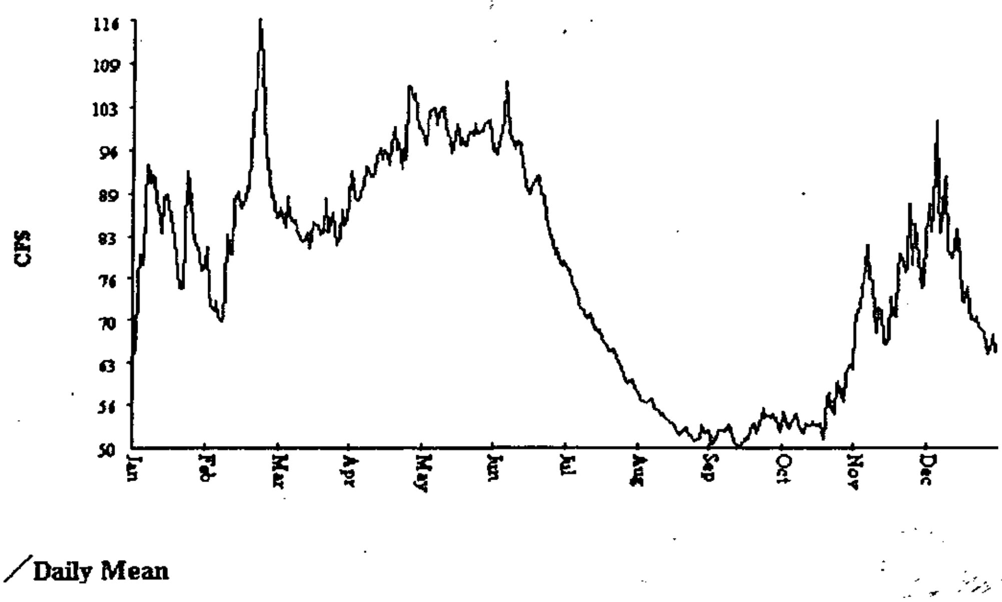


Figure 4-24 -- Annual Precipitation (inches)



Mount Hood sustains a year-round snowpack in its highest elevations. This directly affects stream discharge into the Zigzag River, Camp Creek and Still Creek by providing water storage over the winter, and supplementing flows during the summer. Figure 4-25 details the average daily discharge into the Zigzag River from 1981 to 1994. The data illustrate that average discharges are substantially influenced by rates of snow accumulation and snowmelt within the watershed. The highest sustained flow period occurs in May and June -- indicating runoff from snowmelt. Spikes in December and January may indicate high flows from rain-on-snow events.

Figure 4-25 -- Flow Regime for Zigzag River Near Rhododendron (1981-1994)



Flow Regime

Peakflows

Peak streamflows have important effects on stream channel morphology, sediment transport, and bed material size. Peak streamflows effect channel morphology through bank erosion, channel migration, riparian vegetation alteration, bank building, and deposition of material on floodplains. The vast majority of sediment transport occurs during peakflows, as sediment transport capacity increases logarithmically with discharge (Ritter 1978; Garde and Rangu Raju, 1985). The ability of the stream to transport incoming sediment will determine whether deposition or erosion occurs within the active stream channel. The relationship between sediment load and sediment transport capacity will affect the distribution of habitat types, channel morphology, and bed material size (EPA, 1991). Increased size of peakflows due to urbanization have been shown to cause rapid channel incision and severe decline in fish habitat quality (Booth, 1990).

Another important consideration is the impact of bankfull flow, often described as the high flow during two out of three years, or as a stream discharge having a recurrence interval of 1.5 years (Dunne and Leopold, 1978). The shape of the channel more closely reflects the bankfull width and height than it does the less frequent floods. If the bankfull flow is raised above the range of natural conditions, excess scouring can occur. If lower, the stream may not have the power to move its natural sediment load, causing sediment deposition within the watershed.

The Aquatic Conservation Strategy (ACS) gives clear direction that "the distribution of land use activities, such as timber harvest or roads, must minimize increases in peak streamflows" (B-9), in order to create and sustain riparian, aquatic, and wetland habitats, and to retain patterns of sediment, nutrient, and wood routing.

Peak streamflows of large magnitude inside the Zigzag Watershed are generated by rain-on-snow events. Significant Sandy Basin floods occurred: December 1861, November 1920, January 1923, March 1931, December 1964, January 1965, and January 1972; (Soil Conservation Service [SCS] 1976).

Approximately 78% of the Zigzag watershed is in the transient rain on snow zone from 2400 to 4800 feet. However, based on recent flood history the entire watershed was considered to be in the transient rain on snow zone.

Record floods occur predominantly during November through January. These floods are caused by: Accumulated snow at lower elevations, followed by a rapid rise in temperature; unusually high-elevation freezing levels; and heavy rainfall. In some instances, the ground is frozen prior to snow accumulation, producing more favorable conditions for high runoff (SCS 1976).

The record flood of recent history occurred in December 1964. A total of 155 homes were completely destroyed in the Sandy Basin (many of these within the Zigzag Watershed). While the flood of 1965 was not as severe as the December 1964 flood event, it occurred within one month of the December 1964 Flood. In late January 1965, warming temperatures and heavy rains melted snowpacks and produced heavy runoff in the Sandy Basin's higher elevations (SCS 1976).

The January 1972 flood produced the second-largest discharge on record for many streams within the Sandy Basin. A warming trend, intense precipitation, and low elevation snowmelt combined to produce the event. Because the snowmelt contribution to runoff decreased above the 4,000 foot-elevation (SCS 1976), this event was not as pronounced within the Zigzag Watershed.

Peakflows will be assessed for the Zigzag Watershed by:

1. Examination of trends based on the historical record from the USGS gauging station in the upper watershed.

2. Assessing changes in peakflows associated with rain-on-snow events.

3. Assessing changes in peakflows associated with increases in the stream drainage network.

Trends

Trend analysis using the Season Kendall Test Without Correction For Correlation (SKWOC) was completed for the upper Zigzag Watershed. Because the watershed's only current gauging station is located within its upper reaches, this was the only area analyzed.

Figure 4-26 -- Area Covered by Zigzag River Gauge

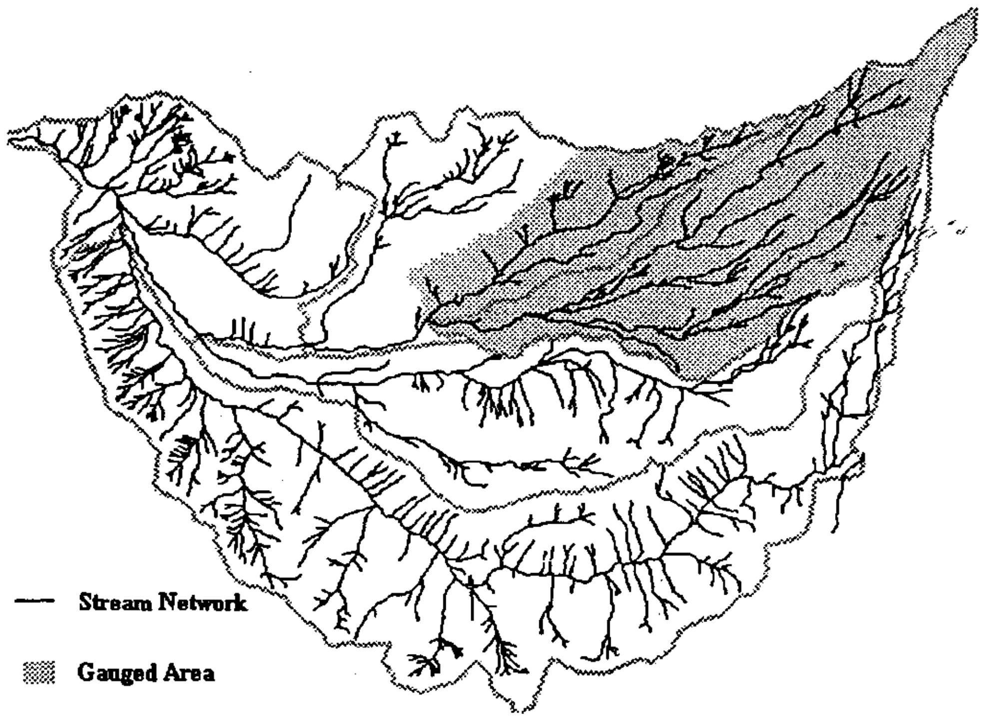
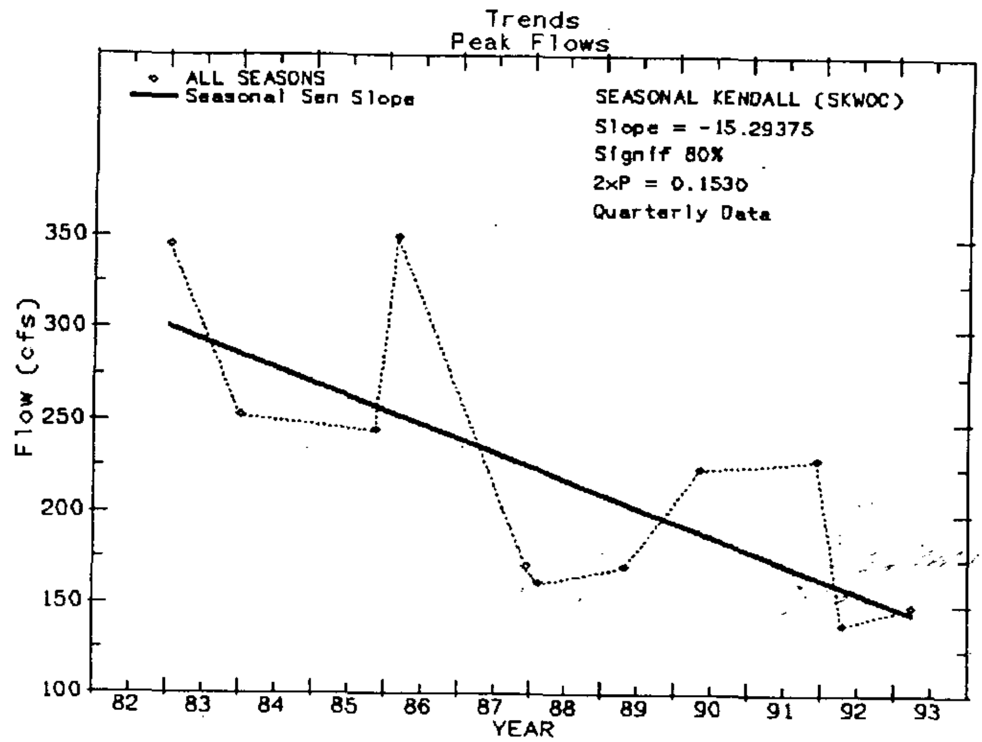


Figure 4-27 -- Peak Streamflow Trends



The trend analysis concluded a decreasing trend exists in daily maximum peak flows (slope = -15.29), statistically significant at the 80% level (based on 13 years of data). This is attributed to the increased canopy closure and stand size after fire events between the turn of the century and 1952, which has resulted in less created openings. A stand is considered hydrologically mature when its trees are 8" diameter with a 70% canopy closure. (When stands reach these parameters, they do not accumulate any more snow than an undisturbed mature stand.) Since the turn of the century, 74% of this area had burned once and 12% had burned twice.

Assessment Of Changes Due To Increased Peakflows From Rain On Snow

This assessment was completed using methodology from the Washington Department of Natural Resources (DNR) Standard Methodology For Completing Watershed Analysis (DNR, 1993). This method assumes that the greatest likelihood for causing significant, long-term cumulative effects on forest hydrologic processes is through the influence of created openings from timber harvest and roads on snow accumulation and melt. The effect of vegetation change on peakflows during rain-on-snow events is the focus of this assessment.

The primary mechanism by which forest practices affect peak streamflows is alteration of snow accumulation and melt in response to forest canopy density.

Peakflows are calculated for: 2, 5, 10, 25, 50, and 100-year recurrence interval peak streamflow events; two storm intensities (average and unusual); and three vegetative cover conditions (existing, 1944, and hydrologically recovered). The vegetative cover conditions from 1944 were modeled as a "snapshot" of historical condition, as well as to reflect fire's influences between the turn of the century and 1944.

The average storm represents a typical rain-on-snow event using average values for precipitation, storm temperature, wind speed, and snow accumulation. The unusual storm uses the average value plus one standard deviation for precipitation, storm temperature, wind speed, and snow accumulation. Hydrologically recovered conditions for vegetative cover were assumed to be 70% canopy closure of trees over 8 inches dbh in coniferous stands.

Figure 4-28 and Figure 4-29 detail changes in peakflows from a hydrologically mature condition.

Figure 4-28 -- Peak Streamflows (Current Condition)

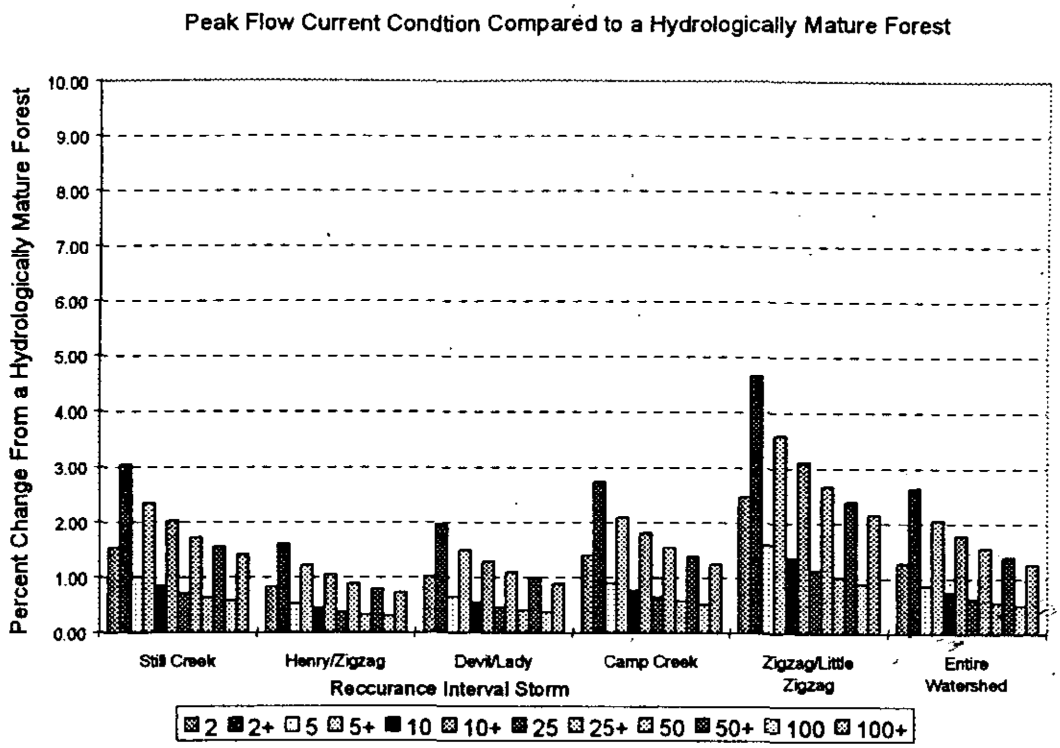
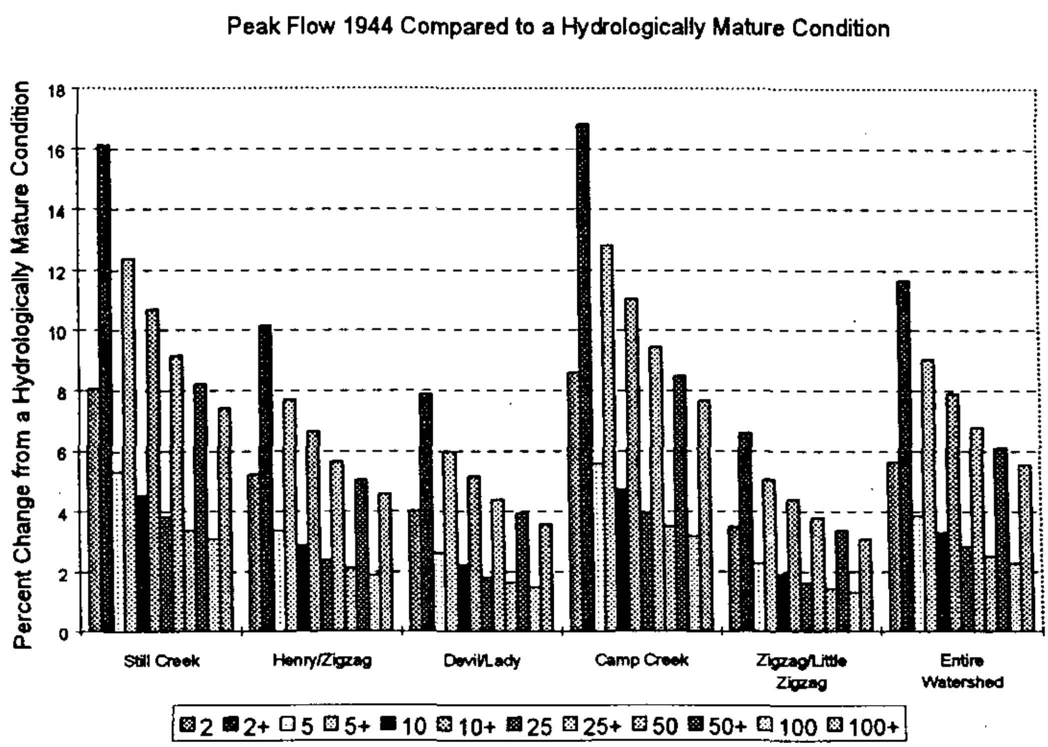


Figure 4-29 -- Peak Streamflows 1944



Results

Figure 4-28 and Figure 4-29 detail increases for different recurrence interval peak streamflows for current stand conditions, and for conditions in 1944. The largest increases are predicted for the 2+ storm. This is the storm with a two-year recurrence interval and "unusual" weather conditions.

Given the inherent error in peak flow prediction methods, the threshold of concern for increases in peakflows based on this methodology is 10%. (Using standard stream gauging methods, changes in peakflows of up to 10% are usually below detection limits.) Based on this threshold of concern, none of the subwatersheds -- or the watershed as a whole -- is at risk for adverse effects from increased peak flows. This is due to rain-on-snow events based on current stand conditions.

Based on the conditions of the watershed in 1944, and the distribution of unstable stream channels throughout the watershed, increased peakflows may have had long-term effects on anadromous fish habitat. The Zigzag River from river mile 2.2 to 7.3 is a Rosgen A3 type channel. (For a complete description on channel types, see this chapter's section on fish habitat.) These channels have: a high sensitivity to disturbance from changes in streamflow magnitude, a poor natural recovery potential, high sediment supply, and high streambank erosion potential. From river mile 2.2 to 7.3, the Zigzag River is located in an area of pyroclastic flow and debris deposits which consist of pebbles, cobbles and boulders in a gray sandy matrix. Areas of unstable channels within volcanic mudflow deposits have the potential to be very unstable due to the compounding effects of the unstable landform on the unstable channel type.

The effect of increased peakflows on the mobilization and scour of stream bed sediments and resulting disruption of the egg incubation environment (redds) is a concern within the Zigzag Watershed's anadromous sections. Salmonids generally bury most of their eggs at depths exceeding the mobile stream bed layer for the two-year flood. Evolutionary strategy would suggest an advantage to burying eggs at depths below the two-year storm mobile bed layer, since scour frequency at shallower depths could affect populations on a nearly annual basis.

Therefore, increasing the 2+ year recurrence peak flow event by 11.7% (based on 1944 stand conditions) across the entire watershed may have scoured redds on a nearly annual basis. Larger floods with greater volumes and duration of flow may cause deeper than "normal" scour of the gravel. However, while these storms occur less frequently and have a lower probability of affecting the entire population, they, nonetheless, could have significant effects on the brood during the years in which they occur (DNR, 1993).

Stream Drainage Network Expansion

Current research suggests roads function hydrologically to modify streamflow generation in forested watersheds by altering the spatial distribution of surface and subsurface flowpaths. Observations suggest roadside ditches and gullies function as effective surface flowpaths which substantially increase drainage density during storm events (B. Wemple, 1994). This increase in drainage density may effect the timing, duration and frequency of peak streamflows. An assessment of the increase in the channel network due to inboard ditches along roads has been completed using methodology that was developed on the Siskiyou National Forest (Elk River WA, 1994).

Channel network expansion is calculated by counting the number of stream crossings within a watershed, multiplying that number by the distance to the first culvert up from the stream crossing, and adding that distance to the stream network. This procedure adds the ditchlines from the stream crossing up to the first ditch relief culvert to the stream system. For this analysis, it was assumed ditchlines on both sides of the stream crossing contributed to the increase in the stream network. Because exact culvert spacing for the subwatersheds could not be determined, channel network expansion was calculated for 200, 250, and 300 feet culvert spacing. Culvert spacing on Still Creek Road (Forest Service Road #2612) was calculated to be 558 feet. Therefore, a 500-foot culvert spacing was used for analysis of the Still Creek subwatershed.

This analysis indicates that there have been significant (greater than 10%) increases in the stream drainage network in Still Creek and Henry/Zigzag subwatersheds.

Figure 4-30 -- Stream Drainage Network Expansion

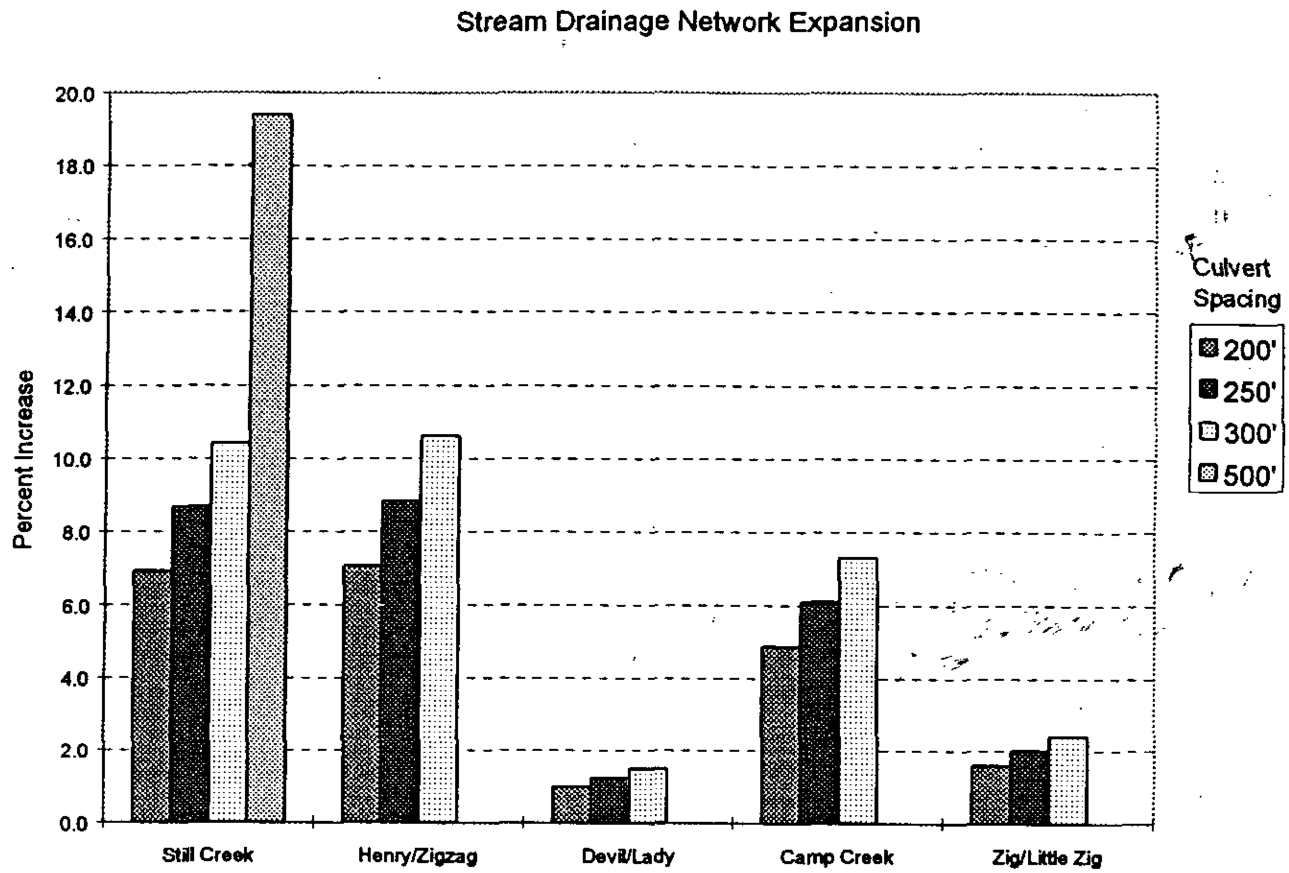


Table 4-10 Road Density and Proximity to Streams

Subwatershed	Road Density (miles/sq mile)	% Within 300' of Streams
1 Still Crk	1.30	51
2 Henry/Zigzag	2.59	36
3 Devil/Lady	0.47	51
5 Camp Crk	2.14	22.
6 Zig/Lit Zig Can	0.54	52

Road densities within the subwatersheds are less than 2.5 miles per square mile (with the exception of Henry/Zigzag subwatershed). Many of the watershed's roads, however, are within 300 feet of streams. In addition, many roads in the watershed are adjacent to the main drainages (Still Creek, Zigzag River, and Camp Creek), which requires that tributaries to these drainages flow across the road to get to the main channel (increasing the number of stream crossings). Still Creek has low road densities (1.3 miles of road per square mile) and high levels of stream drainage network expansion -- attributed to this area's roads being located in riparian areas with many stream crossings.

The Henry/Zigzag subwatershed has higher road densities (2.6 miles of road per square mile), which accounts for the increases in the stream drainage network in this area.

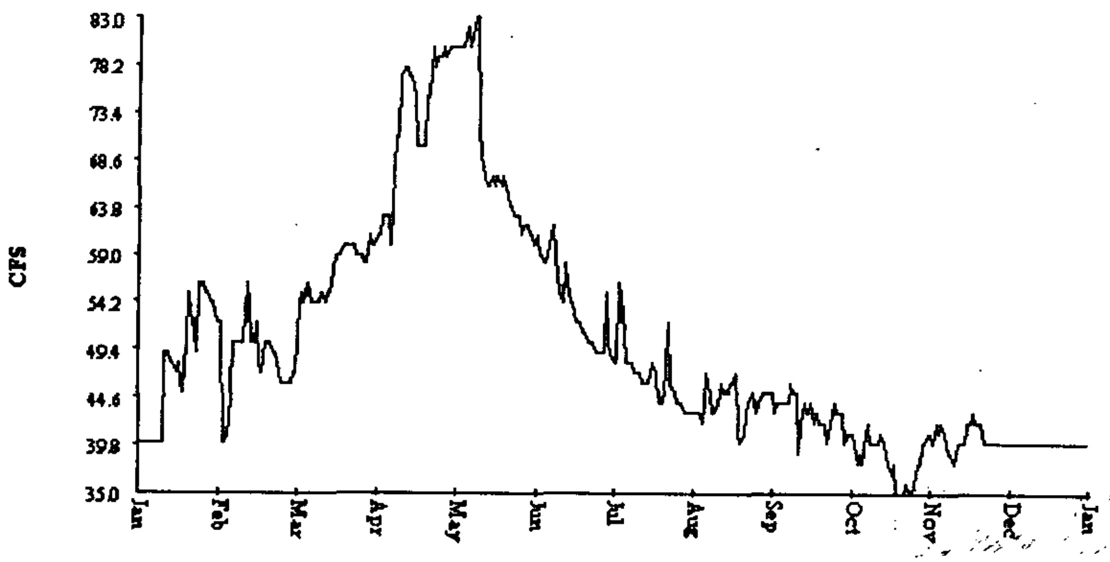
Conclusions Regarding Peakflows

Peak streamflows in the Zigzag Watershed appear to be on a decreasing trend. This is attributed to the increased canopy closure and size of stands after fire events between 1900 and 1952 that resulted in less created openings. Stream drainage network expansion is of concern in this watershed, especially in the Still Creek area, in which more than 50% of the roads are located within 300 feet of streams.

Baseflows

Baseflows are a critical component in maintaining aquatic habitat and wetlands in the Zigzag Watershed. The Aquatic Conservation Strategy (ACS) requires that lands be managed to maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation within wetlands and meadows.

Figure 4-31 -- Minimum Flows (Daily Average) Zigzag River (1981-1994)



⁄ Daily Minimum

Figure 4-31 details the Zigzag River's daily minimum flows at the USGS gauging station. The river's lowest daily average flows occur in mid-October, indicating that summer flows are regulated by snowmelt and the Zigzag Glacier.

Figure 4-32 -- Minimum Flows (30-day duration) Zigzag River

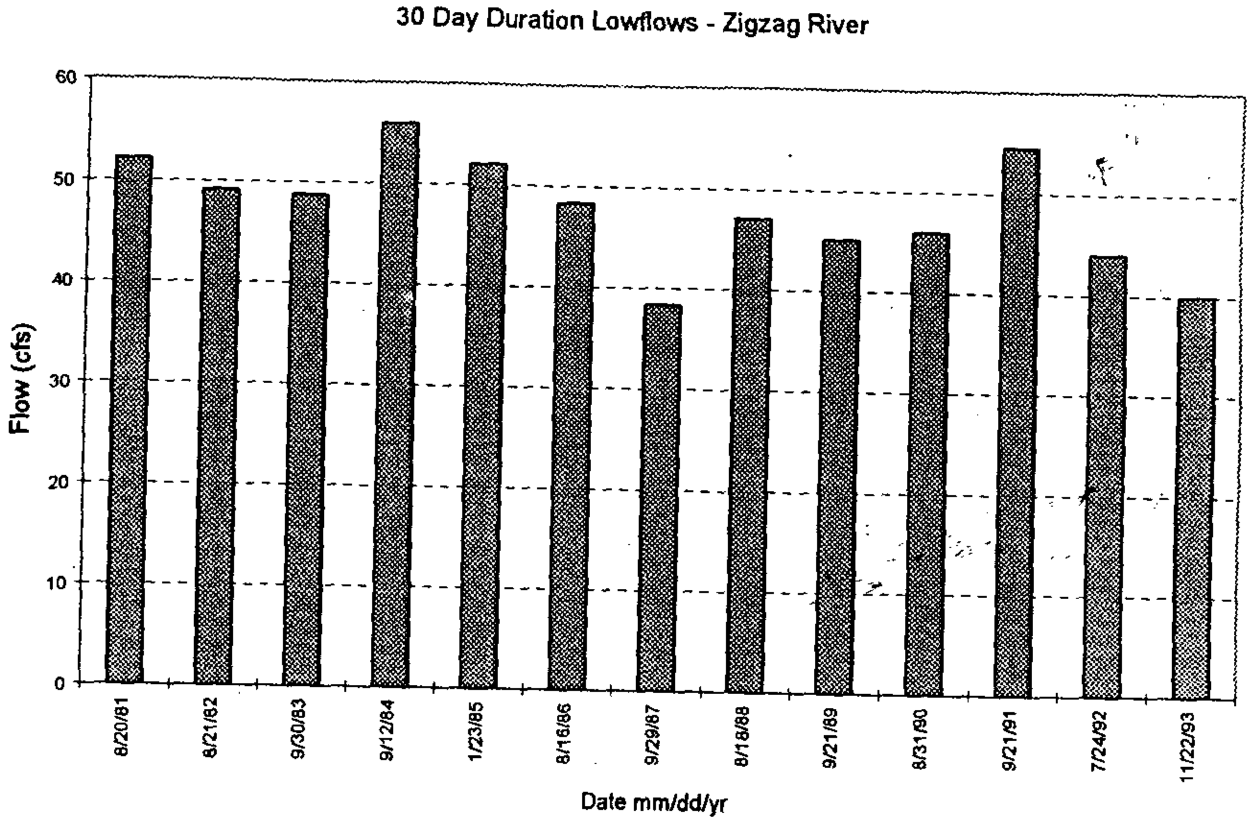
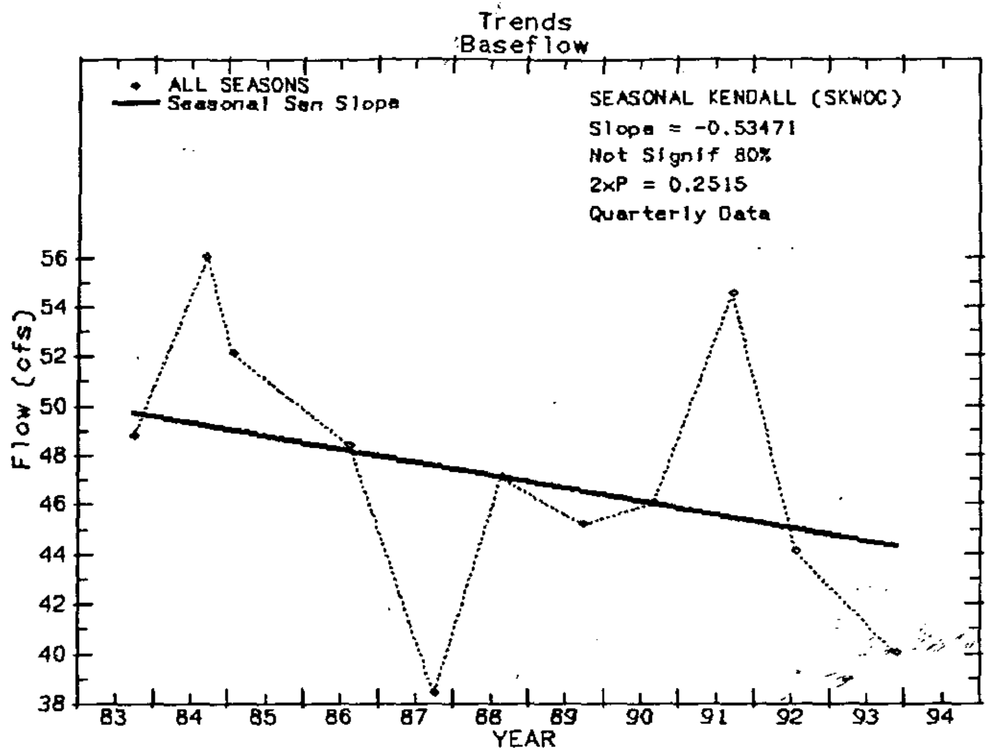


Figure 4-32 details 30-day duration minimum flows, most of which occur in August and September -- indicating that the longer duration low flow periods are earlier than the one-day daily average, and are not as influenced by snowmelt.

Baseflows were evaluated at the Zigzag River's USGS gauging station by determining the average daily low flow in cubic feet per second for a 30-day duration. The values for minimum flows were calculated using a Log Pearson Type III distribution of the daily values from the gauging station. This 30-day duration was used because it was believed to reflect the influence of baseflows on maintaining inundation and water table elevation in wetlands and meadows.

To assess a trend in the baseflow regime, the Season Kendall Test Without Correction For Correlation (SKWOC) was completed. This test compares solely those data points within the same season (3 months). The final test statistic is composed of a linear combination of individual statistics from different blocks. The results are displayed in Figure 4-33.

Figure 4-33 -- Baseflow Trends



The trendline from this analysis indicates a decreasing trend in baseflows, however, this trend is not statistically significant at the 80% significance level. Based on the SKWOC test results and the limited data on baseflows (1981-1993), a conclusion about baseflow trends cannot be made.

There are a number of domestic water rights on streams within the Zigzag Watershed which have the potential to alter the baseflow regime by removing water from streams during low flow periods.

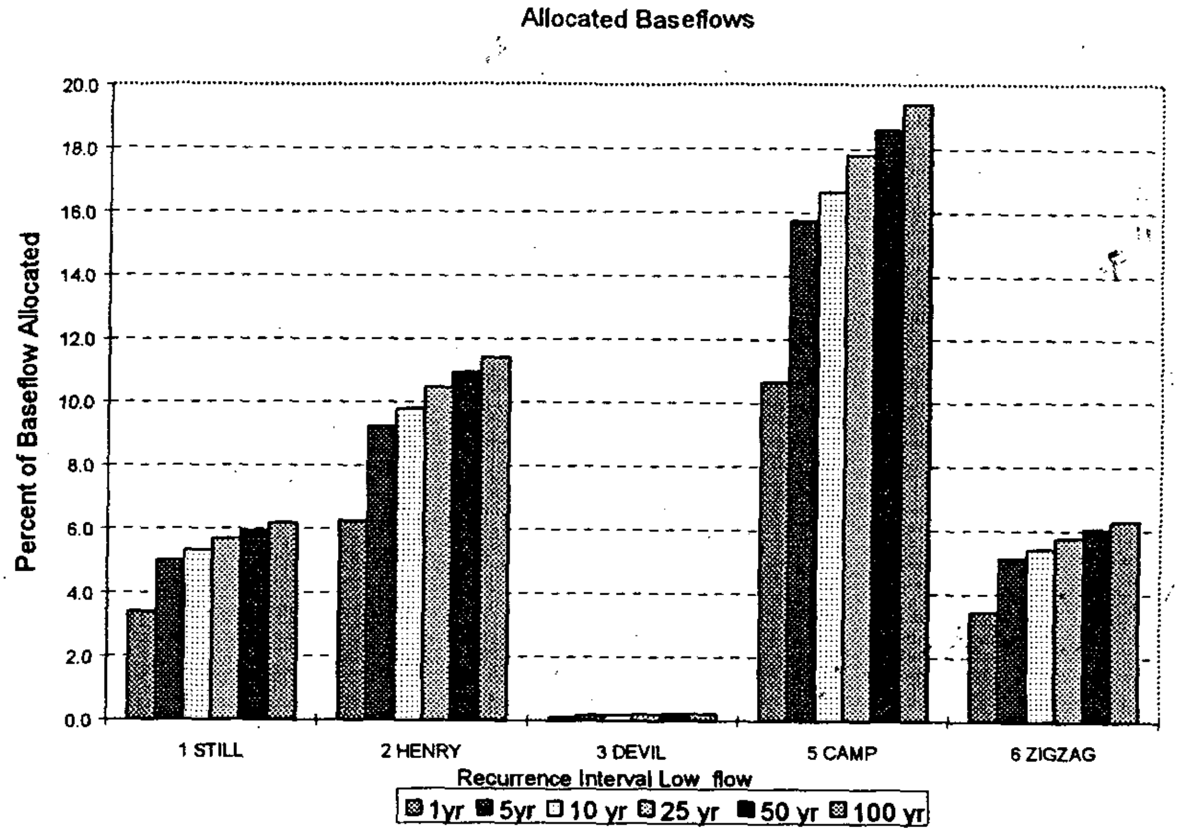
Table 4-11 -- Water Rights

Subwatershed	Use Type	Amount (cfs)
Still	DO	3.315
Henry	DO	2.12
Devil	DO	0.05
Camp	DO	3.405
Zigzag	DO	1.50
Camp	IM	0.90
Camp	TC	0.19

Use Types
DO-Domestic Water Supply
FI-Fish
FP-Fire Protection
TC-Temperature Control
IM-Manufacturing

To assess the effect of water withdrawals on baseflows, the total allocation for primary water rights was removed from the baseflows in each subwatershed. Baseflows were based on the 30-day duration average low flow. Baseflows for each subwatershed were calculated by figuring the per-acre contribution to baseflows in the gauged area of Zigzag River, and applying that figure to the subwatersheds.

Figure 4-34 -- Percent of Baseflows Allocated



With the exception of Camp Creek, less than 12% of the baseflows of any subwatershed are allocated. Camp Creek subwatershed has 10-20% of the baseflows allocated, based on recurrence interval low flow. This is of concern because of the wetlands in the upper subwatershed and anadromous fish habitat in the lower subwatershed that is maintained by low flows.

Sediment Production

Surface erosion occurs when the mineral soil surface is exposed to water from rainfall, snowmelt or runoff. Compacted surfaces increase runoff velocity and susceptibility to erosion. In forested ecosystems, trees, understory vegetation and litter and duff combine to effectively protect most soil surfaces from surface erosion. Surface erosion can result in reduced soil productivity. In addition, transport of eroded materials to water resources such as stream channels can reduce water quality and diminish aquatic habitat. Soil erodibility is influenced by soil characteristics that affect infiltration, permeability, water holding capacity, and aggregate stability. The transport of eroded materials to a water body is influenced by a number of site-specific factors: slope gradient, slope length and shape, surface roughness, vegetation cover, texture of the eroded material, delivery distance, and concentration of the water flow (USEPA-USDA Forest Service, 1980).

Mass Wasting

Mass wasting occurs under natural conditions on the steeper slopes adjacent to Zigzag and Hunchback mountains, Eureka Peak, Wolf Camp Butte, and the south side of Tom, Dick and Harry Mountain. Debris slides tied to high intensity rainstorms are the predominant process. The contribution of these events to the sediment regime is infrequent and episodic. Additional mass wasting occurs on the unconsolidated materials within the watershed. These deposits fan out from the summit of Mount Hood and continue down the mainstem of the Zigzag River to just before the Sandy River confluence. As relatively young, sandy and gravelly materials, these landforms have little internal cohesion and high potential for erosion. Where these slopes are gentle to moderate gradient and well-vegetated slopes, they are stable on the landscape. The steeper stream-adjacent and unvegetated slopes of this landform are highly effective at sediment delivery. The sediment contribution from these slopes is characterized as periodic debris slides and channel-adjacent failures.

Accelerated rates of mass wasting from forest management activities was not shown to be a major contributor to an sediment regime in the Zigzag watershed. Therefore, analysis of the sediment regime will focus on the evaluation of increased surface erosion from management activities.

Surface Erosion

Natural rates of surface erosion in forested watersheds is measured to be quite low (Swanson, F. and G. Grant, 1982; USEPA-USDA Forest Service, 1980). Surface erosion in the watershed is tied to processes which disturb soil litter and duff cover. The series of high intensity fires (1901, 1908, 1910, 1915, 1933/1934) that burned over large acreage's of the watershed would have generated a sediment pulse each winter following the initial disturbance. Surface erosion would have returned to post fire rates as surface covering vegetation became reestablished.

More recent disturbances to soil cover include roads, timber harvest, site preparation, and recreational uses. These disturbances create chronic, long-term supplies of sediment within the watershed. Methods used to evaluate the altered surface erosion rates within the watershed closely follow those described in the Washington Forest Practices Board Manual: Standard Methodology for Conducting Watershed Analysis (DNR, 1993). Assumptions are included in the analysis file. In addition to sediment production from surface erosion, sand applications to snow-covered highway surfaces are a chronic source of sediment in the watershed. Actual rates of sand application were taken directly from Oregon Department of Tranportation records.

Only those sediment sources with high potential for delivery were considered in this process. Sediment production that was not within the delivery zone to perennial streams was not calculated for this analysis.

Results

Results presented below suggest existing roads and highway sanding are the largest contributors to potential sediment in the watershed. Total road miles, as well as landform and proximity to water resources, were factors that most influenced predicted sediment levels from existing roads by subwatershed. (Table 4-10 summarizes road related sediment information.)

Highway Sanding

Potential sediment from highway sanding was computed using actual application rates obtained from the Oregon Department of Transportation. Highway sanding contributes direct sediment input into the Still Creek, Henry/Zigzag, and Camp Creek subwatersheds. The effectiveness of mitigation measures to reduce runoff of sand directly from the highway to the river and its tributaries was not quantified for this analysis. Field observations confirm the sediment barriers along Highway 26 are partially effective in reducing sand input to stream-adjacent slopes. However, residual sand deposits (presumably from the previous winter) up to several inches thick were observed directly downhill of these barriers. Per-mile sanding rates were assumed to be greatest in the watershed's higher elevations, as well as where the road surface grade was highest.

Modeled estimates of sediment transport considered roads within 300 feet horizontal distance of streams within the watershed. While steep slopes along Highway 26 receiving highway sand within 300 feet slope distance may be effective in delivering sand to streams, they were not considered in the estimates.

Highway 26 travels 12.32 miles through the Zigzag Watershed. Highway 26 is within 300 feet (horizontal) of streams for 3.88 miles in the watershed. The highway is within 300 feet (horizontal) of Camp Creek for 1.67 miles, and within 300 feet (slope distance) for an additional mile.

The largest road cut and fill slopes within the watershed are those along Highway 26 adjacent to Camp Creek. Many of these cut and fill slopes are poorly vegetated and/or covered with residual highway sand during the fall and spring.

Table 4-12 – Road Related Sediment Contribution by Subwatershed

SUBWATERSHED	TOTAL ROAD MILES	ROAD DENSITY	MILES WITHIN 300 FEET OF STREAMS	ESTIMATED ROAD SEDIMENT (Tons/Year)	HIGHWAY SANDING SEDIMENT (Tons/Year)
Still Creek	29.37	1.30	15.08	328.33	693.77
Henry/Zigzag	20.24	2.59	7.24	160.01	121.69
Devil/Lady	4.19	0.47	2.15	25.15	0.00
Camp Creek	20.77	2.14	4.61	285.87	2102.14
Zigzag/Little Zigzag Canyon	5.44	0.54	5.70	331.76	406.40
Watershed Total	80.01	1.36	34.78	1348.90	3324.00

Road Sediment

Highway 26 and Still Creek Road (Forest Service Road #2612) are the roads with the highest potential for sediment delivery within the watershed. Field measurements were taken along these roads to determine effective ground cover and road cut and fill acreage. Estimates of road cut and fill slopes were used for all other roads. Vegetation along Still Creek Road includes dense shrub cover on some cut and fillslopes and within the ditchline. While brush in the ditchline is effective at reducing sediment supply and transport, it is also effective at diverting waterflow along the road surface, contributing to road surface erosion.

Frequent culvert failures and subsequent washout of Still Creek Road's surface along Still Creek have been observed to contribute large pulses of sediment during intense winter storms. Quantities of sediment from culvert failures were not calculated for this process.

While road densities within the Zigzag Watershed are low, many roads in the watershed run parallel to major streams and have the potential to effectively contribute to reduced water quality and habitat degradation. Model results for individual roads can be used to prioritize roads for field evaluation and restoration or improvements.

Table 4-13 – Potential Sediment Contribution from Recreation and Harvest Activities

SUBWATERSHED	SUBWATERSHED ACRES	RECREATION (tons/year)	HARVEST (tons/year)
Still Creek	14412	8.00	0.00
Henry/Zigzag	4994	5.16	15.12
Devil/Lady	5708	.21	
Camp Creek	6225	8.53	0.00
Zigzag/Little Zigzag Canyon	6390	13.31	0.00
Total	37729	35.21	15.12

Recreation

Recreation activities within the watershed can also contribute to increased potential for surface erosion. Unvegetated ski slopes, campgrounds, and some trails can contribute to surface erosion. While the amount is significantly lower than that from roads and highway sanding, recreation sites are often directly adjacent to water resources. The table above summarizes the estimated sediment contribution of recreational related sediment. Revegetation and reduction of erosion potential on these sites can effectively reduce direct erosion and sediment transport.

Harvest

Natural revegetation following timber harvest is assumed to be effective in reducing erosion within five years of the ground disturbance. There were no timber harvest activities within the last five years on national forest lands within the Zigzag Watershed. In the Henry/Zigzag subwatershed, 150 acres of private land were harvested in 1992 and 1993. Results from sediment modeling for harvest are shown in Table 4-13. Erosion rates from harvest activities are anticipated to return to undisturbed levels five years following the disturbance.

On a per area basis, of all the Zigzag Watershed's subwatersheds, Camp Creek has the highest modeled sediment yield. For its small size (6,390 acres) Zigzag/Little Zigzag Canyon subwatershed has the next highest sediment yield per area, followed closely by Still Creek. Effective measures to reduce both the production and transport of sediment within these drainages would be efficacious in these drainages.

Table 4-14 -- Summary of Estimated Sediment Yield (tons/year)

SUBWATERSHED	ROAD SEDIMENT	HIGHWAY SANDING	RECREATION	HARVEST	TOTAL
Still Creek	328.33	693.77	8.00	0.00	1303.10
Henry/Zigzag	160.01	121.69	5.16	15.12	301.98
Devil/Lady	25.15	0.00	.21		25.36
Camp Creek	285.87	2102.14	8.53	0.00	2396.54
Zigzag/Little Zigzag Canyon	331.76	406.40	13.31	0.00	751.47

Sediment Deposition

The consideration of sediment production at the subwatershed level can assist in the identification of priorities for mitigation and restoration. In order to assess the potential impact on in-channel habitat, low gradient reaches which provide habitat for aquatic species of concern were identified. As the following map displays, depositional reaches are often associated with stream junctions.

Key depositional reaches were identified to simplify the analysis. For these key reaches, cumulative sediment delivery and deposition to those points was computed. The key reaches and their estimated sediment deposition are listed in Table 4-15. Fine sediment delivery to stream channels and transport to depositional reaches within the watershed can alter substrate competition important to aquatic species (invertebrates, amphibians, fish, and plants).

Figure 4-35 – Key Depositional Reaches within the Watershed

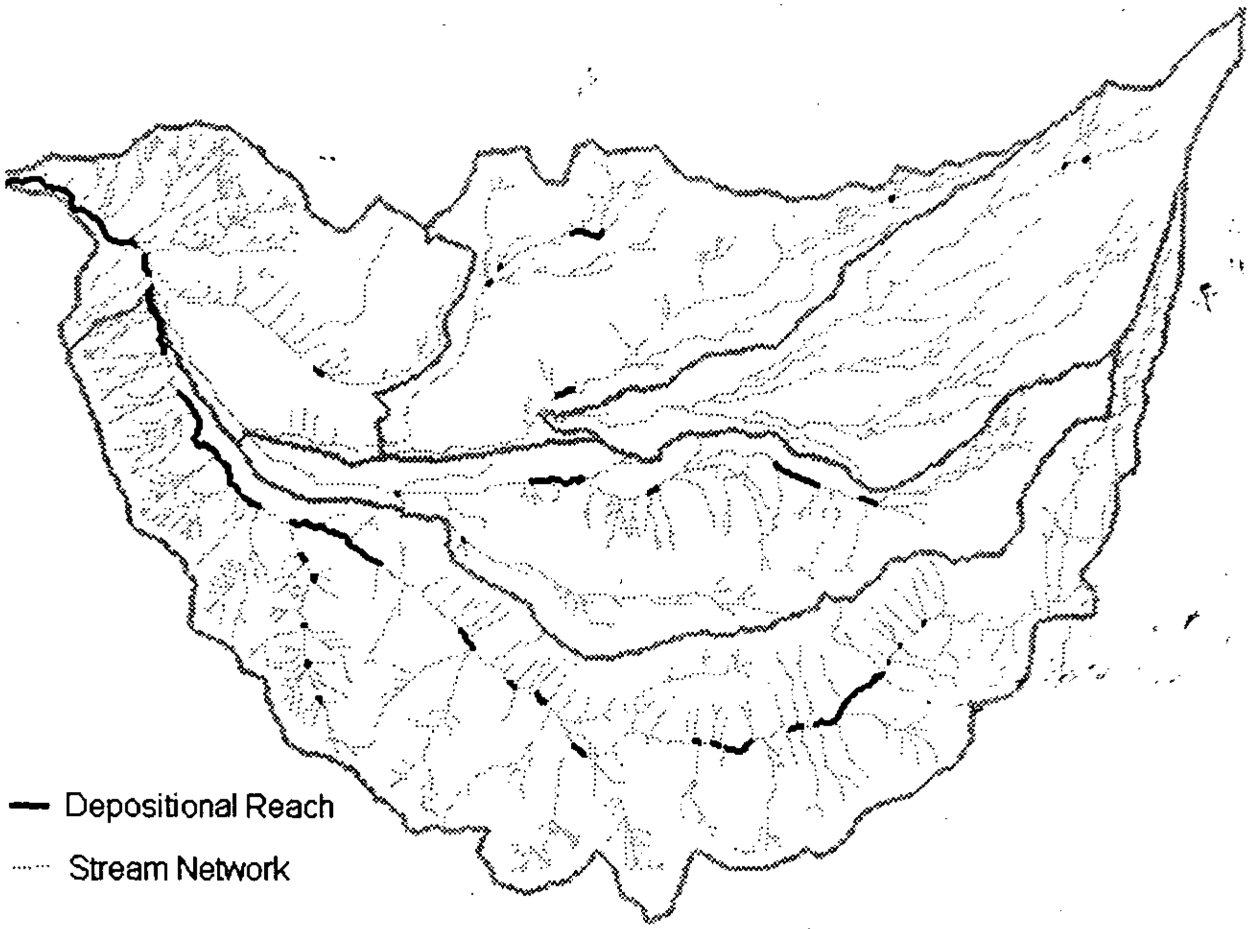
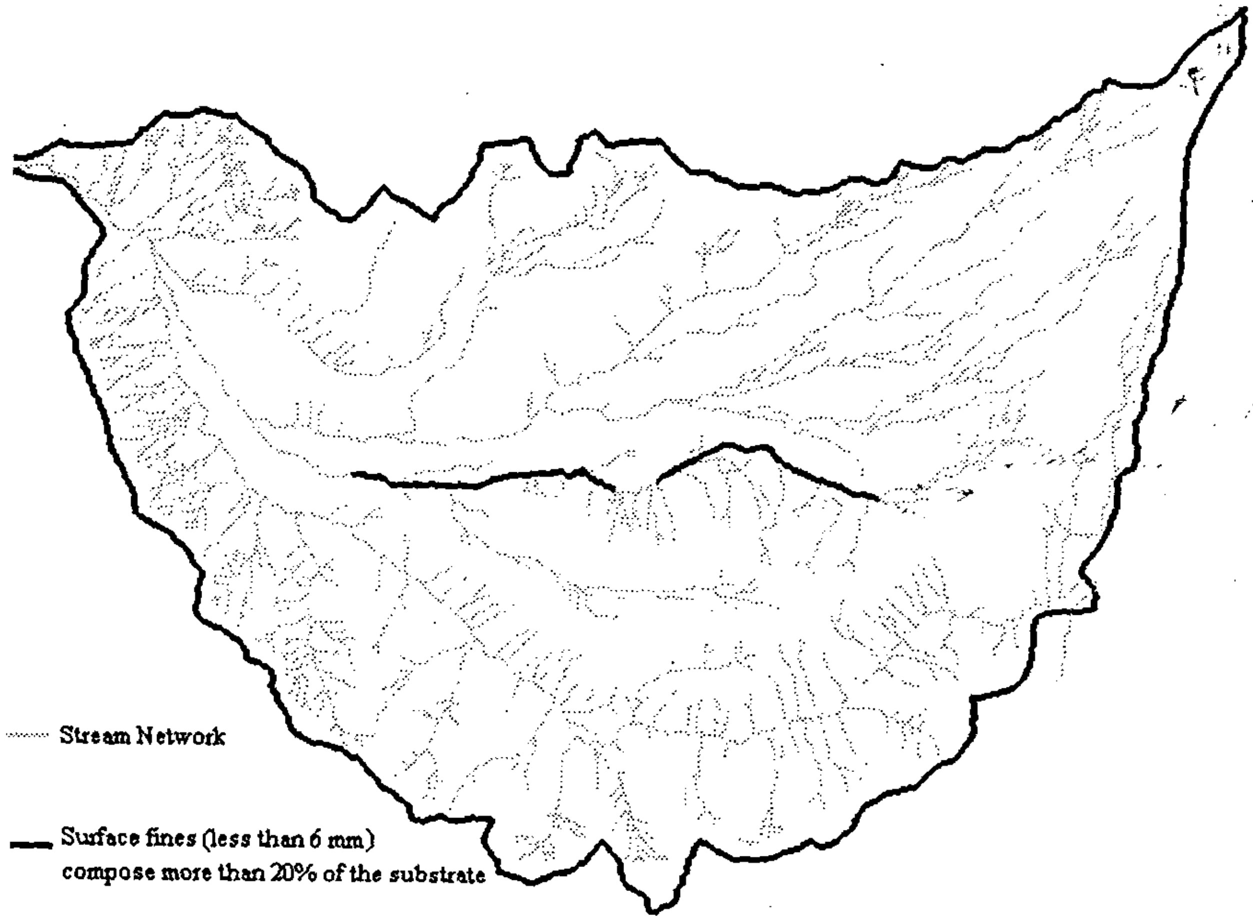


Table 4-15 – Cumulative Sediment Deposition at Key Reaches

KEY DEPOSITIONAL REACH	ACRES	ESTIMATED SEDIMENT DEPOSITION (Tons/Year)
Still Creek Key Site Riparian	3968	950.37
Still Creek at confluence with Zigzag River	10714	352.73
Camp Creek below Laurel Hill	3782	531.48
Zigzag River at confluence with Sandy River	19536	2943.87

As can be seen from the Cumulative Sediment Delivery summary, the Zigzag River at its confluence with the Sandy River has the highest overall sediment delivery. Still Creek at the KSR has the highest per area impact. When examined on a per area basis, it is clear that there is a concentration of sediment production from management related sources above this reach. Sediment production upstream of the Camp Creek reach indicates a concentration of sediment input occurs above this management reach as well. (Effects of sediment deposition on aquatic resources is described in Chapter 6.)

Figure 4-36 - Depositional Reaches Where Fine Sediment Levels Exceed Forest Plan Standards



Conclusions Regarding Sediment

Restoration priorities to reduce sediment within the watershed should focus on the greatest potential sources previously identified: highway sanding and roads. Highway sanding produces the largest single impact to the sediment regime in this watershed. Restoration efforts that significantly reduce transport to stream channels would be efficacious. Sediment from road surfaces and cut/fill slopes is a great concern in all the subwatersheds. While overall road density in the watershed appears low, most roading has taken place directly adjacent to major streams and tributaries. Reducing sediment from roads can be prioritized by proximity to stream, surfacing type, cut and fill slope vegetation, and landform. While modeled erosion rates for sediment supply from recreation sites were low, particular sites within ski areas and campgrounds have direct effects to aquatic resources. Revegetation and hardening of these sites would assist in the reduction of erosion and improve aesthetics. (Recommendations for restoration priorities are explained in Chapter 7.)

Water Quality

Water quality was assessed at three scales:

1. Watershed-wide for deviations of Sandy Basin Water Quality Standards, LRMP Standards, and ACS Objectives.

2. Subwatersheds for assessment of nonpoint pollution sources, including sediment and water temperature.

3. Point sources for point source pollution.

Watershed Scale Assessment of Water Quality

DEQ Nonpoint Source Assessment

Initial assessment of water quality was completed using the Oregon Department of Environmental Quality's (DEQ) Non-Point Source 1988 Assessment.

Figure 4-37 -- DEQ Stream Identifiers

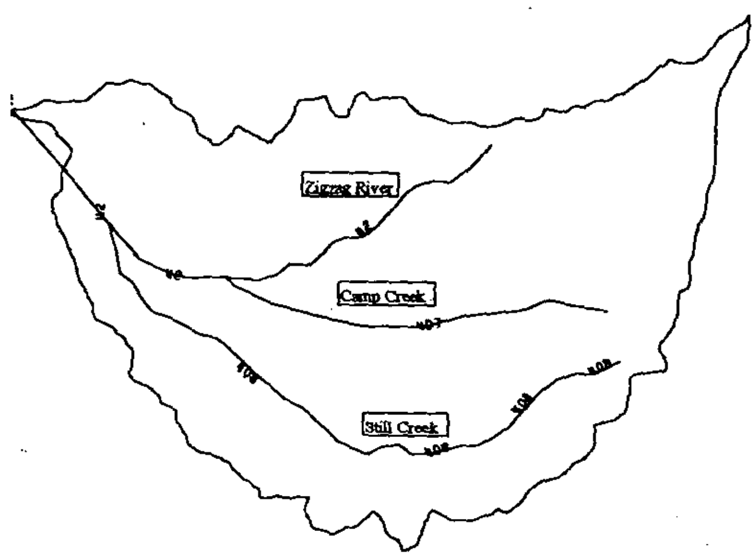


Table 4-16 -- Water Quality Concerns Zigzag Watershed (DEQ 1988)

Stream	Deq_Id	Length (feet)	Anadromous Reach	Turbidity	Sediment	Erosion	Stream Structure	Comments
Zigzag R	42	95	Yes	M2	M2	S2	M2	Glacial runoff/unstable channel/loss of woody structure
Zigzag R	42	3618	Yes	M2	M2	S2	M2	Glacial runoff/unstable channel/loss of woody structure
Zigzag R	42	3737	Yes	M2	M2	S2	M2	Glacial runoff/unstable channel/loss of woody structure
Zigzag R	42	8267	Yes	M2	M2	S2	M2	Glacial runoff/unstable channel/loss of woody structure
Camp Creek	407	10283		M1	M1	M1	M2	Sed from road cut erosion/hwy sanding/loss woody debris from 1952 fire
Still Creek	408	1204	Yes		M1	M1	M1	Sediment from hwy runoff and bank cutting/fire 1976
Still Creek	408	1754	Yes		M1	M1	M1	Sediment from hwy runoff and bank cutting/fire 1976
Still Creek	408	3706	Yes		M1	M1	M1	Sediment from hwy runoff and bank cutting/fire 1976
Still Creek	408	10428	Yes		M1	M1	M1	Sediment from hwy runoff and bank cutting/fire 1976

M1-Moderate problem; data available
M2-Moderate problem; observed
S2-Severe problem; observed

The DEQ assessment (Table 4-16) indicates moderate problems with turbidity, sediment, and stream structure; and severe problems with erosion in Zigzag River. Beneficial uses affected include cold water fisheries and water contact recreation. These problems are attributed to glacial runoff, an unstable channel, and loss of woody structure. The Zigzag River was cleaned of large woody debris and channelized after the 1964 Flood, which would account for the unstable channel and lack of large woody debris.

Camp Creek is assessed as having moderate problems with turbidity, sediment, erosion, and stream structure. Beneficial uses affected include cold water fisheries and water contact recreation. Impacts are attributed to sediment from road surface erosion and sanding on Highway 26, and loss of woody debris from the 1952 Zigzag Fire.

Still Creek is assessed with moderate problems of sediment, erosion and stream structure affecting domestic water supply, cold water fisheries, and water contact recreation. Problems are attributed to sediment from highway runoff and road surface erosion.

At the landscape level the 1988 DEQ non-point pollution assessment was felt to relfect conditions within the Zigzag watershed. Documented sources of non-point pollution including glacial runoff, unstable stream channels, highway sanding and road surface erosion have all been observed within the watershed.

Storage and Retrieval (STORET) Database

The STORET database was queried for any information on the Zigzag Watershed. There were a number entries (562) for the period 1974-1979.

Table 4-17 details locations and parameters where current water quality standards were exceeded.

Table 4-17 – Zigzag Watershed STORET Data

Site	pH	Conductance (micromhos/cm)	Turbidity (NTU's)	DO (% of saturation)	Temp (°C)
Camp Creek above Zigzag R	•	•			
Camp Creek at Laurel Hill Rockpit	•	•		•	
Still Creek .1 mile above Zigzag R	•	•		•	
Still Creek @ Still Creek Campground	•	•		•	
Still Creek Trib. 0.13 miles below sta 013	•				•
Still Creek above BDG and north of RD S12	•				
Still Creek below junction of unnamed trib Station 17	•				
Wind Creek above Mirror Lake		•	•	•	•
Wind Creek below Mirror Lake		•	•	•	•
Zigzag River above Camp Creek	•	•			
Zigzag River below Devil Canyon	•	•			
Zigzag River below Lady Creek	•	•			

pH <=6.5 or >=9.0
Conductance >100
Turbidity >=5.0 NTU's
Dissolved Oxygen <=90
Temperature > 14.0 °C

Because apparently erroneous readings were discovered in the STORET database (i.e. conductivity readings over 2,000 and dissolved oxygen at 60% of saturation), many of the same sites where water quality problems were noted were re-sampled in September 1995.

Based on the apparent erroneous readings, all the data from the STORET database was treated as suspect.

Table 4-18 -- 1995 Water Quality Monitoring (9/8/95)

Site	Temp (°C)	Conductivity (micromhos/cm)	Turb (NTU's)	Dissolved Oxygen (% of saturation)	pH
Camp Creek 8' above sewage treatment plant outfall	8.7	47	1.3	88.0	7.3
Camp Creek at outfall	14.4	195			7.3
Camp Creek below outfall	8.9	53	1.3	83.8	7.2
Camp Creek @ Mirror Lake bridge	7.9	4.2	1.2	89.1	7.3
Camp Creek @ Laurel Hill rockpit	9.8	40			7.5
Camp Creek at Zigzag River	10.6	40			7.6
Zigzag River @ Lady Creek	8.3	75			8.3
Zigzag River @ Devil Canyon (above Highway 26 bridge)	9.2	66			7.8
Zigzag River below Devils Canyon @ Highway 26 bridge	8.5	65	3.5	91.6	7.5
Zigzag River above Camp Creek					
Still Creek above summer homes	10.2	101	0.8	91	7.6
Still Creek at Zigzag River	11.2	94	0.9	92.4	7.6

Dissolved oxygen (DO) in Camp Creek from above the sewage treatment plant outfall to Mirror Lake Bridge is slightly below the state standard for the Sandy River Basin which states: "DO concentrations shall not be less than 90% of saturation at the seasonal low." The DO levels in the upper watershed are attributed to the levels of organic material associated with the wetlands in this area. The effects at the sewage treatment plant outfall disappear by the time Camp Creek flows past the Mirror Lake Trailhead.

The remaining "red flag" within the data is the turbidity reading of 3.5 NTUs in the Zigzag River at the Highway 26 bridge just east of Rhododendron. The level of turbidity is attributed to glacial runoff, not management activities. Therefore, no further assessment was completed.

Nonpoint Sources

Based on the DEQ assessment, a major source of the watershed's nonpoint pollution appears to be sediment into the stream channels from highway sanding and road cutbank erosion. Stream temperature is the other source of nonpoint pollution that will be assessed in this document.

Suspended Sediment

An increase in sediment load is often the most important adverse effect of forest management activities on streams. Large increases in the amount of sediment delivered to the stream channel can greatly impair or even eliminate fish and aquatic invertebrate habitat. These increases can also alter the structure and width of the streambanks and adjacent riparian zone (EPA, 1991).

The physical effects of increased fine sediment load can be as equally far-reaching. The amount of sediment can affect channel shape, sinuosity, and the relative balance between pools and riffles. Changes in sediment load will affect the bed material size, and, in turn, alter both the quality and quantity of the habitat for fish and benthic invertebrates (EPA, 1991).

Of particular concern in the Zigzag Watershed is the degradation of pool habitat in the anadromous section of the watershed through introduction of fine sediment. (For further discussion, see Sediment Production section earlier in this chapter.)

Temperature

Increased stream temperatures are often a concern in forested watersheds due to created openings from timber harvest, roads and recreational facilities. Direct solar radiation intercepting the stream surface is the principle factor in raising stream temperature within forested watersheds (Brown, 1969). For the most part, stream temperatures within the Zigzag Watershed are well below the state standard of 14.4^{0}C. This is based on both STORET data and water quality samples from 1995. Only two sites appear in the STORET data with stream temperatures over 14.4^{0}C, a tributary to Still Creek and a tributary to Wind Creek below Wind Lake. (The tributary to Still Creek could not be identified based on the description in the database.) Because Wind Lake's water is heated by intercepting solar radiation, these temperatures in Wind Creek may be the natural condition.

Stream Shade

Management activities have the potential to alter the amount of solar radiation intercepted by the stream surface through altering riparian vegetation and channel form. To assess the effects of management on stream shade and the associated increase in solar radiation intercepted by the stream surface, canopy closure within the Riparian Reserves was calculated by subwatershed.

Figure 4-38 -- Stream Shade Distribution

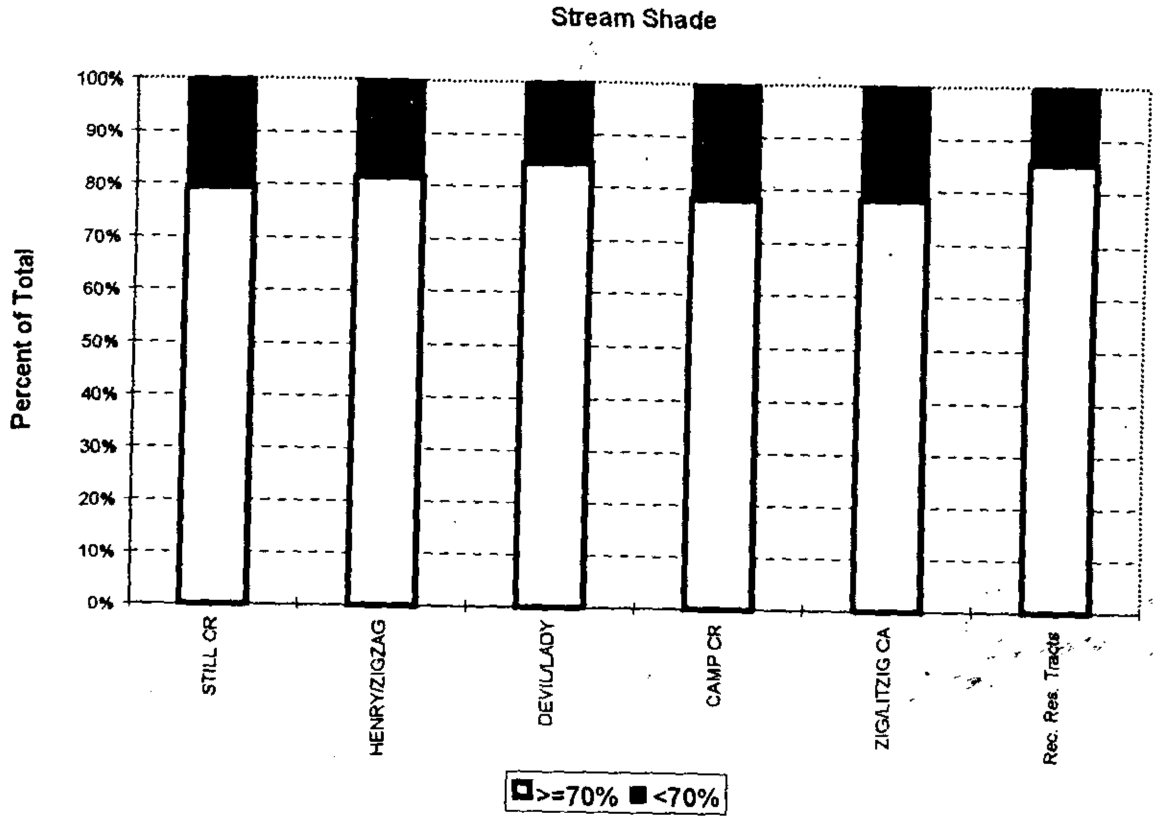
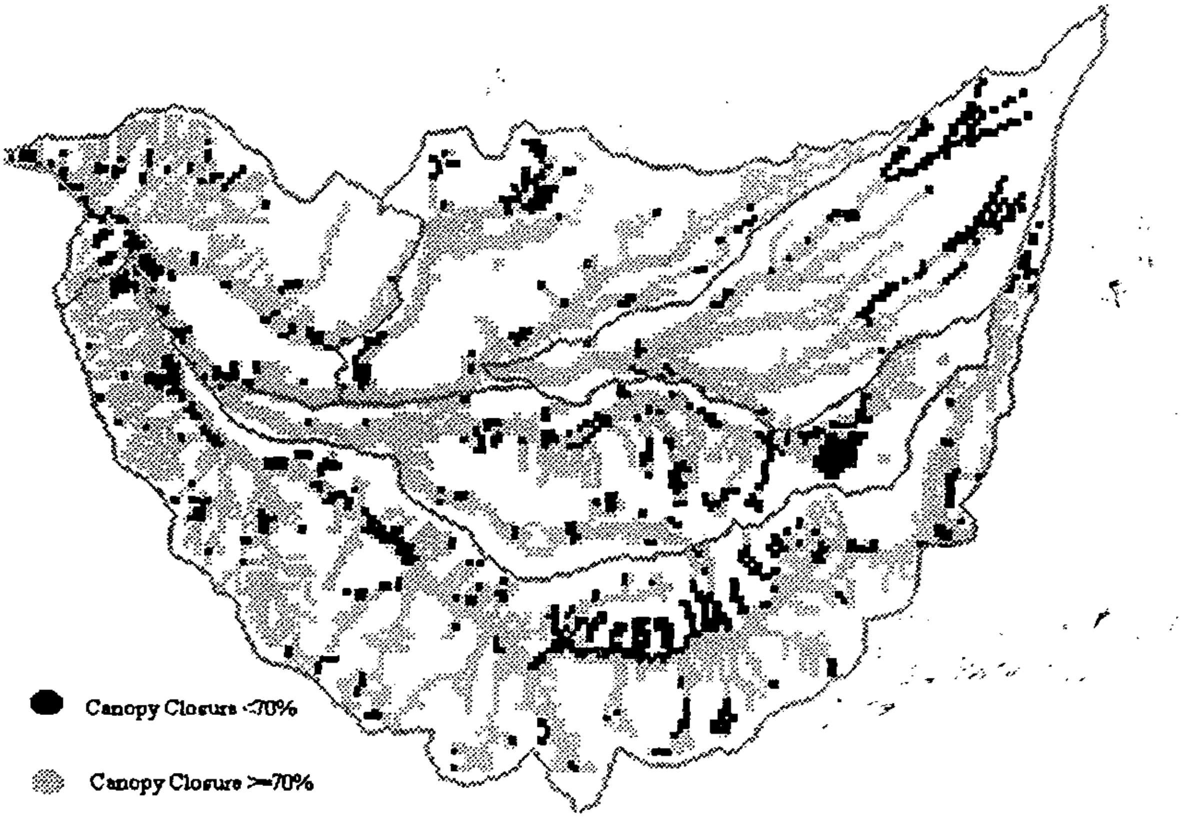


Figure 4-39 – Stream Shade



As Figure 4-38 and Figure 4-39 demonstrate, for all the subwatersheds and the Recreational Residence tracts, canopy closure is greater than or equal to 70% for more than 80% of the area. Because canopy closures are so high within the Riparian Reserves, stream temperatures are not a concern.

Point Sources

During the completion of this watershed analysis, three sources of point source pollution were identified:

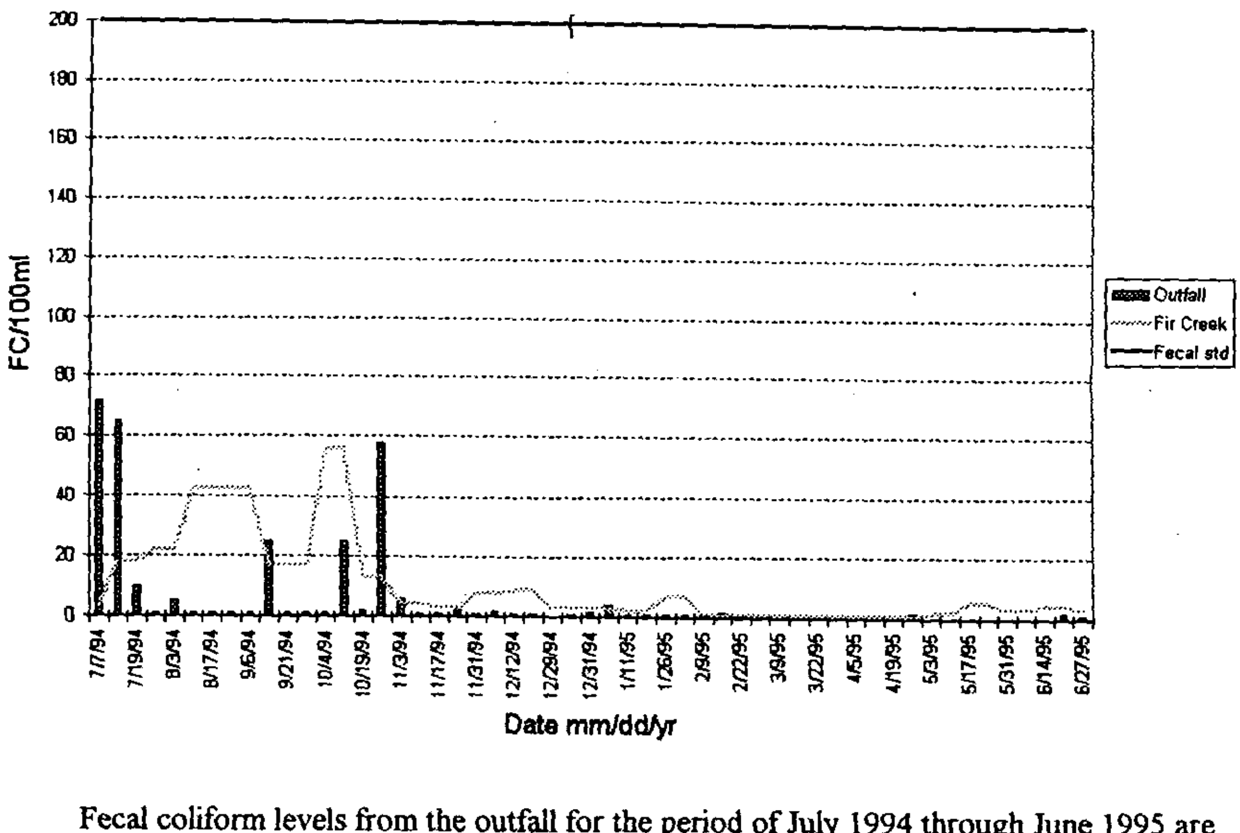
1. The Government Camp Sewage Treatment Plant.
2. The septic systems within the Recreational Residence tracts.
3. The salting of Palmer Snowfield.

Sewage Treatment Plant

To assess the effects of Government Camp's sewage treatment plant on Camp Creek's water quality, water quality data from the plant's outfall was analyzed. Variables assessed were fecal coliform and pH.

Fecal coliform bacteria are those coliform bacteria present in the gut and feces of warm blooded animals. The National Pollutant Discharge Elimination System (NPDES) Water Discharge Permit for the sewage treatment plant establishes a standard of 100 fecal coliform per 100 ml average monthly concentration, and 200 fecal coliform per 100 ml for the average weekly concentration within the sewage treatment plant discharge. Outside the allowable mixing zone (30 feet downstream from the point of discharge), the standard is 200 fecal coliform per 100 ml average monthly concentration (state water quality standards Sandy Basin).

Figure 4-40 -- Fecal Coliform Levels -- Sewage Treatment Plant Outfall



Fecal coliform levels from the outfall for the period of July 1994 through June 1995 are well below standards for the NPDES permit and the Sandy Basin water quality standards, except for one reading from Dec. 29, 1994 of 1220 FC/100ml.

The Draft Engineering Report for the Government Camp Sanitary District Water Facilities Plan (July 1995) completed by Curran-McLeod Inc. Consulting Engineers, was reviewed for information regarding discharges of high concentrations of fecal coliform bacteria. The NPDES permit limit is 200 FC/100ml.

Table 4-19 -- High Fecal Coliform Discharges

Date	FC/100ml
March 3, 1993	265
June 24, 1993	530
July 12, 1993	Too numerous to count
July 19, 1993	112
August 16, 1993	102
September 24, 1993	14,500
June 22, 1994	141
December 29, 1994	1220

When the effluent contains high concentrations of fecal coliform bacteria, it may be harmful to human health. When fecal coliform concentrations are high, the wastewater is not being adequately disinfected and disease-causing (pathogenic) organisms may be present. These conditions are a serious concern during the summer season when hikers or others may be exposed to bacteria in the tributary of Camp Creek that receives the discharge (Curran-McLeod, 1995).

According to the discharge monitoring reports, treatment plant effluent is chlorinated with one to three pounds of chlorine per day. Chlorine residuals typically range from 0.1 to 1.0 mg/L. (Curran-McLeod, 1995).

The chlorine disinfection process itself raises a concern about chlorine toxicity since chlorine is an indiscriminate disinfectant. It kills both harmful and beneficial organisms. If high concentrations of chlorine are discharged into a receiving stream (without adequate dilution) the discharge may be toxic to beneficial organisms in the receiving stream (Curran-McLeod, 1995).

Numeric standards have been adopted by the DEQ to evaluate the potential for instream chlorine toxicity. The acute toxicity criteria is 0.019 mg/L. The chronic toxicity criteria is 0.011 mg/L. These criteria can be used to evaluate the amount of dilution needed to prevent instream toxicity. Based on predicted flow rates in Camp Creek, and the average chlorine residual from the effluent, the necessary dilution to prevent acute and chronic chlorine toxicity equals 49 (Curran-McLeod, 1995).

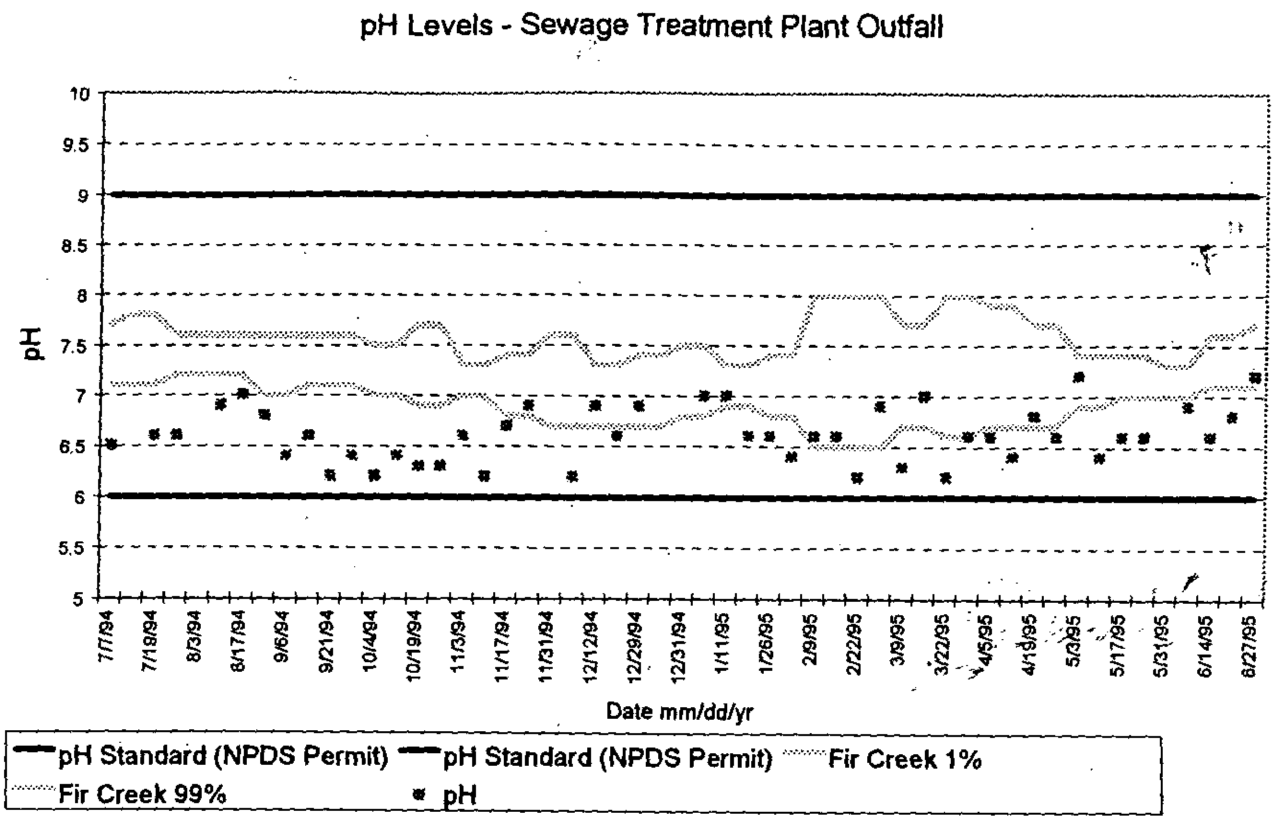
Because of the low flow rates in the tributary of Camp Creek receiving the discharge, the potential for chlorine toxicity is a legitimate concern. Although chlorine is an effective disinfecting agent, it is often difficult to achieve the correct balance of adding enough chlorine to kill the harmful organisms without harming the beneficial ones. The dilemma is compounded in situations where the disinfected effluent is discharged into a small receiving stream, like the tributary to Camp Creek (Curran-McLeod 1995).

Levels of fecal coliform in the nearby Bull Run Watershed's Fir Creek were plotted to demonstrate fecal coliform levels in an undisturbed watershed (no roads or timber harvest activity) with no human entry allowed. Levels of fecal coliform in the outfall for the period from July 1994 - June 1995 are above that of an undisturbed watershed within the Sandy Basin in early July and November. The drinking water criteria for total coliform (including the fecal coliform group) with some allowance for an occasional positive test is zero. For freshwater bathing, the geometric mean value of at least five samples equally spaced over a 30-day period should not exceed 126 E. coli/100 ml, or 33 enterococci/100ml (EPA, 1986).

Water quality within Camp Creek at the sewage treatment outfall would exceed drinking water standards, however this standard is for treated water. E. coli is part of the fecal coliform group and the mean of the 30-day period with the five highest readings for fecal coliform is 31 FC/100ml. This is below the standard for freshwater bathing. With respect to fecal coliform concentrations, it appears that water from the sewage treatment outfall meets applicable water quality standards most of the time. There have, however, been a number of incidents of high fecal coliform discharges which are of concern in Camp Creek. The other concern would be chlorine toxicity associated with wastewater discharges.

pH is defined as the concentration of hydrogen ions in water in moles per liter. A pH range of 6.5 to 9.0 has been established as the criteria to protect freshwater aquatic life (EPA, 1986). The pH standard from the NPDES permit is that pH shall be within the range of 6.0-9.0. The state water quality standard for the Sandy Basin is that pH values shall not fall outside the range of 6.5 to 8.5.

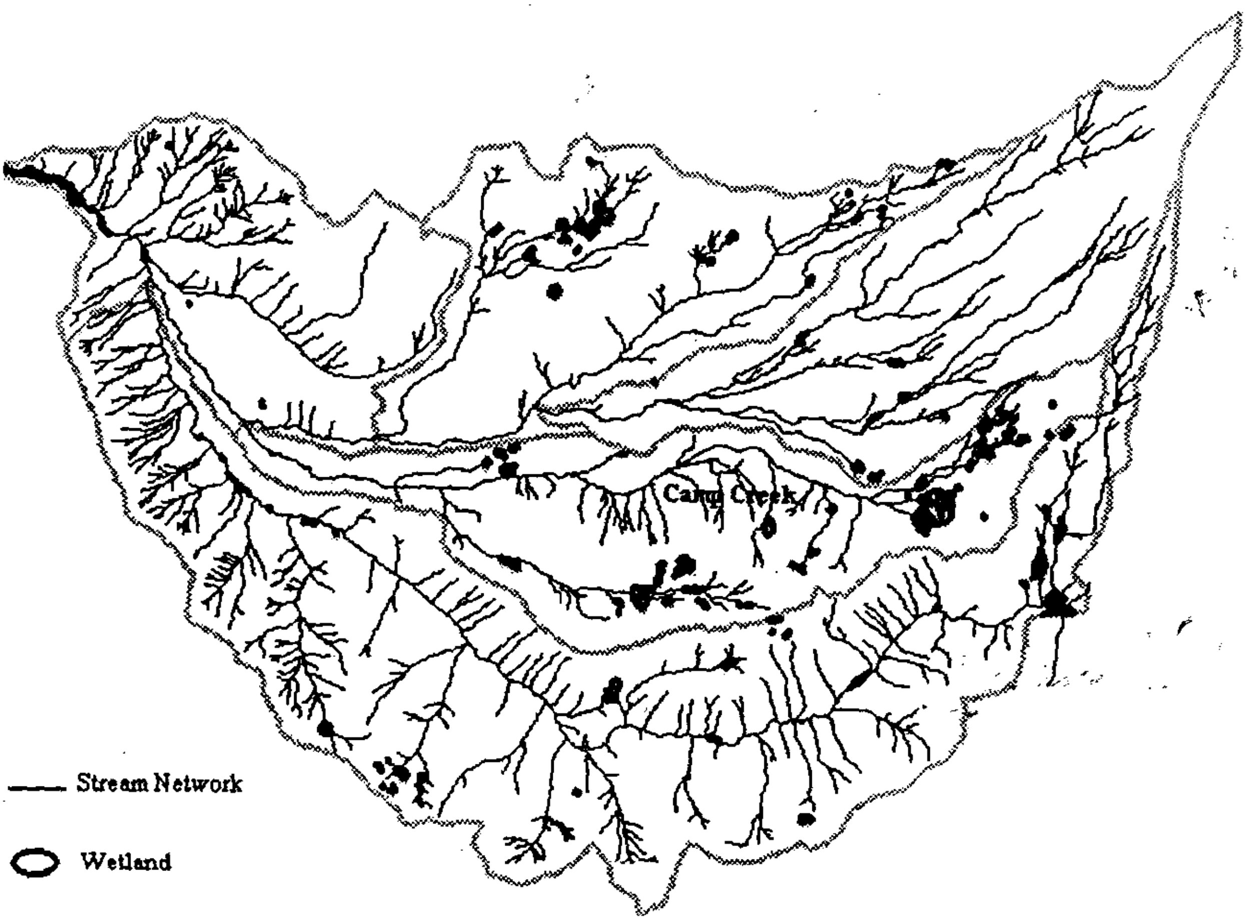
Figure 4-41 -- pH Levels - Sewage Treatment Plant Outfall



pH levels for the outfall are within the requirements of the NPDES permit, however, they are outside the standards for the Sandy Basin. While the one sample taken outside the mixing zone in Sept. 1995 is within Sandy Basin standards, it appears that for a significant portion of the time, pH is near or outside the standards (based on data from the outfall). Camp Creek has lower pH (and is considered more acidic) than the other subwatersheds (based on data collected in 1995), both above and below the sewage treatment plant outfall.

The major influence on the pH of natural waters is the geology with which the water contacts (Faust, 1981). Because the rock types in the area are primarily andesites composed of c. 55-60% silica, 10-11% aluminum, and minor amounts of magnesium, iron, and potassium (Seyer, 1983), the waters feeding Multorpor Fen are most likely fairly acidic. Camp Creek is influenced more by groundwater than the other subwatersheds, as evidenced by the large number of wetlands in the upper watershed. This allows more contact time with the soils, which are fairly acidic (pH 4.8 to 5.8), and is reflected in the surface water. It appears that the low pH from the effluent is associated with the water used for the disinfection process, and not the process itself. (Government Camp's water supply is from the upper Camp Creek subwatershed).

Figure 4-42 -- Wetlands



Recreational Residences Septic Systems

Of the 557 Recreational Residences within the Zigzag Watershed, approximately 484 are located within Riparian Reserves. Because these Recreational Residences are not serviced by a sewer system, septic needs are handled on site. Table 4-20 details the distribution of septic systems within the Recreational Residence tracts.

Table 4-20 -- Septic Systems

Septic System	Percent of Total
Approved Septic	71
Cesspool	11
Outhouse	5
Unknown	13

Approved septic systems include: a 1,000 gallon tank, with a drainfield with at least 100 feet of leach lines; an above ground sand filter system; a low pressure distribution system; or a 300-500 gallon septic tank with a separate concrete leaching tank.

Concerns were raised for water quality based on the number and type of septic systems within the Riparian Reserves. Many of these septic systems are in porous soils close to surface water. Based on this concern, macroinvertebrates were sampled in Still Creek in September 1994.

Table 4-21 -- Results Aquatic Benthic Macroinvertebrate Monitoring Sampling

Parameter	Sta 1 (KSR)	Sta 2 (Cool Creek)	Sta 3 (Smolt trap)
MHBI	3.05 Slight Organic Enrichment	3.62 Slight Organic Enrichment	3.86 Slight Organic Enrichment
USFS Biotic Condition Index	57 Poor	60 Poor	61 Poor
EPT to Chironomidae ratio	.901	.763	.710

Three indices were used to evaluate the effects of the Recreational Residences on water quality. Three sites on Still Creek were sampled: the Key Site Riparian area, the confluence with Cool Creek (just above the Recreational Residences), and the Forest Service smolt trap (near the confluence with the Zigzag River).

The Modified Hilsenhoff Biotic Index (MHBI) has been used to detect nutrient enrichment, high sediment loads, low dissolved oxygen, and thermal impacts. It is best at detecting organic pollution. Waters with values of 0-2 are considered clean, 2-4 slightly enriched, 4-7 enriched, and 7-10 polluted.

The index indicates slight organic enrichment for the entire area sampled, with the highest level recorded at the smolt trap (below the Recreational Residences). Index values between Stations 2 and 3 are very close, which indicates limited water quality degradation from the Recreational Residences. Index values between Stations 1 and 2 are greater than between Stations 2 and 3. This indicates some influence occurs on water quality in the area between Stations 1 and 2. Because Still Creek Road is also adjacent to the stream in this area, sediment input associated with the road may be affecting the results of this monitoring.

The Forest Service "Community Tolerant Quotient/Biotic Condition" is calculated by comparing the predicted macroinvertebrate community to the sampled community. The unimpacted benthic macroinvertebrate community structure (CTQp) is predicted based on total alkalinity, sulfate, substrate size, and stream gradient. The actual benthic macroinvertebrate community structure (CTQd) corrected for taxa dominance is then divided by the CTQp, and multiplied by 1030 to determine the biotic condition index (BCI). Waters having a BCI greater than 90 are considered excellent, 80-90 good, 72-79 fair, and less than 72, poor. Based on this index (with very little difference recorded between stations), the entire reach sampled would be considered poor.

The EPT to Chironomidae ratio evaluates the relative abundance of these indicator groups as a measure of community balance. Good biotic conditions are reflected in communities with even distribution among all four taxonomic groups, with substantial representation in the sensitive groups Ephemeroptera, Plecoptera, and Trichoptera (EPT). Skewed populations having a disproportionately high number of the generally tolerant Chironomidae relative to the more sensitive groups, may indicate environmental stress. Chironomids tend to become increasingly dominant along a gradient of increasing enrichment or heavy metal concentration. The ratio indicates higher levels of Chironomids lower in the watershed, with the greatest level of Chironomids at the lower site. The greatest difference between sites occurs at Stations 1 and 2, which may indicate input of sediment from Still Creek Road. There is a small difference between Stations 2 and 3, indicating limited impacts from the Recreational Residences.

Water quality was sampled on the Zigzag River within the Recreational Residence tracts on Aug. 31, 1995 to assess water quality within an area suspected of impacts from these residences.

Variable	Reading	Sandy Basin Standard
Fecal Coliform	2 FC/100ml	200 FC/ml monthly average
Enterococcus	<2 Enterococcus/100ml	61 Enterococuss/100ml

Levels of fecal coliform bacteria are well below the state standard, as well as below levels in Fir Creek (43 FC/100ml) during the same time period.

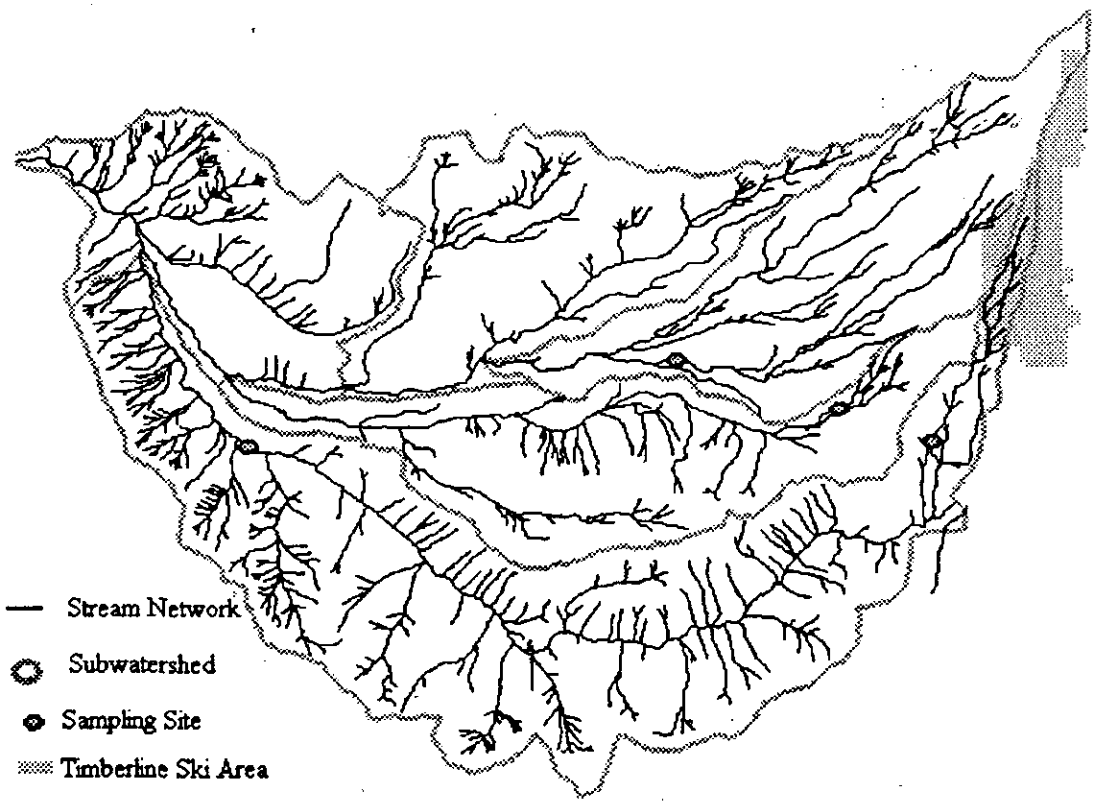
Based on macroinvertebrate sampling, as well as a single water quality sample, it appears that there is not a problem with septic systems affecting water quality in the Recreational Residence area. However, sampling has been limited. Based on the level of concern, it may be appropriate to develop a more refined sampling strategy.

Palmer Snowfield Salting

Water quality effects from the salting of the Palmer Snowfield (for Timberlodge Lodge's ski area operation) are a concern for the Zigzag Watershed. Sodium chloride is applied at the rate of 600,000 to 700,000 pounds per year to maintain skiing conditions in the spring and summer (pers comm Steve Kruse, Timberline Ski Area Manager). While most of the snowfield drains into Salmon River, a small portion drains into Still Creek. Conductivity and chloride levels were analyzed in Still Creek, Camp Creek, and Little Zigzag River. The data included weekly samples taken in 1992, as well as yearly means for the salting period (mid-May to early September) for 1990, 1991, and 1992. Samples were collected by the Timberline Lodge Ski Area's operator.

Samples were collected in Still Creek, Camp Creek and Little Zigzag River in the Zigzag watershed. Still Creek is the only are with a surface water connection to Palmer Glacier. Camp Creek and Little Zigzag River are adjacent to Still Creek and were sampled to compare areas that did not receive inputs from Palmer Glacier. Fir Creek is an unmanaged subwatershed in the Bull Run watershed that is used an indication of the undisturbed condition for comparsion purposed.

Figure 4-43 -- Sampling Sites



Conductivity refers to the ability of a substance to carry an electrical current. The conductivity of water is a function of water temperature and the concentration of dissolved ions. Conductivity is beneficial for quickly assessing water quality. In doing so, often times a linear relationship can be established between conductivity and the major ionic species (EPA, 1991).

Melted snow in the western U.S. has a conductivity of 2 to 42 micromhos/cm (Hem, 1970). Generally, an inverse relationship occurs between conductivity and discharge (Keller et al., 1986, Aumen et al., 1989). Water that is slowly transmitted to the stream (baseflow) has more opportunity to pick up dissolved ions through weathering and other chemical reactions. Water that is quickly transformed from precipitation to runoff tends to have fewer dissolved ions, thus causing a corresponding decline in conductivity at high discharges. This relationship between conductivity and discharge means that simultaneous discharge measurements are needed to properly interpret conductivity data (EPA, 1991).

Figure 4-44 -- Conductivity 1992

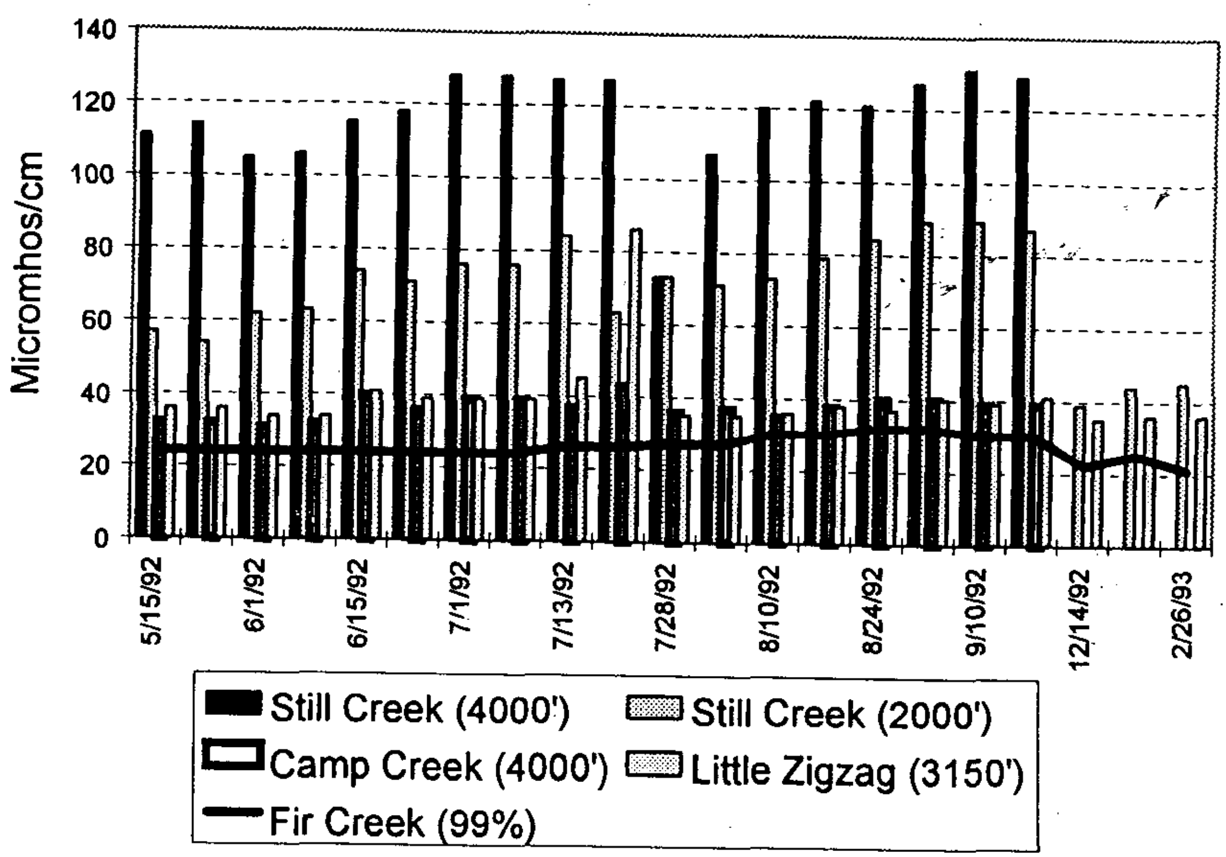
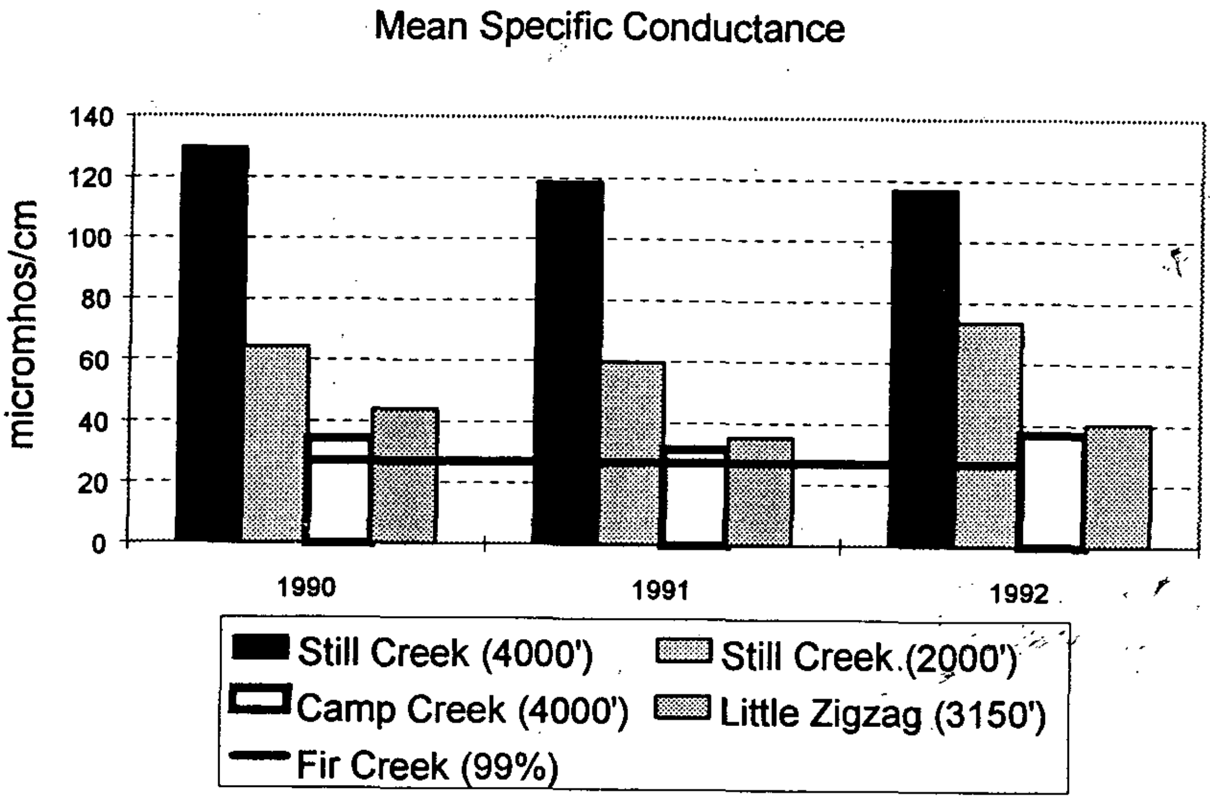


Figure 4-45 -- Conductivity (Mean 1990, 1991, 1992)



Conductivity readings are presented for various streams in the Zigzag Watershed, and for Fir Creek within the Bull Run Watershed. Fir Creek is an unroaded and unharvested basin used, in this case, to show the condition of an undisturbed watershed within the Sandy Basin. Still Creek and the Little Zigzag River are similar. Both originate from glaciers. Conductivity readings in Still Creek are much higher than those in adjacent watersheds and in Fir Creek. Conductivity levels at Still Creek's 4,000-foot elevation are higher than those at its 2,000-foot elevation. This indicates that the source of the higher readings is in the upper watershed. The Little Zigzag station, located higher in the watershed, has lower conductivity. It originates from a glacier and flows through similar material (pyroclastic and debris flow) as does Still Creek. The conditions in Camp Creek and the Little Zigzag seem to closely approximate that of an undisturbed watershed.

Studies of sodium chloride movement in soils have indicated that the chloride ion is a conservative ion and is not involved in biological or soil chemistry processes (Wilcox, 1986). The chloride ion moves with soil water and can be used as a tracer to track the rate of water movement (Megahan and Clayton, 1983). Chloride concentrations were used to track the movement of the sodium chloride from Palmer Glacier in the Zigzag Watershed.

Figure 4-46 -- Chloride Concentrations

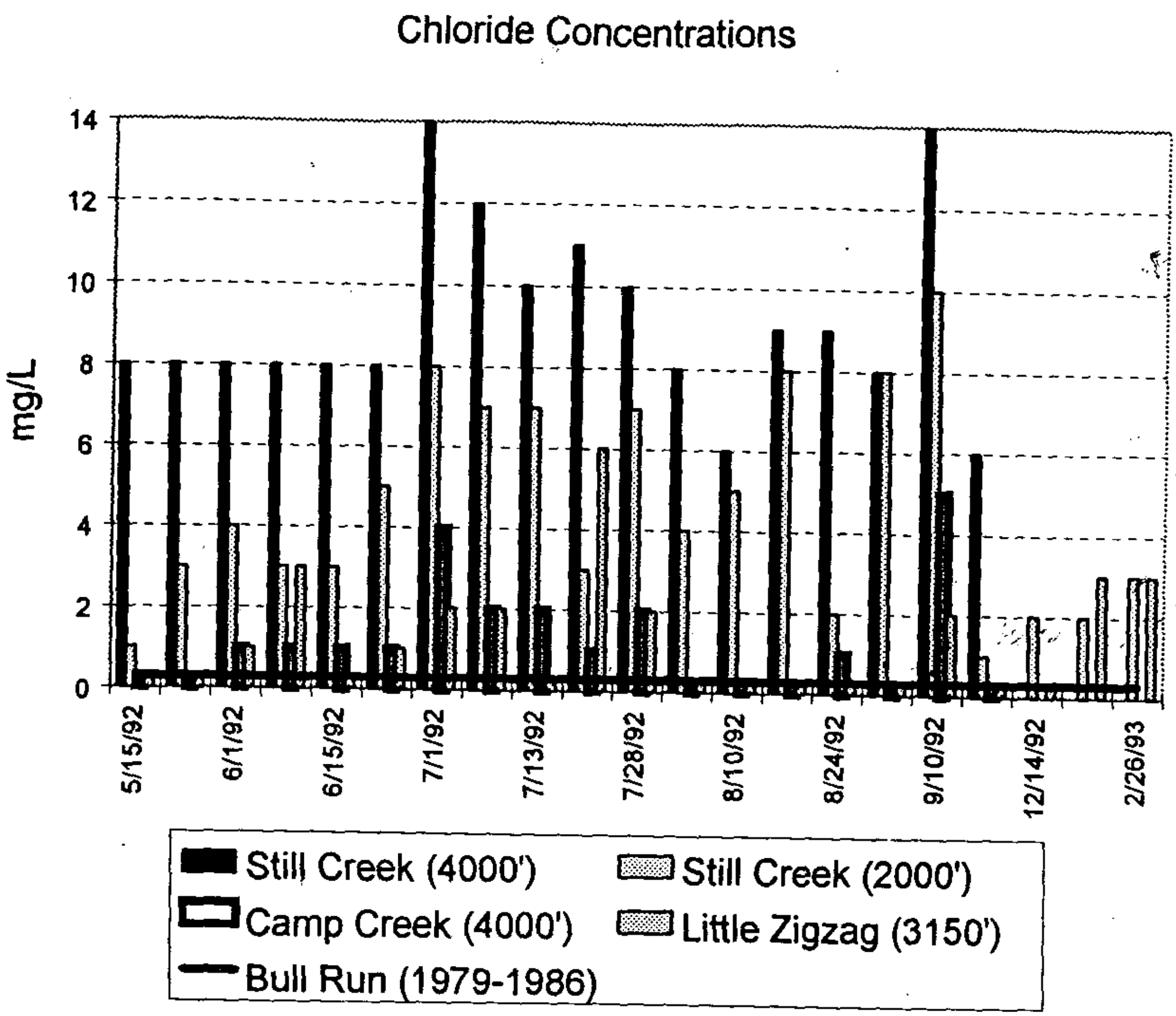
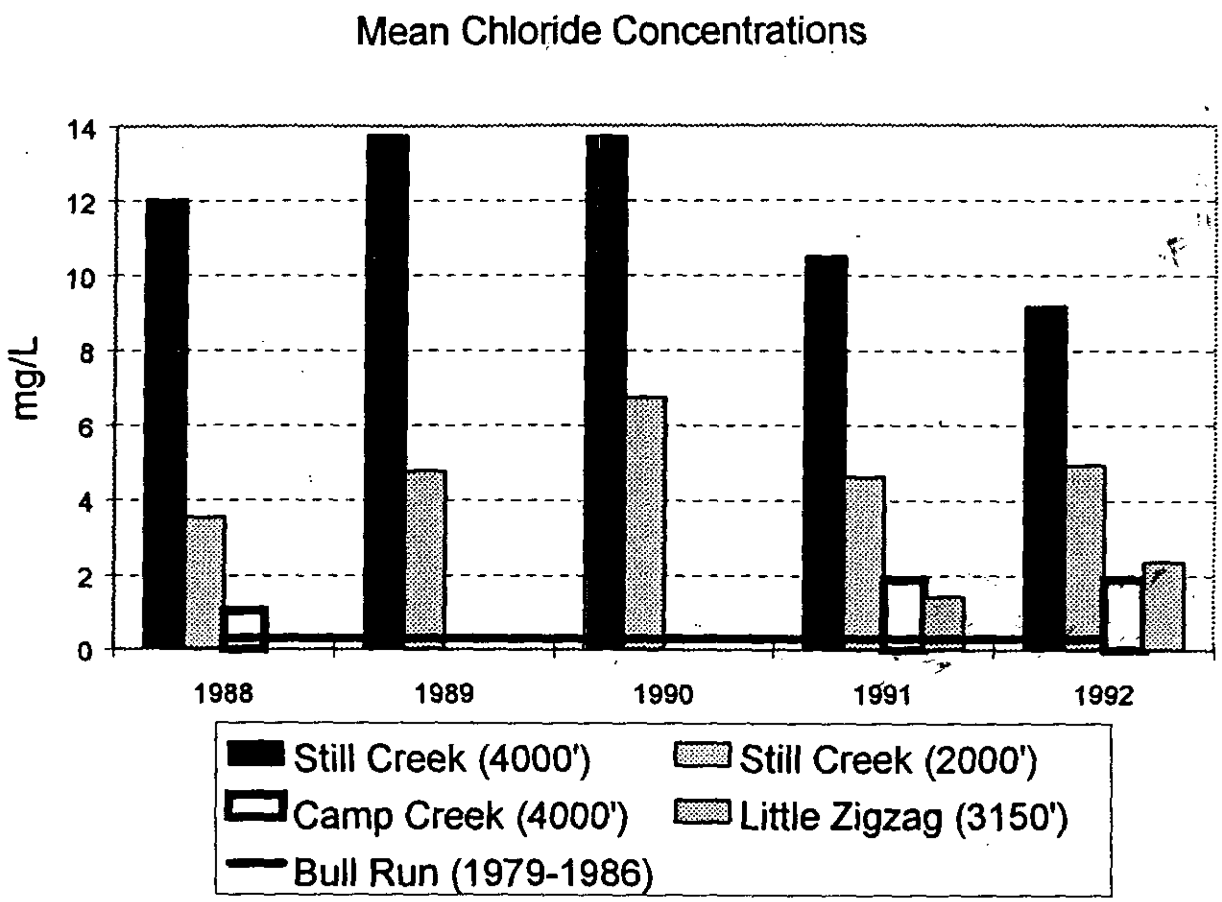


Figure 4-47 -- Mean Chloride Concentrations



Concentrations of chloride are much higher in Still Creek than the Zigzag Watershed's other streams, and within the Bull Run Watershed's Fir Creek. Maximum concentration of chloride in the Little Zigzag River is 3 mg/L, while concentrations in Still Creek reach 14 mg/L. Because concentrations of chloride are higher in upper Still Creek, the source is in the upper watershed. Average annual concentrations within Camp Creek and the Little Zigzag River are more similar to those in the Bull Run than to those in Still Creek.

Based on conductivity and chloride data, the salting of the Palmer Snowfield with sodium chloride is having an effect on the water quality in Still Creek.

Conductivity and chloride levels are below any documented threshold of concern. The EPA National Water Quality Criteria for salt sensitive biota state that a four-day average of not more than 230 mg/L Cl and a one-hour average of not more than 860 mg/L Cl (at an average frequency of once every 3 years) will not "unacceptably affect" aquatic biota. The maximum level recorded below the Palmer Snowfield was 44 mg/L Cl. Macroinvertebrate sampling completed in 1994 does not indicate any impactes from elevated cloride concentrations in Still Creek (see discussion on Recreational Residence septic systems for more detail). However, conductivity levels and sodium and chloride concentrations are well above those for melted snow in the western U.S. and within the Bull Run Watershed. These levels appear to be above base or background levels, and outside the range that species, populations and communities are uniquely adapted.

Since 1988, monitoring has been in effect to assess the effects of the Palmer Snowfield salting since 1988. In order to quantify sodium and chloride concentrations associated with diurnal fluctuations and rain on snow events, additional elements have been added to the monitoring program.

Conclusions: Water Quality

- The Zigzag River has moderate problems with turbidity and sediment associated with glacial runoff and unstable channels.

- Camp Creek has moderate problems with turbidity and sediment associated with highway sanding and road surface erosion.

- Still Creek has moderate problems with sediment associated with highway sanding and road surface erosion.

- With some exceptions, fecal coliform concentrations in the Government Camp Sewage Treatment Plant's outfall meet appropriate water quality standards and are within the range of an undisturbed area. However, there have been a number of short duration, yet high concentration, of fecal coliform bacteria discharges into Camp Creek. These discharges may violate the National Pollutant Discharge Elimination System Water Discharge (NPDES) permit and Oregon state water quality standards.

- The salting of the Palmer Snowfield with sodium chloride is having an effect on water quality in Still Creek. However, measured conductivity and chloride levels within Still Creek are below any documented threshold of concern. Conductivity levels and chloride concentrations are well above those for adjacent streams (Camp Creek and Little Zigzag River) as well as the Bull Run Watershed. These levels appear to be above base or background levels and have the potential to bring water quality outside the range that maintains the biological, physical and chemical integrity of the system.

Fisheries

Introduction

The Mt. Hood National Forest uses salmonids (salmon, trout, and char) as management indicator species for aquatic habitats. Because of their value as game fish and their sensitivity to habitat changes and water quality degradation, salmonids have been selected to monitor trends in the streams and lakes of the Mt. Hood National Forest. Although there are other fish species present in the river (sculpins and dace, for example), population trends are unknown. Much more information exists on salmonids, making this group a better choice for monitoring aquatic environments.

The Zigzag Watershed supports both anadromous (sea-run forms) and resident species of salmonids. Within these species are distinct stocks, some native to the upper Sandy Basin and some introduced. Native stocks, as defined in this analysis, are those stocks found historically in the Sandy River subbasin that have maintained a high degree of genetic integrity, with little genetic influence from other introduced stocks.

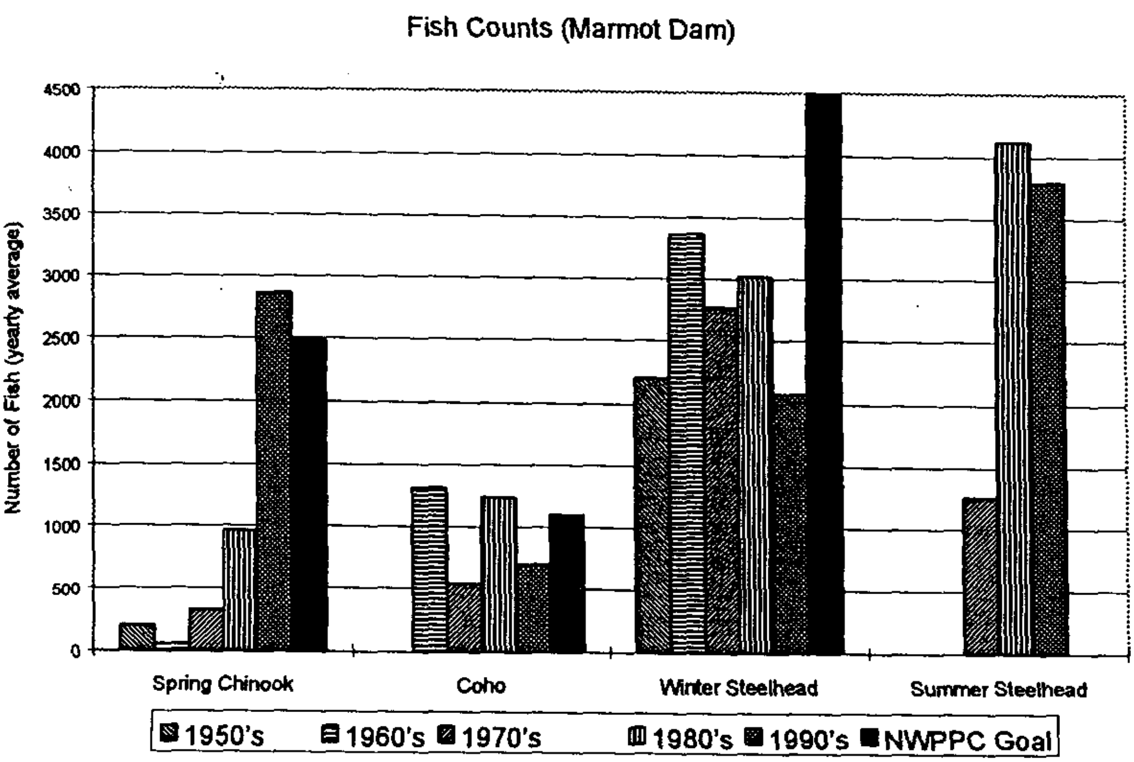
Wild stocks, as defined in this analysis, are self-sustaining populations that originated from or have been significantly altered genetically by hatchery introductions. Hatchery stocks are defined as first generation fish outplanted from hatchery facilities. The native stocks are uniquely adapted to the special conditions found in the Zigzag River (a glaciated drainage) and its clear-running tributaries.

Populations of native stocks of salmonids are much reduced from historical levels due to habitat degradation, hydroelectric dam operation, overfishing and ocean rearing conditions. The Oregon Department of Fish and Wildlife (ODFW) has developed a Wild Fish Policy and angling regulations to protect these stocks, which include spring chinook and coho salmon, and resident and anadromous forms of rainbow and cutthroat trout. High quality habitat is critical for maintaining these stocks. The Zigzag River and its tributaries provide large amounts of this high quality and diverse fish habitat.

The Zigzag River and its tributaries are well known among local and Portland metropolitan-area anglers for excellent fishing opportunities. Primary fisheries include summer steelhead, resident rainbow and cutthroat trout. The river system also supports winter steelhead, coho and spring chinook salmon -- contributing significantly to downstream fisheries in the lower Sandy River. Dace, whitefish and sculpin are also present, although little is known of their distributions and population status. High in the watershed, several small lakes and ponds contain cutthroat, rainbow and brook trout, supporting popular fisheries. Some of these salmonid stocks are native to the upper Sandy River, while others have been introduced and are naturally sustaining through wild reproduction (wild stocks). Still, other stocks are regularly supplemented with hatchery-reared stock released by ODFW to improve recreational fishing within the Zigzag and Sandy rivers.

Little is known about the current status of individual stocks in the streams of the Zigzag Watershed. Overall fish stock status in the upper Sandy River Basin is illustrated in Figure 4-48. Spawning fish returns (escapement) into the upper Sandy River during the last 45 years appear to show increasing numbers for some stocks -- spring chinook and summer steelhead -- and more variable status for coho and winter steelhead. However, spring chinook and summer steelhead counts in the 1970s-90s were most likely predominately composed of returning hatchery released fish. In general, as hatchery releases hit peak levels in the 1980s to early 1990s, a decline in winter steelhead and coho escapement also occurred. This trend likely held true for native and wild spring chinook runs as well. Northwest Power Planning Council escapement goals are included as a point of reference. These goals were presented in the ODFW Sandy River Subbasin Plan in 1990. The existing plan emphasized increased wild winter steelhead production and maintenance of salmon populations.

Figure 4-48 -- Fish Counts and Existing Escapement Goals, Upper Sandy River

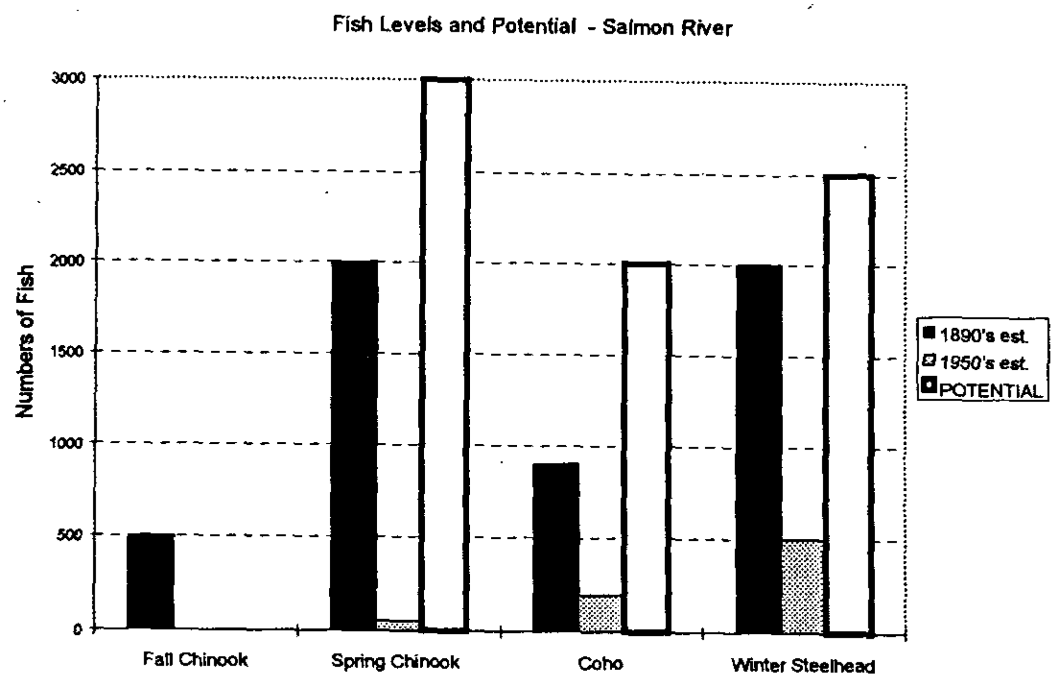


NWPPC-Northwest Power Planning Council

Existing salmon and steelhead counts passing into the upper Sandy Basin appear to be greatly reduced from levels present prior to the 1850s. Little information is available on historical run size. Comparisons of 1890s' records from an old hatchery operated on the neighboring Salmon River Watershed with recent spawning surveys in the Salmon and Zigzag watersheds indicate current spawning returns are likely 10-25% of the 1890s' levels. (It is also noteworthy that these 1890 levels were already reduced by decades of heavy fishing on the Columbia River.)

Historical hatchery records from the Salmon River (Figure 4-49) indicate the drastic relative change in fish numbers in upper Sandy tributaries within the 1890-1950 time period. (Historical data is extrapolated from hatchery egg-take records by Chester Mattson in a 1955 report to the Oregon Fish Commission.) Mattson included his estimates of the potential production for the drainage as "potential" returns of adult spawners. This potential should be equivalent to historic production prior to the impacts of commercial fishing on the Columbia, and later by habitat destruction, hydroelectric development, and habitat degradation.

Figure 4-49 -- Estimated Population and Potential, Salmon River (Mattson, 1955)



Information sources for this discussion of fish stocks include: ODFW's Sandy River Subbasin Salmon and Steelhead Plan, 1990; PGE's (Portland General Electric) Hydroelectric Development and Fisheries Resources on the Clackamas, Sandy and Deschutes Rivers, 1995; and Mt. Hood National Forest habitat and population inventories, and historical reports (Mattson, 1955).

Fish Stocks in the Zigzag Watershed

Summer Steelhead

Native Stock

ODFW's Sandy River Subbasin Plan (1990) and local information indicates a native summer steelhead stock may be present in the Sandy River subbasin. Native or wild produced steelhead returning in late summer/fall are seen passing Marmot Dam in very low numbers. Little else is known about the origin, status or distribution of the fish. Evaluation of this stock is needed, which will likely occur as a result of the Sandy Subbasin Fish Management Plan (in progress). No records of this stock in the Zigzag Watershed exist, although habitat conditions are very good for summer run steelhead.

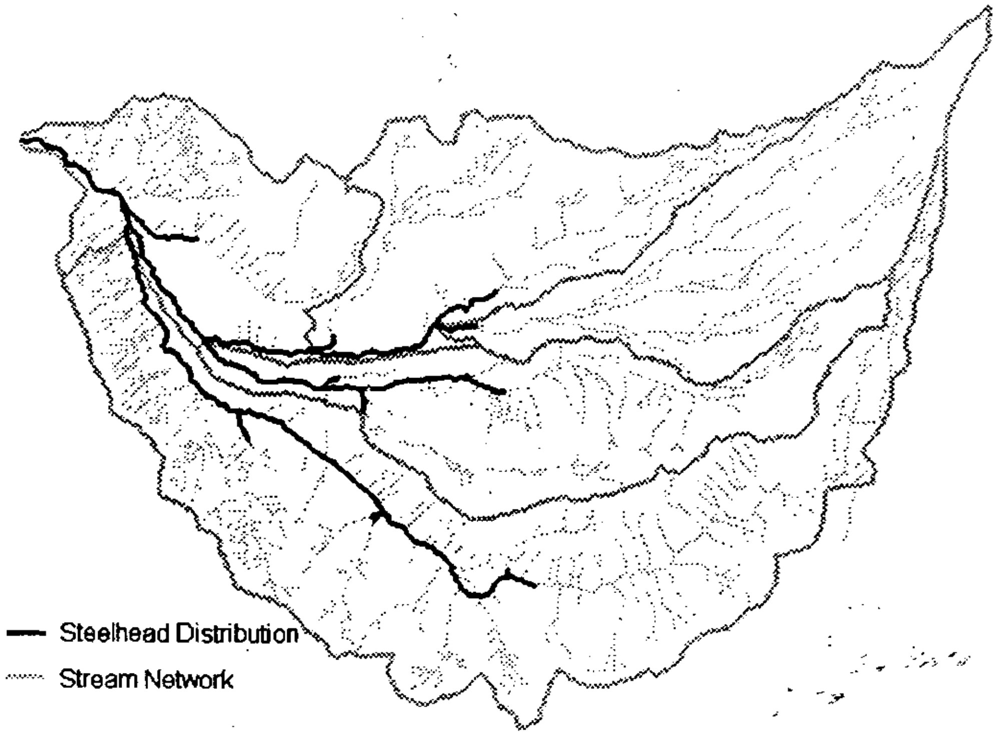
Introduced Stock

A new stock of summer steelhead was introduced to the Sandy Basin in 1975. (The Foster stock is the hatchery stock presently used. This stock was developed at the South Santiam Hatchery from eggs obtained from the Skamania Hatchery on the Washougal River.) Average adult return to the upper Sandy was nearly 3,500 fish for return years 1978 through 1993, with a peak in 1985 of 7,598 fish. Initial counts for 1995 indicate relatively low returns, likely related to poor ocean rearing conditions.

The run has been maintained with annual smolt outplanting in upper Sandy tributaries (averaging 70,000 fish). Most of these fish are planted and return to the Salmon River, although about 20,000 smolts are planted annually in Still Creek and the Zigzag River to provide additional fishing opportunities. Because the stock spawns early (January-February), it was originally assumed that egg and embryo survival would be low due to that time of year's harsh environmental conditions, and because little opportunity appeared to exist for cross-breeding with the native summer or winter stocks. However, increasing numbers of wild summer steelhead are being caught in the mid-summer fishery in the upper Sandy Basin, including the Zigzag Watershed. Natural reproduction is obviously occurring, and some holdover (residualization) of smolts is suspected. The effects on native salmonids are unknown and should be evaluated.

Figure 4-50 (on following page) details the current distribution of steelhead within the Zigzag Watershed.

Figure 4-50 -- Steelhead Distribution



Winter Steelhead

Native Stock

Native winter steelhead contribute significantly to the Sandy River fishery, one of the most popular and successful in the state of Oregon. The stock is listed at moderate risk of extinction in the recent evaluation of Pacific Coast salmon and steelhead stocks published by the American Fisheries Society (Nehlson, Williams, and Lichatowich, March 1991). All native steelhead stocks in Oregon are currently being evaluated for listing as a Threatened and Endangered Species by the National Marine Fisheries Service (NMFS).

The existing stock of winter steelhead in the Zigzag Watershed is essentially a native upper Sandy late-run stock. Some genetic mixing with hatchery winter steelhead stocks planted prior to 1964 is suspected. In addition, some straying of hatchery fish from the lower Sandy Basin may still be occurring (with continuing opportunity for genetic mixing and/or competition to occur).

The native stock returns to the river from December to March, and spawns from March through May. (Spawning surveys indicate substantial steelhead spawning activity prior to March, likely composed of both summer and straying winter hatchery stocks.) Due to the native run's later spawning period, fry of this stock emerge later than summer run and hatchery winter stocks. The native run fry may also be at a competitive disadvantage due to the age/size difference between the three stocks. Adult returns to the upper Sandy basin have been moderately stable, averaging approximately 3,000 fish the past 30 years. However, returns over Marmot Dam have decreased in the last several years, coinciding with the introduction of summer steelhead and the elimination of hatchery outplanting of winter steelhead in the upper basin.

Introduced Stock

Prior to 1964, early-run Big Creek stock and other stocks were released throughout the upper Sandy Basin. More recently, stocking was limited to below the Sleepy Hollow Bridge -- below the confluence of the Salmon and Sandy Rivers. Since 1989, no hatchery stocking of winter steelhead has occurred above Marmot Dam.

Stock Status

Figure 4-51 illustrates the number and timing of smolts trapped as they left Still Creek in 1995. (Note: while emigration patterns are similar for both hatchery summer and native winter steelhead, the hatchery fish tend to migrate in mass immediately following stocking.) From these numbers, smolt production for the Still Creek drainage can be calculated. Still Creek represents a significant portion of total habitat for winter steelhead in the Zigzag Watershed (approximately 35%). Figure 4-52 displays the estimated smolt production from Still Creek in 1994 and 1995, based on smolt trapping operations. Because sampling was incomplete, 1995 hatchery steelhead estimates are most likely low. Potential production from the entire Zigzag Watershed was extrapolated applying this estimate and the proportion of habitat represented by Still Creek in the Zigzag Watershed.

Figure 4-51 -- Smolt Counts 1995

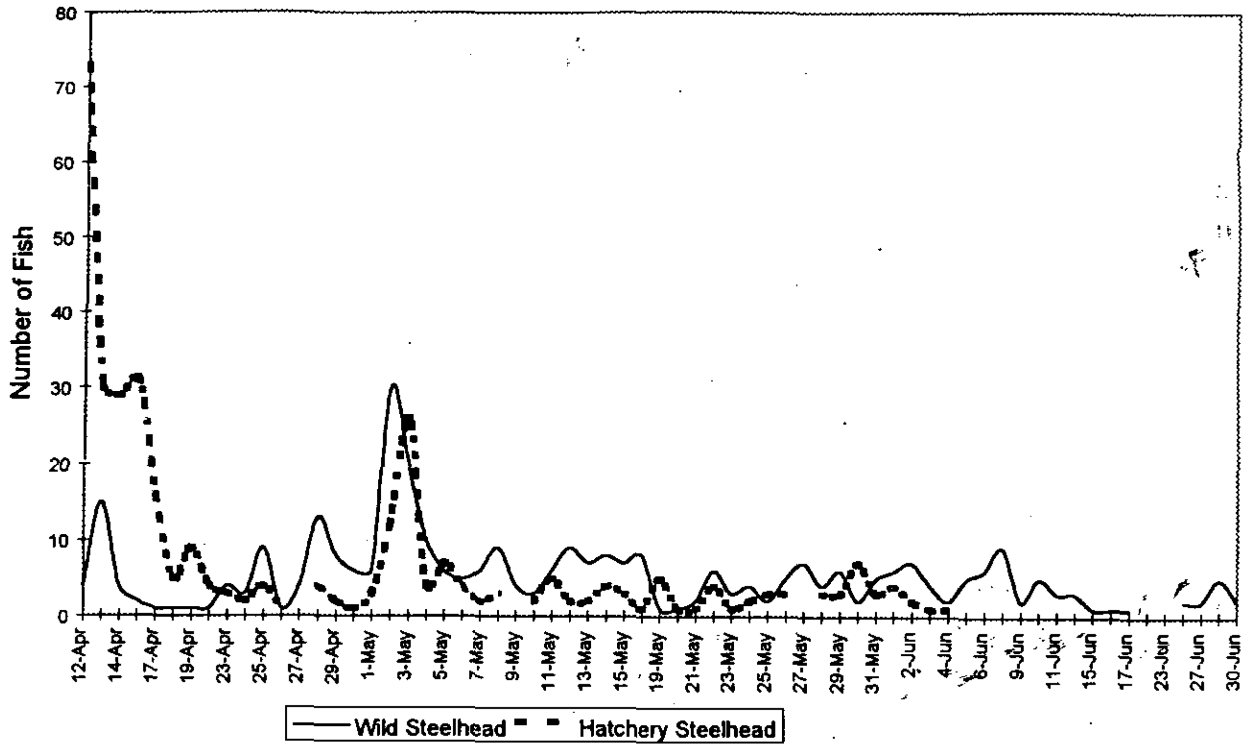
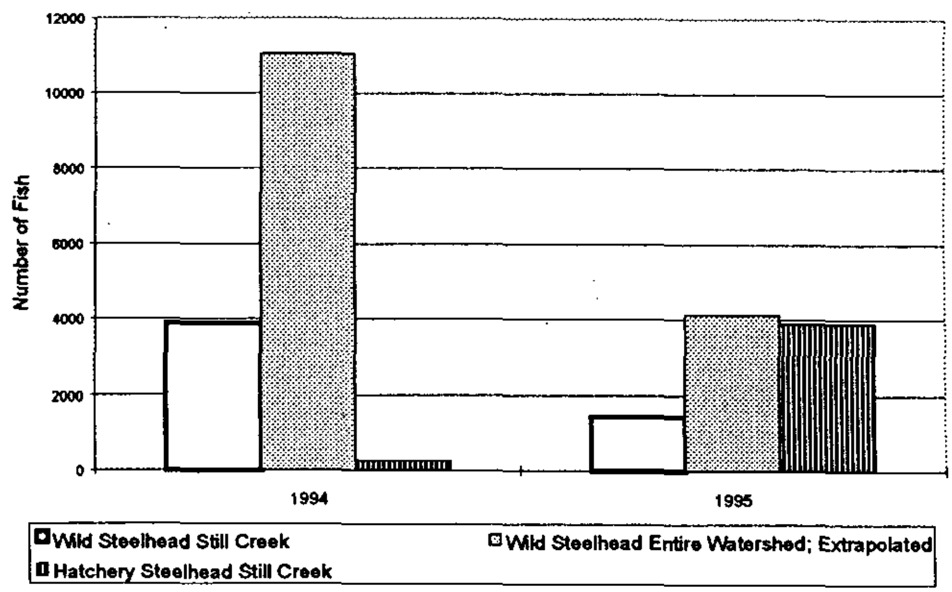


Figure 4-52 -- Steelhead Smolt Population Estimates (From Smolt Trap Data)



As mentioned previously, production of native winter steelhead has significantly declined in the 1990s. Therefore, these smolt production estimates are likely not representative of historic numbers, or of potential for the watershed. Low returns are likely related to poor ocean-rearing conditions or other factors operating in the ocean environment. This could include possible incidental interception by high seas commercial fishing operations.

Spring Chinook

Native Stock

The native run, historically abundant in the upper Sandy, has been decimated by many factors, including: hatchery egg-taking operations (one of the first hatcheries in Oregon operated from 1898 to 1912 near the mouth of the Salmon River, and later at Marmot Dam); high harvest levels in commercial and recreational fisheries on mixed native and hatchery stocks; poor ocean-rearing conditions; and -- most significantly -- the construction and operation of Marmot Dam. Water withdrawal from the Sandy River that started in 1912 de-watered long reaches of the river until 1974. Until 1951, the diversion canal was unscreened. Therefore, from 1912-1951, much of the smolt production was diverted into and killed by the Bull Run power generating facilities. Because they spawn and rear in main river environments, the dam appears to have affected these chinook disproportionately.

Figure 4-53 -- Marmot Dam

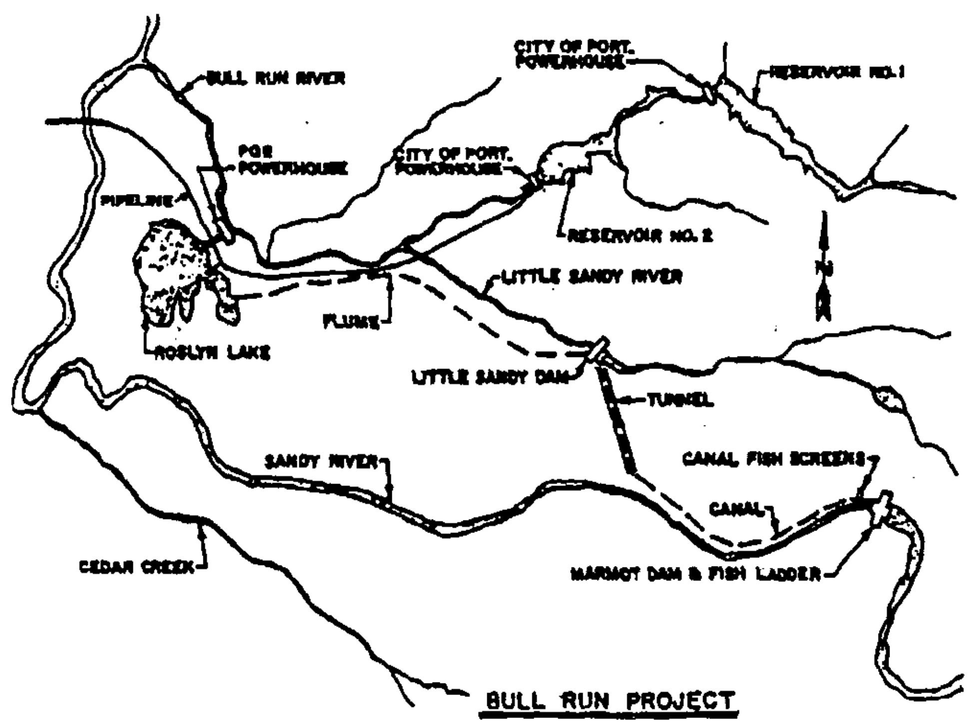
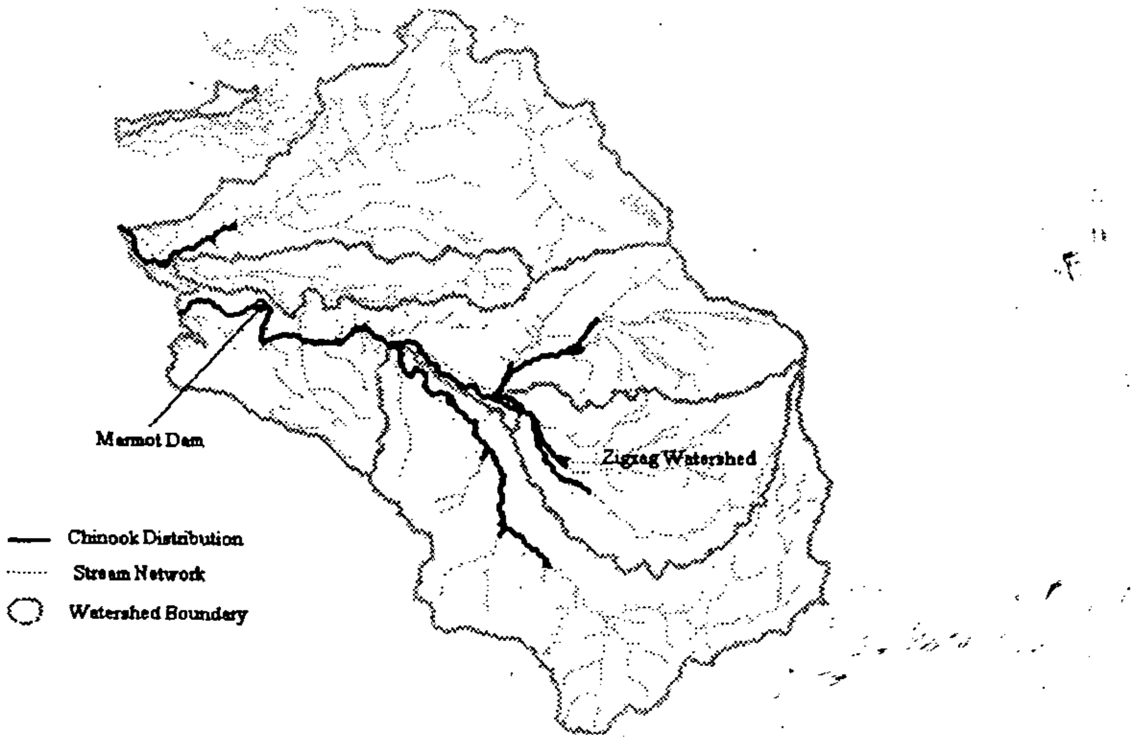


Figure 4-54 -- Chinook Distribution Sandy Basin



The status of the native run is presently unknown, but is likely small or non-existent. The stock is listed as possibly extinct by Nehlson et al, (1991). From 1955-70, less than 100 fish per year returned over Marmot Dam. During several of these years, less than 50 fish returned. All chinook stocks in Oregon are being reviewed by the National Marine Fisheries Service for listing as threatened or endangered species.

Introduced Stock

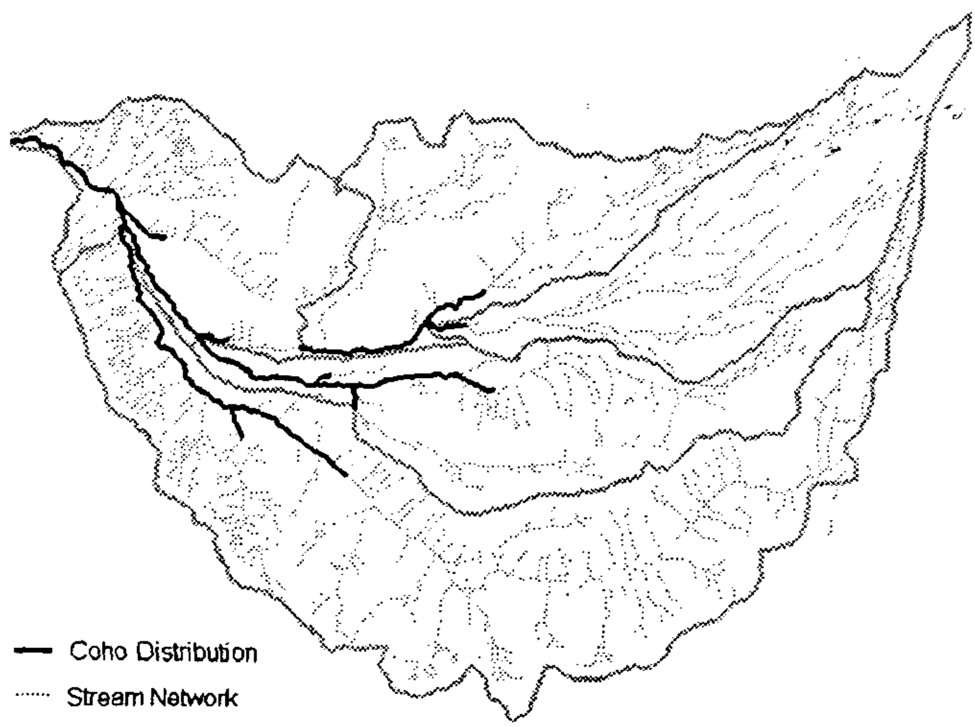
Since the mid-60s, chinook populations in the upper Sandy Basin were supplemented with hatchery releases of Willamette stock chinook. From 1986-94, counts over Marmot Dam have ranged from 700-6,984 fish. Most of these fish were likely returns from hatchery outplanting. Until 1994, the Salmon River run was supplemented annually with smolt introductions. Straying into the Zigzag Watershed was likely occurring. ODFW is now releasing all hatchery spring chinook smolts below Marmot Dam. Based on spawning surveys from Still Creek and the neighboring Salmon River, it appears that natural production may be stable or increasing (probably from progeny of both native and hatchery stocks), and contributing to recent run increases. Because hatchery fish are not marked, it is impossible to assess -- with certainty -- the relative contribution of wild production or the status of wild stocks. What effect the increased production of the hatchery derived stock and straying hatchery adults has on any remnant native run is unknown, although the potential for interbreeding and hybridization is high due to overlap of spawning periods in September. Initial 1995 counts at Marmot Dam indicate very low returns, probably due to poor ocean-rearing conditions.

Coho Salmon

Native Stock

Coho salmon of the Sandy Basin are listed by the state of Oregon and Forest Service as a sensitive species. The stock is listed at high risk of extinction (Nehlson et al, 1991). The National Marine Fisheries Service is currently reviewing the status of lower Columbia River stocks for possible listing as threatened or endangered. Several factors have contributed to the decline of this stock, including: habitat degradation, overfishing in a mixed stock fishery with numerous hatchery runs, poor ocean-rearing conditions, and competition with outplanted hatchery stock. The stock has reached critically low levels in recent years.

Figure 4-55 -- Coho Salmon Distribution



Introduced Stock

The introduced stock is derived from mid-basin Sandy River fish (Cedar Creek hatchery). Coho from Sandy Hatchery were outplanted throughout the upper Sandy Basin in the 1980s as adults, pre-smolts and smolts to supplement declining native coho wild production. Although it appears that coho pre-smolt supplementation was largely ineffective on a statewide basis, adult returns and natural reproduction increased in the upper Sandy Basin during that period. Since 1990, virtually all stocking of coho has been limited to below Marmot Dam.

Population Status

Counts at Marmot dam increased from 283 in 1977 to approximately 1,500 in 1985-87. However, poor ocean-rearing conditions in the last several years have contributed to very low returns and small-sized fish. In addition, there is a growing concern about the status of the stock. Initial forecasts for the 1995 run are very low.

Figure 4-56 shows the number and timing of smolts trapped in 1995 as they left Still Creek. Using this information, along with other trapping data from previous years, estimates of total smolt production from the Still Creek drainage were calculated for several years. Figure 4-57 shows Still Creek drainage coho smolt production estimates for 1991 and 1993-95. Potential production from the entire Zigzag Watershed was extrapolated based on these estimates, along with the relative proportion of coho habitat represented by Still Creek within the Zigzag Watershed.

Figure 4-56 1995 -- Coho Salmon Smolt Trap Data

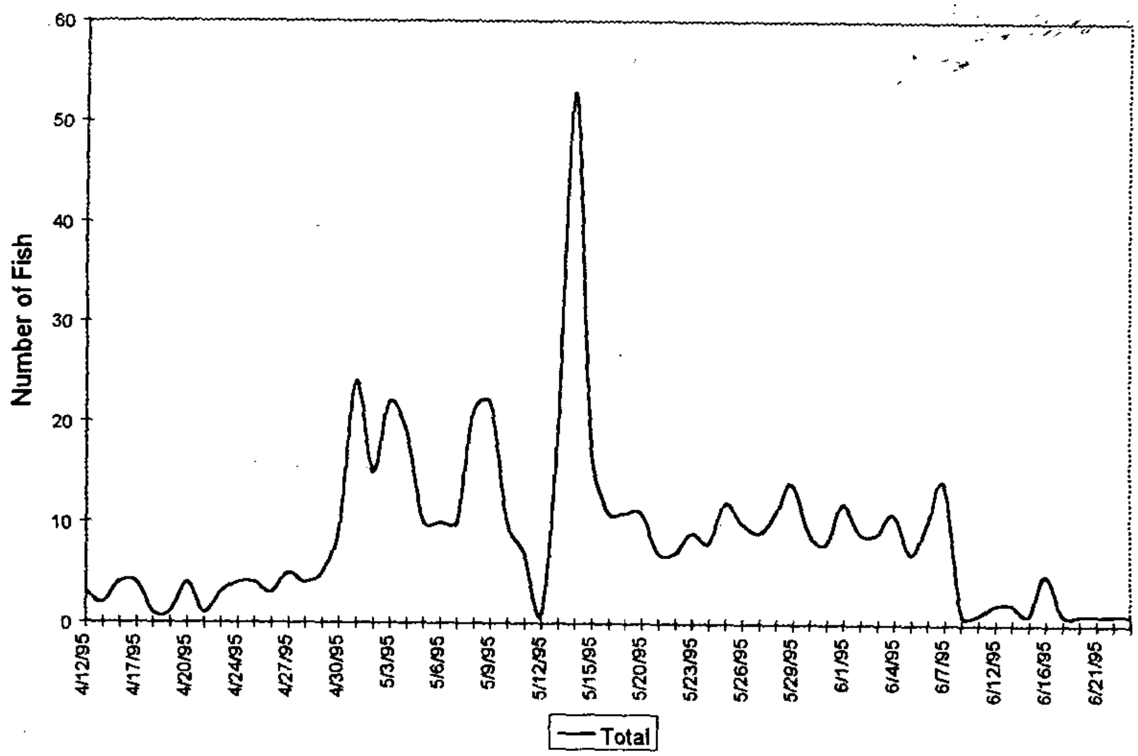
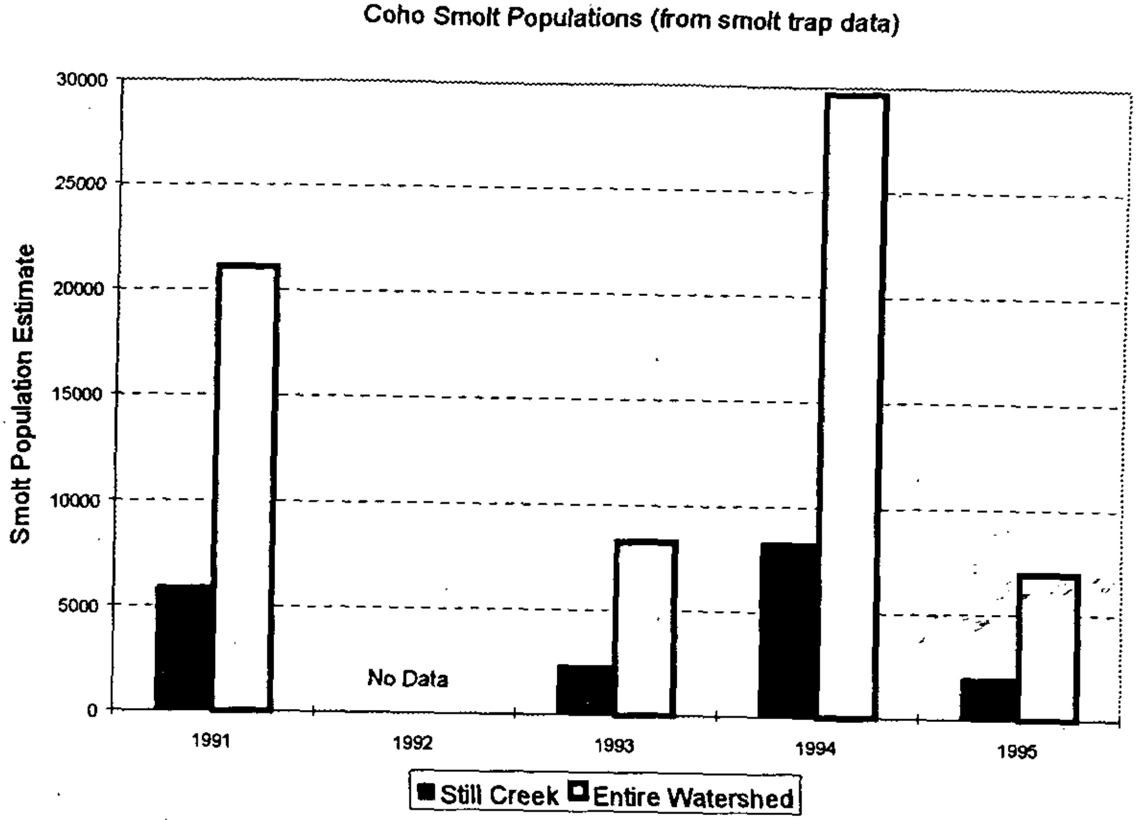


Figure 4-57 -- Coho Salmon Smolt Population Estimates



Cutthroat Trout

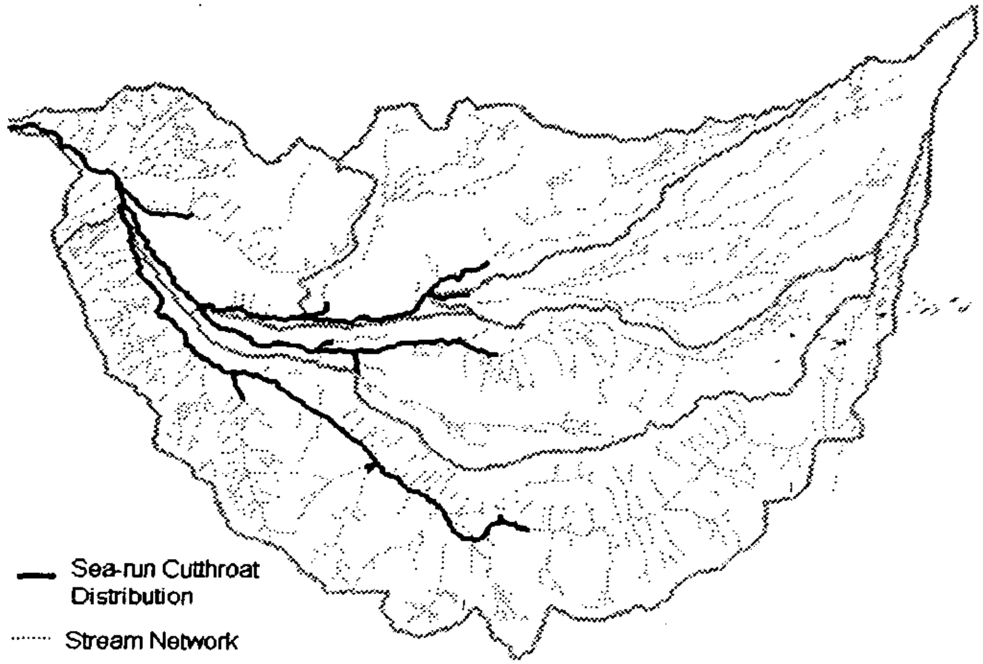
The cutthroat trout population in the Zigzag Watershed is composed of at least two native stocks: an anadromous (sea-run) form that is likely present in Still Creek and possibly other tributaries below impassable barriers; and a resident stock that is present throughout the drainage, particularly above barriers such as the falls on Devils and Still creeks. Preliminary results of genetic analysis of cutthroat trout in Still Creek indicate they may be a distinct population segment within the larger lower Columbia River assemblage of stocks. It is not known whether the stock is the anadromous or resident form.

The sea-run stock is currently listed by the Forest Service and ODFW as a sensitive species. It is classified as coastal cutthroat by ODFW, and populations have been in severe decline throughout its range. The AFS report (Nehlson et al, 1991) lists the stock as in moderate danger of extinction. Historically, much of the sea-run production was likely in the lower Sandy Basin, but a small run continues to return to the upper basin.

High quality cutthroat habitat present in Still Creek and other tributaries indicates the Zigzag Watershed may have served as an important production area for this fish.

However, adult fish returns at Marmot Dam have plummeted. Few have been counted passing the dam in recent years. While few smolts are observed at Marmot Dam and the trap on Still Creek, they remain consistent from year to year. The fish are prized by anglers and are easy to catch. Given the very high levels of recreational fishing within the watershed and entire upper Sandy basin, it is likely that overfishing has contributed to the decline of the stock. Other factors likely include poor ocean-rearing conditions and degradation of habitat throughout the Sandy Basin.

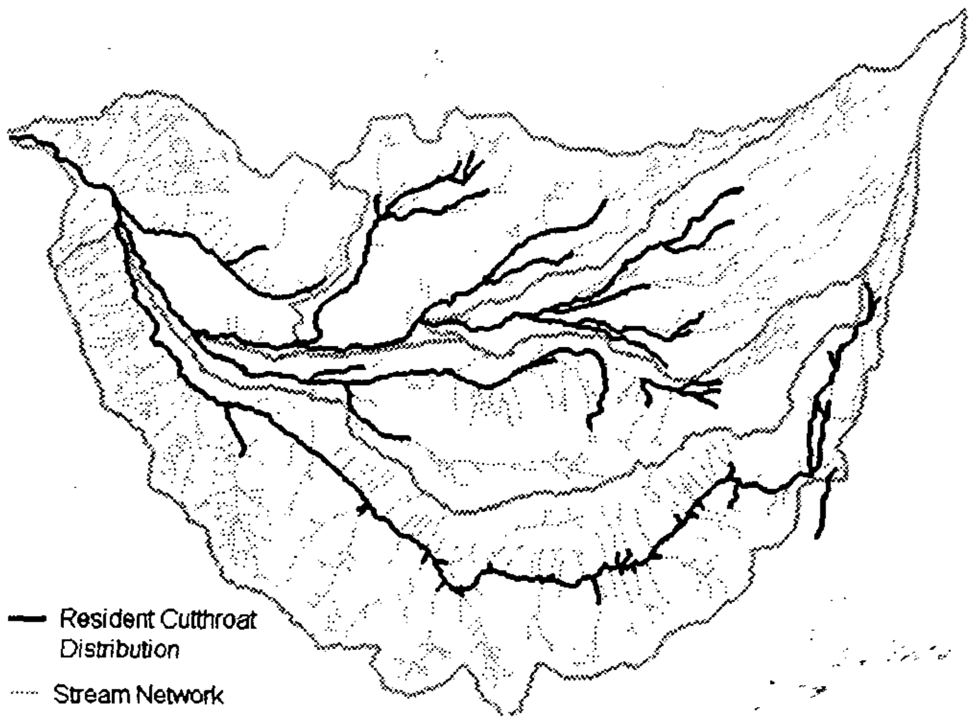
Figure 4-58 -- Sea-Run Cutthroat Trout Distribution



While the cutthroat trout resident stock is well-distributed throughout the drainage, several factors may be limiting its numbers in some areas. It, too, is easily caught, and areas near roads and development may literally be "fished out" of larger, reproductive-age trout. It does not compete well for food and space with some other salmonid species and may be displaced from its habitat. This appears to be the case where Eastern brook trout were introduced into upper Camp Creek, (from Mirror and Multorpor Lakes). Cutthroat may also hybridize with rainbow trout.

The introduction of hatchery strains of rainbow and cutthroat trout to Mirror Lake (along with brook trout) may have introduced those strains downstream into Camp Creek. If so, hybridization with cutthroat could have occurred. For these reasons, the "refuge" habitat provided in remote drainages above migration barriers, is especially important for retaining genetically pure stock of this fish.

Figure 4-59 -- Resident Cutthroat Trout Distribution



Resident Rainbow Trout

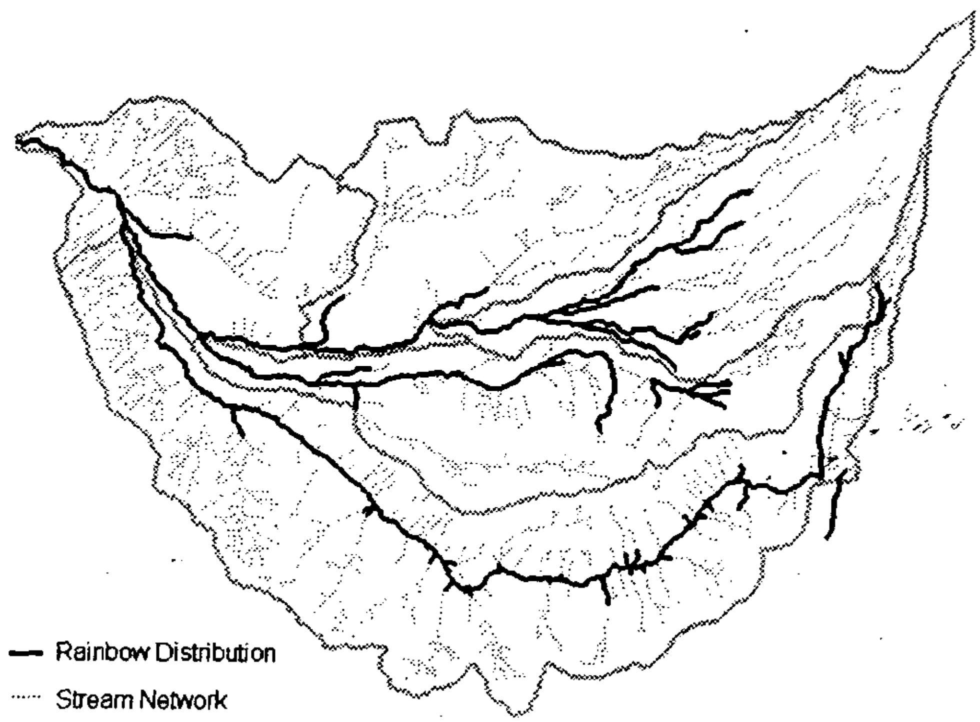
Native Stock

Resident rainbow trout are likely present in the Zigzag Watershed. Fish sampling to date is inconclusive on their present distribution (juveniles are visually indistinguishable from steelhead in anadromous habitat). Also, in the past, several streams were either directly stocked with rainbow, or their headwater lakes were stocked. Therefore, identification of the distribution of native resident rainbow can only be inferred at this time. It is likely they occur in the same environments as steelhead, and may be found above migration barriers in some isolated watersheds.

Introduced Stock

The Zigzag River, Still Creek and other streams were stocked with rainbow historically. Stocking has also occurred in several locations within the Camp Creek drainage. Due to easy access, attractive environment, nearby campgrounds, and good fishing, Mirror Lake and Camp Creek attract heavy use by anglers. Resident trout populations were likely heavily impacted by intensive fishing decades ago. For this reason, ODFW supplemented trout populations with catchable-size fish on Camp Creek near the Camp Creek Campground, and fingerling rainbow at Mirror Lake. (In 1994 ODFW discontinued the stocking of legal-sized rainbow on Camp Creek.) Downstream movement of fish from Mirror lake into Camp Creek could occur, where they may compete with resident and juvenile anadromous fish for food and space. Although the hatchery stocks are not expected to reproduce, there is also a possibility for interbreeding with native stocks.

Figure 4-60 -- Resident Rainbow Trout Distribution



Redband Trout

A stock of inland rainbow trout ("redband") has been identified in the Little Sandy subwatershed. In addition, they may exist elsewhere in the upper Sandy. No stocks believed to be redband have been found in the Zigzag Watershed; however, suitable habitat is present. Redband trout are currently proposed for listing by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act.

Bull Trout

The USFWS is also reviewing possible listing of bull trout as a Federal Threatened or Endangered Species. Bull trout are currently listed as a sensitive species by the State of Oregon and the Forest Service. There are anecdotal reports of bull trout historically in the Zigzag Watershed (Still Creek), but no confirmed observations. Fish population sampling in the watershed has been very extensive from 1975 to present. No bull trout have been recovered. Suitable habitat and isolation exists to support this species in the watershed, especially on the Zigzag and Little Zigzag rivers.

Lower Columbia Fall Chinook

Lower Columbia River fall chinook salmon are listed as a state sensitive species and are identified at high risk of extinction by the AFS status report (Nehlson et al, 1991). This stock was apparently present in the upper Sandy basin (at least on the Salmon River) until Marmot Dam was constructed. There are no records of this fish in the Zigzag Watershed, although suitable habitat exists. This stock was not able to adapt to pressures from egg-take for hatcheries, intensive fisheries, extended periods of low mainstem flows, poor upstream passage conditions, and high smolt mortality that were imposed by dam operations from 1912-1951 and later. The fish are now found only in the lower reaches of the Sandy River, although spawning adults were documented in the Salmon River in the fall of 1994. The Sandy Basin Plan (in progress) is defining two and possibly three stocks of fall chinook: tule stock (September to mid-October), lower river wild stock (late October through December), and late bright stock (December through February). The stock referred to in the AFS text is the late component of the lower river wild stock.

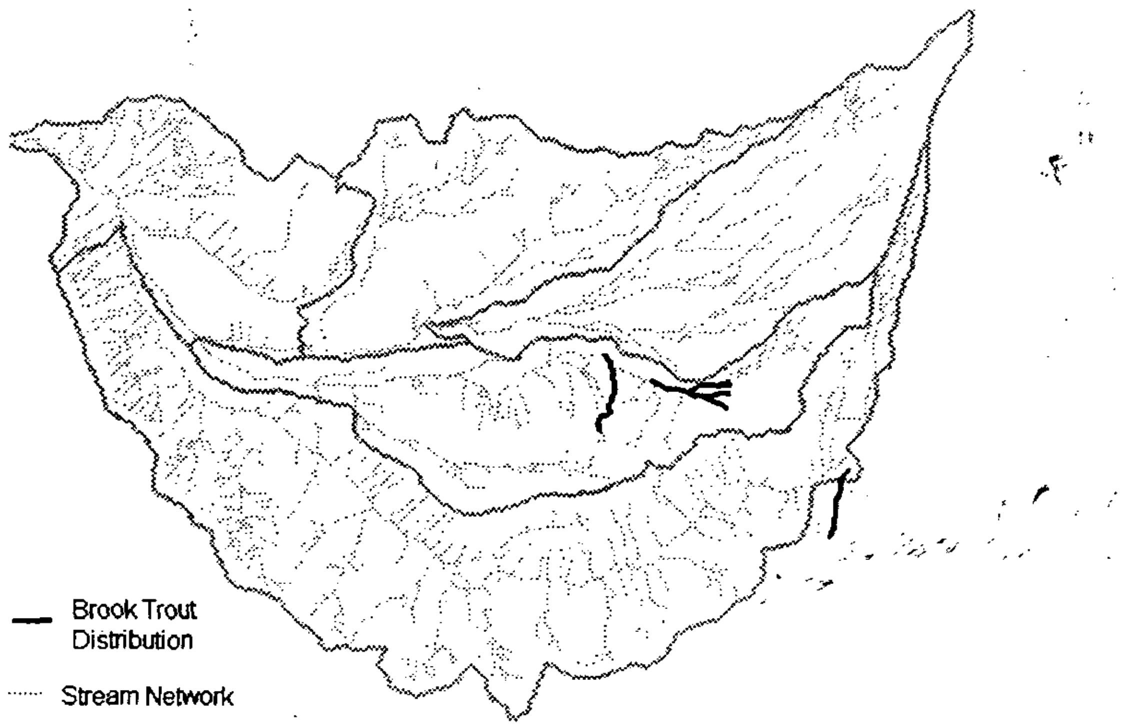
Brook Trout

Brook trout are stocked by ODFW in the watershed's lakes to provide recreational fishing opportunities. The fish are normally stocked as fingerlings that grow to catchable size in one year. Brook trout are favored for these lakes because they are well adapted to the habitat conditions present. The hatchery trout stocks (rainbow and cutthroat) available do not survive as well in these lakes due to variability in water quality and food supply. The lakes are generally small and shallow, with a thick cover of ice in winter and relatively warm summer water temperatures. Brook trout can endure a wider range of water temperatures and dissolved oxygen. They are feeding generalists, finding food on the lake bottoms, mid-water and surface environments.

Naturally reproducing populations of brook trout appear to be present in upper Camp and Devils creeks, Multorpor Fen, and Mirror, Devils, Hidden, and Enid Lakes. These introduced char are probably descended from fish stocked in the lakes. Habitat in these stream reaches and lakes is optimum for this species, with cool stream temperatures, braided low-gradient meandering channels, shallow ponds, and high levels of cover provided by overhanging and emergent vegetation. These fish are successfully competing for food and space with native trout stocks. Most of the lakes in which these fish were stocked were likely barren of fish prior to stocking. The effect of brook trout on plankton, macroinvertebrate and amphibian populations in these lakes is not known, although research in other areas of the Cascades shows substantial changes in the structure of lake ecosystems. . Devils Lake has indications of overgrazing by the brook trout within the lake The extent of changes should be evaluated, especially in the Wilderness area

(Devils Lake, Devils Creek and Hidden Lake) to encourage improved protection and management of lake ecosystems.

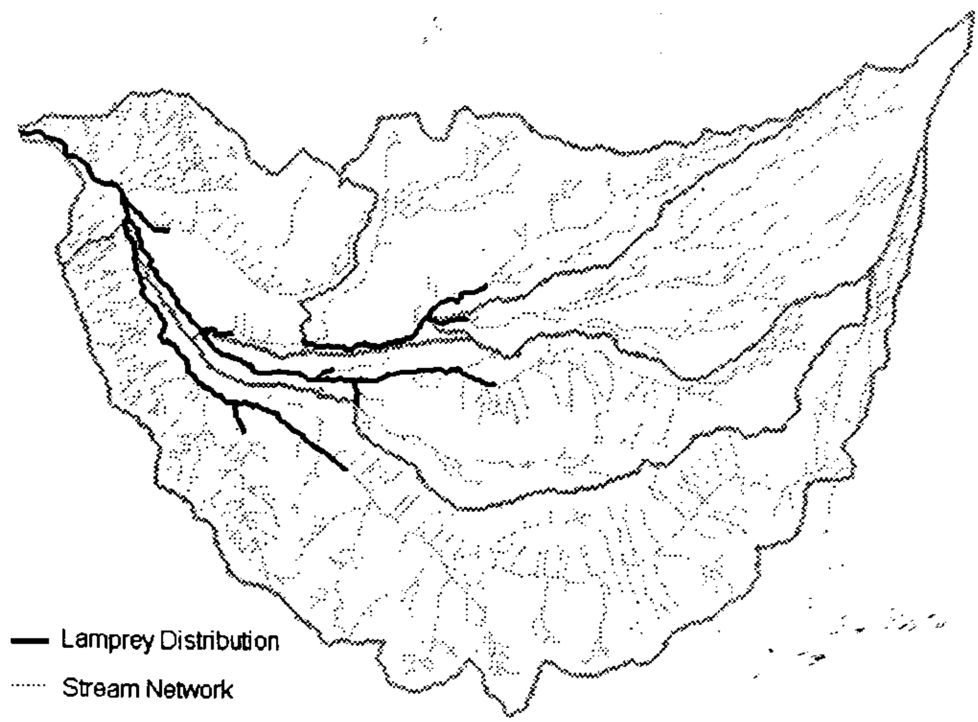
Figure 4-61 -- Brook Trout Distribution



Pacific Lamprey

Pacific lamprey are listed as sensitive by the State of Oregon and are included as a species of concern on the Oregon Natural Heritage database. The range of distribution for the lamprey is coincident with anadromous fish. Lamprey have been observed in the Zigzag River, Still and Camp creeks, and are likely to be present in much the same distribution of coho salmon within the watershed. The habitat requirements for the lamprey are somewhat similar to the salmonids (spawning requirements are identical to coho). However, lamprey have an extended larval phase (five to six years) in which the young (ammoceates) filter feed in fine substrates along stream margins. Rapid or prolonged water withdrawal from streams may dry out these environments and endanger the young. Other risks to the species include high water temperatures, impacts to water quality; and very high barriers may limit migration of adults.

Figure 4-62 -- Pacific Lamprey Distribution



Other Fish Stocks

Several non-game fish are found within the watershed. Mountain whitefish and longnose dace have been observed in lower Still Creek and the Zigzag River; they are likely present in low gradient reaches near the mouths of most of the tributary streams. One or more species of sculpins are also found throughout the range of cutthroat trout in the watershed, and may extend into smaller, steeper areas above the limit of those fish. The status of these populations is unknown.

Table 4-22 -- Summary of Fish Stocks Zigzag Watershed

Species/Stock	Origin	Trend
Spring Chinook	Wild Spawning (Naturalized)	Stable/Decrease
Coho	Wild Spawning (Naturalized) Native	Decrease Decrease
Winter Steelhead	Native Hatchery/Wild Spawning (Naturalized)	Decrease Decrease (since 1991)
Summer Steelhead	Hatchery/Wild Spawning (Naturalized) Native	Stable Unknown
Rainbow Trout	Native Hatchery	Decrease Stocked in Lakes
Cutthroat Trout -Anadromous -Resident	 Native Native	 Decrease Stable
Brook Trout (lakes)	Hatchery/Wild Spawning (Naturalized)	Stable
Mountain Whitefish	Native	Unknown
Dace (Longnose)	Native	Unknown
Sculpin -Torrent -Shortnose	 Native Native	 Unknown Unknown
Pacific Lamprey	Native	Decrease

Index of Biological Integrity

Biological integrity for the Zigzag Watershed was assessed using Indices of Biological Integrity from the California Department of Wildlife and Fisheries (Moyle and Brown 1986). This index evaluates the status of native communities, the impact of introduced fish, and habitat degradation. Table 4-22 shows fish stocks used for calculating the index. Index ratings for the Lahonton drainage of Northern California were used for comparison and evaluation. (This drainage appeared most similar in terms of species composition.) Factors leading to competition or interbreeding are rated on a scale of one to five, then summed to give an overall rating of integrity. Higher numbers indicate higher levels of biological integrity.

Table 4-23 Biological Integrity

Metric	Index ratings for: Wild & Native species
% Native Fish (#)	5
% Native Species	3
Total Fish Abundance	3
Total Fish Species	5
# of Salmonid spp.	5
Juvenile Salmonid Abundance	3
Catchable Wild Trout	3
Sculpin Abundance	5
Total	32 (Good)

This analysis indicates biological integrity is good overall and that wild spawning stocks are in relatively good condition. However, there is a decreasing trend in the population of wild spawning stocks within the watershed. Limiting factors that are operating on biological integrity in the watershed include:

1. Introduced species; competition/interbreeding -- Brook trout and summer steelhead may be affecting cutthroat trout and winter steelhead.

2. Habitat changes -- Flood control work in anadromous habitat has changed the balance of habitat types (riffles/glides/pools), favoring some species over others (steelhead more, coho less).

3. Harvest/handling stress -- Selects against native trout/salmon.

Stock Management

Anadromous Fish Stocks

Anadromous fish stocks in the Zigzag Watershed are managed under guidelines established in the ODFW Sandy River Subbasin Salmon and Steelhead Plan (1990). A new subbasin plan is in progress. The 1990 plan outlines a strategy for protection of native populations of salmon and steelhead, while continuing to provide for relatively high levels of consumptive recreational fishing, near previous levels.

Under this plan, stocking of coho and winter steelhead has been eliminated from the upper Sandy Basin. Stocking of summer steelhead smolts is continuing in the Zigzag River and Still Creek. Hatchery spring chinook smolts are released in holding facilities directly below Marmot Dam. In 1994, the stocking of catchable rainbow trout was discontinued in the watershed's streams. Several fishing regulations have also been implemented in the upper Sandy Basin to encourage natural reproduction and to protect emigrating smolts in the Zigzag Watershed. These include: a late opening date for trout season, eight-inch minimum size restriction, catch and release of wild unmarked adult steelhead (barbless hook regulations), complete closure for salmon above Brightwood Bridge, and seasonal closures for protection of native steelhead spawners.

Current objectives of the subbasin plan for spawning escapement in the upper Sandy Basin (above Marmot Dam) are shown in Figure 4-48.

Since the plan was adopted, escapement has generally been below the goals for all species. Also, based on historical information on production from the Salmon River, it appears that these goals may be conservative (with the exception of winter steelhead). These escapement goals will likely be reviewed, and possibly revised, in the new fish management plan.

Strategies proposed in the plan to achieve increases in escapement include: improved juvenile bypass facilities at Marmot Dam, habitat improvement in the upper Sandy Basin, and changing hatchery practices and releases.

Resident Fish Stocks

Usual methods for population management of resident gamefish, and providing a fisheries on these fish, include stocking programs coupled with fishing regulations, and, in some cases, public access management. Besides the stocking practices and fishing regulations mentioned previously, an eight-inch minimum size limit and a five fish daily limit are also currently in effect for trout on Zigzag Watershed streams. Trout regulations for the watershed's lakes are six inches and ten fish per day.

Resident populations appear generally stable under current conditions of access and stocking, although anecdotal evidence suggests that cutthroat populations have diminished in some areas due to heavy fishing pressure. Public reports indicate that the maximum size and number of catchable trout has also diminished over time. In the future, increasing public access to remote stream reaches, without special regulations for protecting native populations, may exacerbate this trend in the watershed.

In addition, there is some public concern that even with an eight-inch minimum size limit, significant numbers of smaller trout and smolts are being killed to handling stress and injuries from deep hooking. This may be more likely to occur when fishing with bait. There is also concern that a five fish per day bag limit may not be sustainable in heavily fished areas. Currently, no regulations specifically protect sea-run cutthroat, which is probably harvested indiscriminately in the resident trout fishery in both juvenile and adult forms. These concerns should be addressed in the new management plan.

Habitat

Habitat conditions for salmonids in the drainage range from low to high quality. Habitat surveys of the mainstem and tributaries have identified a wide diversity of habitat types, ranging from low-gradient, wide, meandering river channels to small, high-gradient glacier-fed creeks. The "typical" habitat for the watershed is a moderate to small-sized stream with boulder and rubble substrate, moderate to steep gradient, moderate to low levels of pools, and in-channel large woody debris.

Fish habitat has been degraded in some areas. Large floods in 1964 and the 1970s scoured the channel and swept much of the large woody material out of the system. Following these floods, the U.S. Army Corps of Engineers, the Forest Service and other public agencies and private individuals removed large logs and boulders from Still Creek, Camp Creek and the Zigzag River. The Zigzag River was deepened and straightened in this area, cutting off meanders, oxbows and side channels. Substantial habitat was lost, and the diversity and quality of habitat was reduced.

Only one diversion, Marmot Dam (operated by Portland General Electric [PGE]) is located between the Zigzag Watershed and the Pacific Ocean. This dam is equipped with a fish ladder for returning adults and screens to aid the downstream migration of smolts. These facilities were improved in 1983. In the late 1980s the dam was removed and reconstructed. Both downstream and upstream passage conditions are considered good at this time. PGE conducts surveys of fish runs to the upper Sandy Basin by using a system that photographs each fish entering the fishway.

Figure 4-63 -- Fish Habitat Sandy Basin

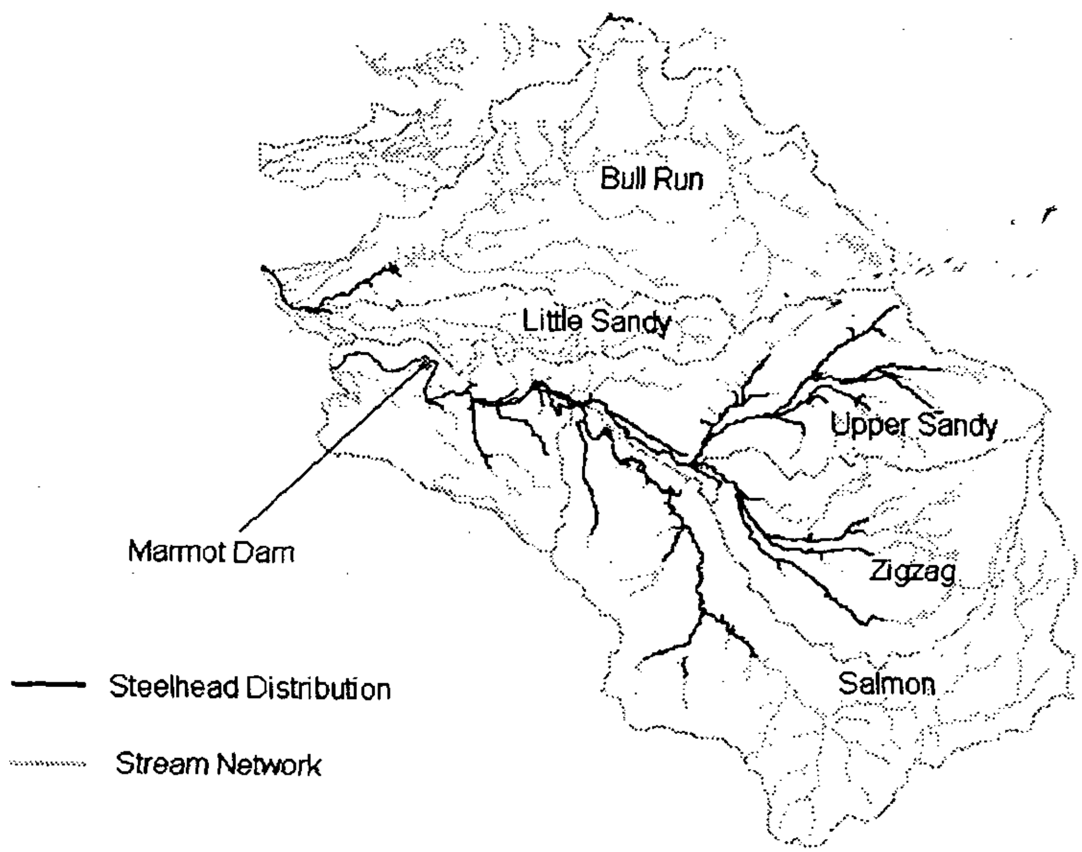
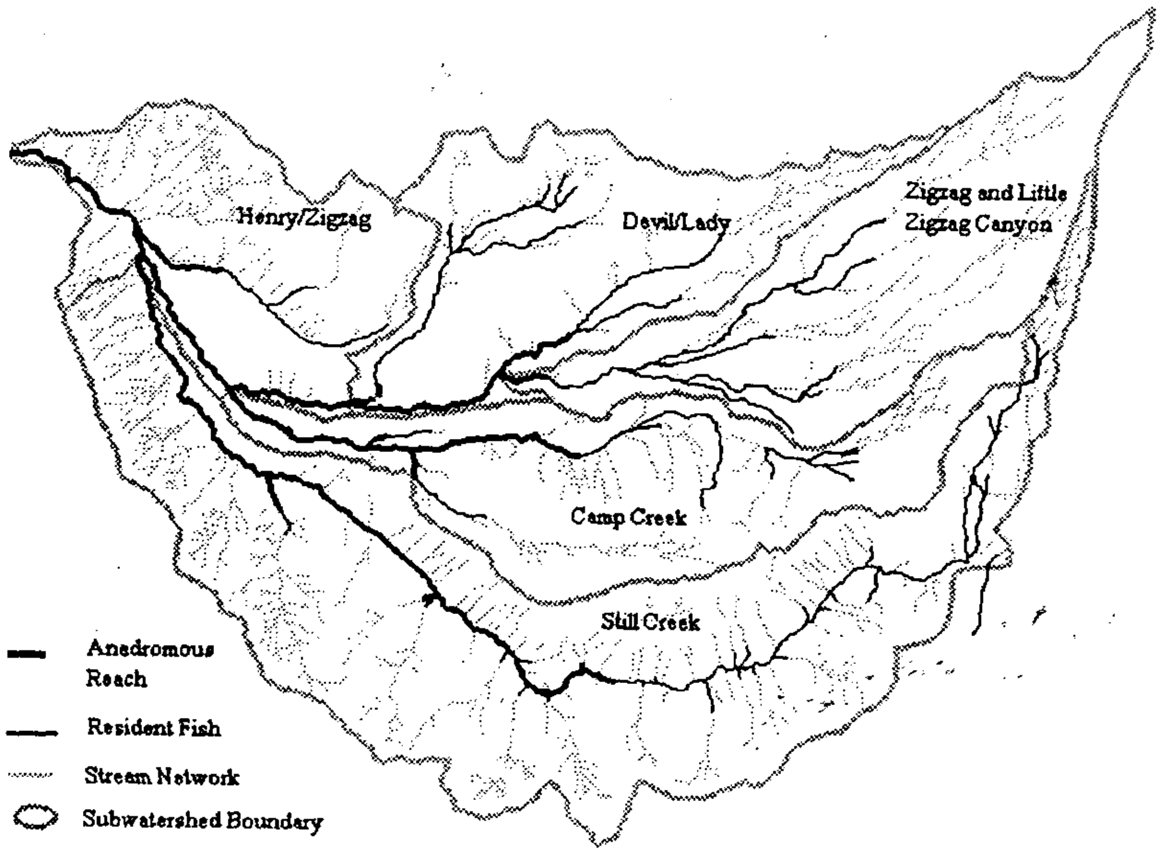


Figure 4-64 -- Fish Habitat and Subwatersheds Zigzag Watershed



Stream Geomorphology

Channel morphology and condition reflect the input of sediment, water, and wood to the channel, relative of the channel's ability to either transport or store these inputs (Sullivan et al., 1987). Systematic and local differences in transport capacity, coupled with the nature and magnitude of inputs through a channel network, result in a distribution of different channel types throughout a channel network. This reflects spatial differences in channel slope, flow depth, sediment supply, and the availability of large woody debris. Because of these differences, certain channels are more or less sensitive to similar changes in these input factors (Washington Department of Natural Resources [DNR], 1993).

Rosgen (Rosgen in prep.) developed a channel classification system utilizing channel morphological indices in defining stream types. Rosgen stream types for the Zigzag Watershed were identified from stream surveys, or delineated by generating stream gradients with a digital elevation model and using information from stream surveys on bankfull width, bankfull depth and dominant substrate. Figure 4-65 details the Rosgen stream types by subwatershed. By understanding these types, habitat hot spots and future restoration opportunities can be identified. An understanding of sensitivity of stream types to management can influence the width of Riparian Reserves.

Figure 4-65 -- Rosgen Stream Types

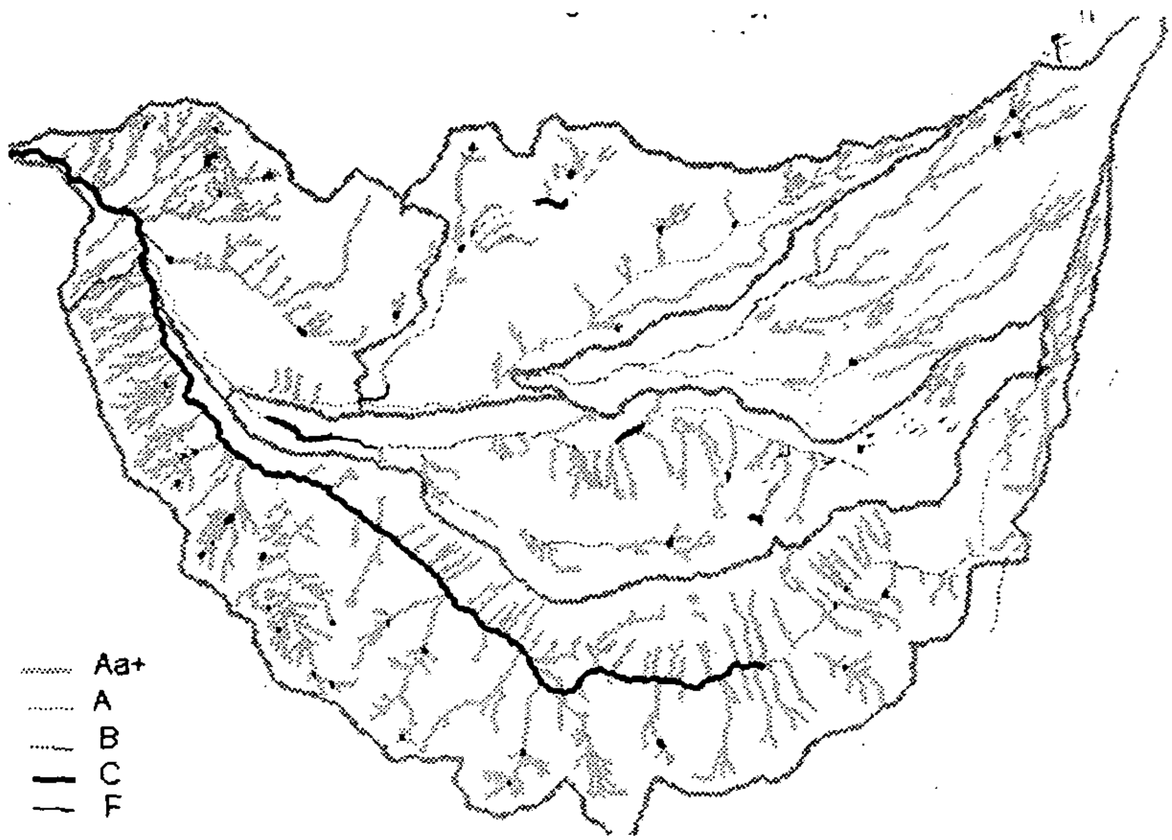
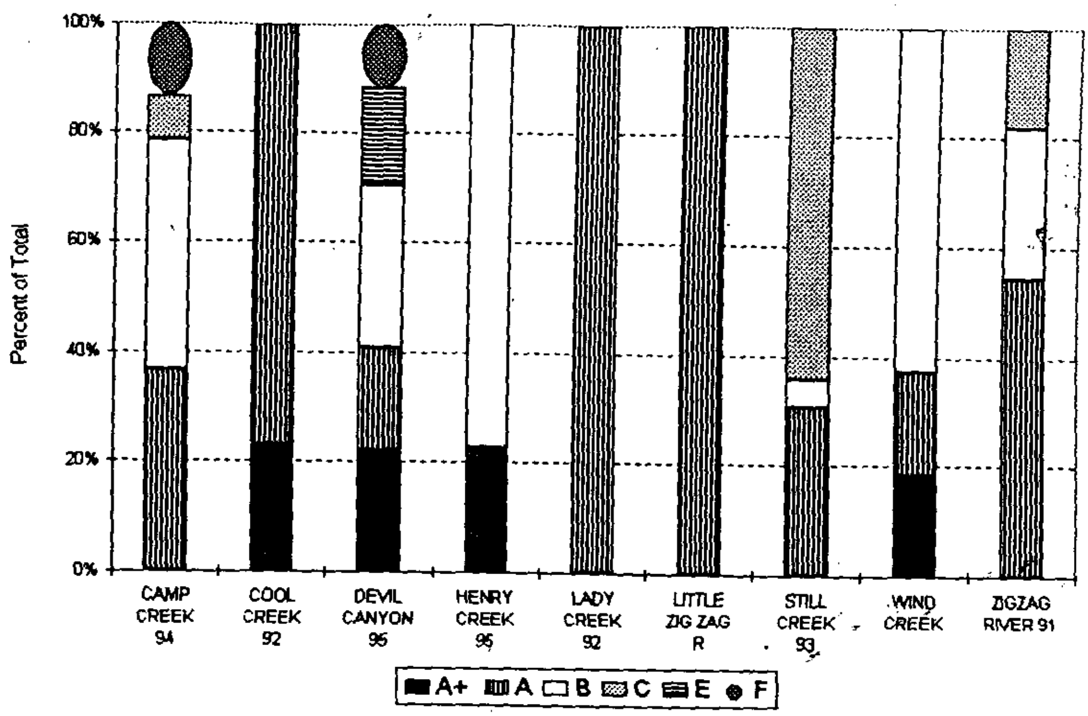


Figure 4-66 -- Rosgen Stream Distribution



General definitions of stream types:

- Aa+ -- very steep, deeply entrenched debris transport streams.
- A -- Steep, entrenched, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.
- B -- Moderately entrenched, moderate gradient, riffle-dominated channel with frequently spaced pools. Very stable plan and profile. Stable banks.
- C -- Low gradient, meandering, point-bar, riffle-dominated channels with broad, well-defined floodplains.
- E -- Low gradient, meandering riffle/pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander width ratio.
- F -- Entrenched meandering riffle/pool channel on low gradients with high width/depth ratio. Meandering, laterally unstable with high bank erosion rates.

The watershed was delineated into five subwatersheds based on land/fish distribution, land allocation and landform:

- Still Creek -- anadromous and resident fisheries, Late Successional Reserve, Special Emphasis Watershed, weak and resistant rock, steep moderate slopes.

- Camp Creek-- anadromous and resident fisheries, Riparian Reserve, Unroaded Recreation, unconsolidated and weak material, gentle slopes.

- Henry Creek/Zigzag River -- anadromous and resident fisheries, Wilderness, resistent rock gentle slope, and weak rock moderate slope.

- Devil Creek/Lady Creek -- resident and anadromous fisheries, Wilderness, resistant rock gentle slope.

- Upper Zigzag River/Little Zigzag River -- resident fisheries, Wilderness, unconsolidated material, gentle and moderate slopes.

The Still Creek subwatershed includes Still Creek, Cool Creek and their tributaries. Within the first and second order channels (including Cool Creek), A stream types occur. C stream types characterize the anadromous portion of Still Creek (river mile 0 to 6.8). This subwatershed's A+ and A channels will transport sediment into the C channels, where it will be deposited. C channels within this area have been identified as high quality habitat for anadromous fisheries.

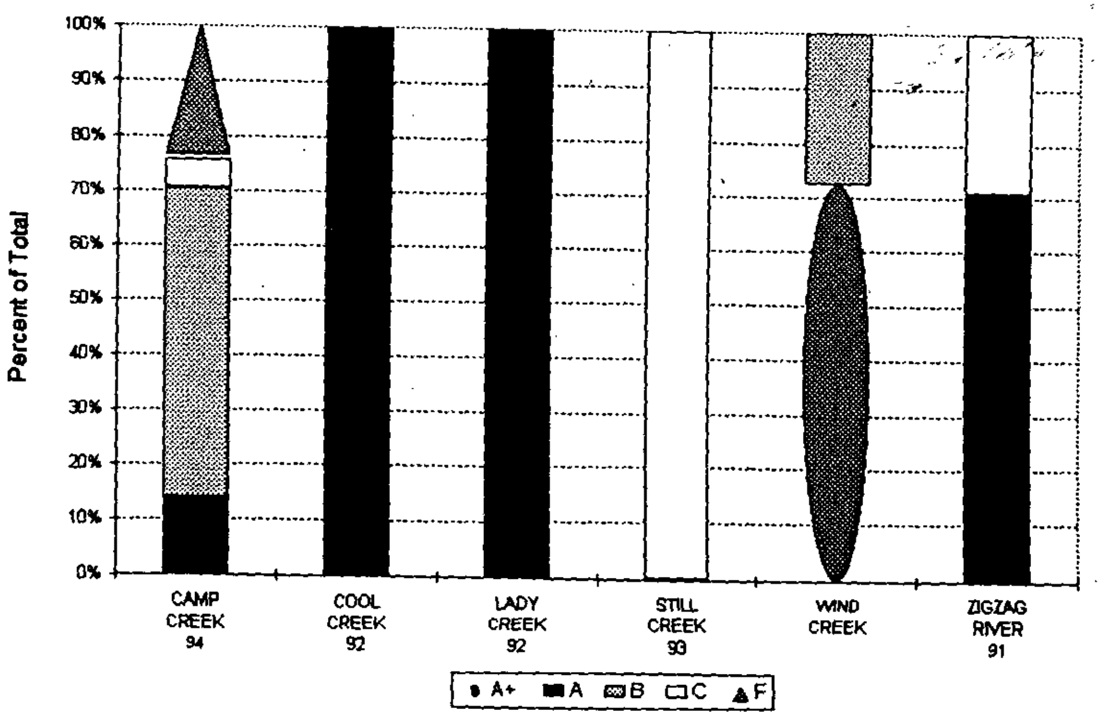
The Camp Creek subwatershed includes Camp Creek, Wind Creek and their tributaries. Approximately 40% of the channels in this area are A or A+. The remaining 60% are predominately B. The unconsolidated material in this watershed would be routed through the A and B type channels into depositional reaches in the lower part of the watershed which have been identified as high quality habitat for anadromous fish.

The Henry Creek/Zigzag River subwatershed is characterized by A+, A and B channels higher in the watershed, and C channels within the Zigzag River's lower two miles, which flow through unconsolidated material in a mudflow deposit. Any sediment generated in the A+ and A channels within the mudflow deposits would be moved through the B channels and deposited in the C channel type (rivermile 0-2.2) at watershed's mouth -- within the high quality anadromous fish habitat.

Devils Creek/Lady Creek subwatershed is characterized by A, B, and E channel types. The entire length of Lady Creek is an A type channel. Devils Creek is an A or B type channel for 3.2 miles upstream from its confluence with the Zigzag River, where it becomes an E type channel for a 0.4 miles, then becomes -- and remains -- an A+ channel type. Sediment generated in the 0.4 miles above the E type channel would be deposited in that section of channel. Sediment generated below that point would be routed downstream toward the depositional reaches on the lower Zigzag River.

Upper Zigzag/Little Zigzag subwatershed is in an area of unconsolidated material within the Wilderness characterized by A and B type channels. Sediment generated through natural processes in this area would be routed downstream toward depositional reaches on the lower Zigzag River.

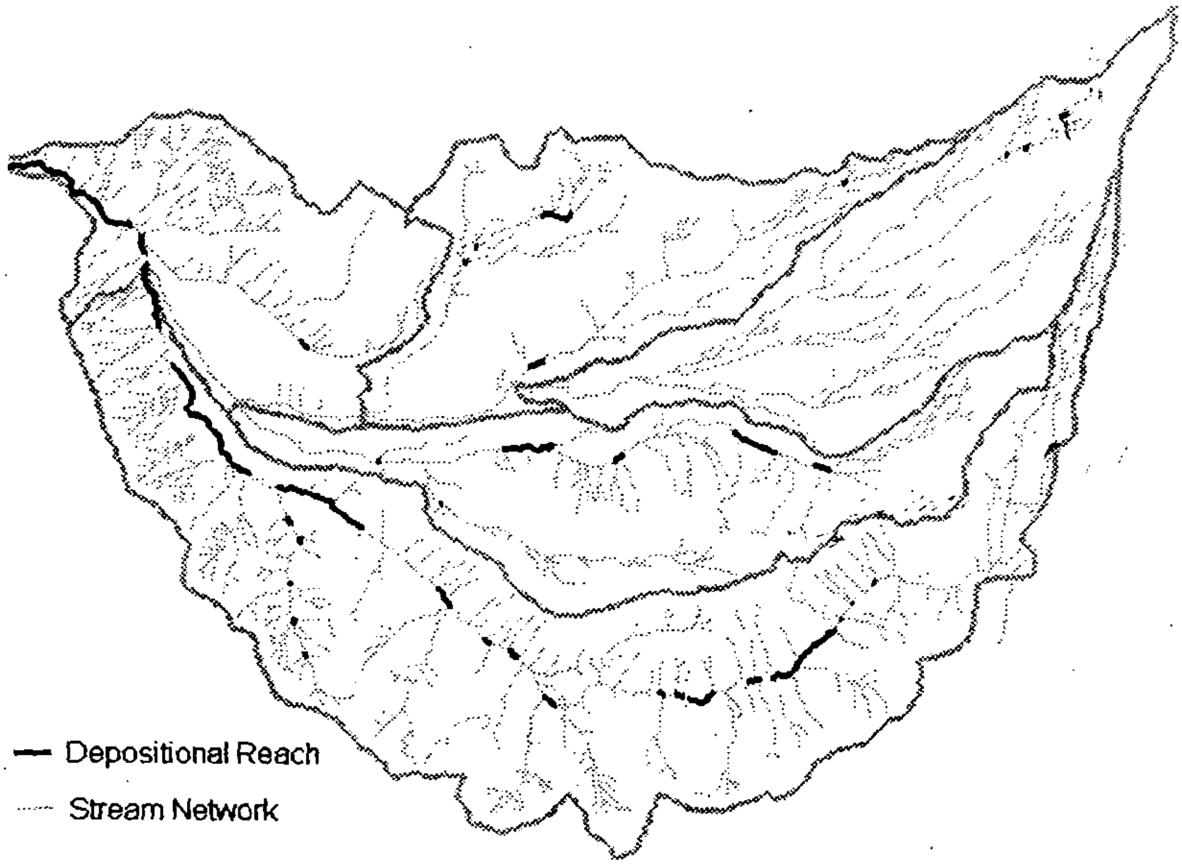
Figure 4-67 -- Rosgen Level I Stream Types withinthe Anadromous Section of the Zigzag Watershed



Cool Creek, Lady Creek and 70% of the Zigzag River are high energy debris transport streams. Camp Creek is a mix of debris transport and erosional stream types, with a depositional reach from rivermile 0.4 to 0.6, where sediment will accumulate. Wind Creek is a steep gradient high energy stream in the upper reaches, and a debris transport stream for the last 0.1 mile. Still Creek is a C type channel within the anadromous reaches.

Depositional reaches have been identified as high quality habitat for resident and anadromous fish and are mapped in Figure 4-68.

Figure 4-68 -- Depositional Reaches



It is notable that there are depositional reaches at many of the tributary junctions in the middle watershed. Depositional reaches tend to have very diverse habitat mixes and are frequently key habitats for fish production.

Stream surveys identified Level II channel types that can be used for management interpretations. Entrenchment, width/depth ratio, sinuosity and stream gradient are used to delineate Level I channel types. To further stratify channels, channel substrate is also a primary factor used to classify channels in Level II classifications.

Substrate classifications: Level I -- bedrock substrate; Level II -- boulder substrate; Level III -- cobble substrate; Level IV -- gravel substrate.

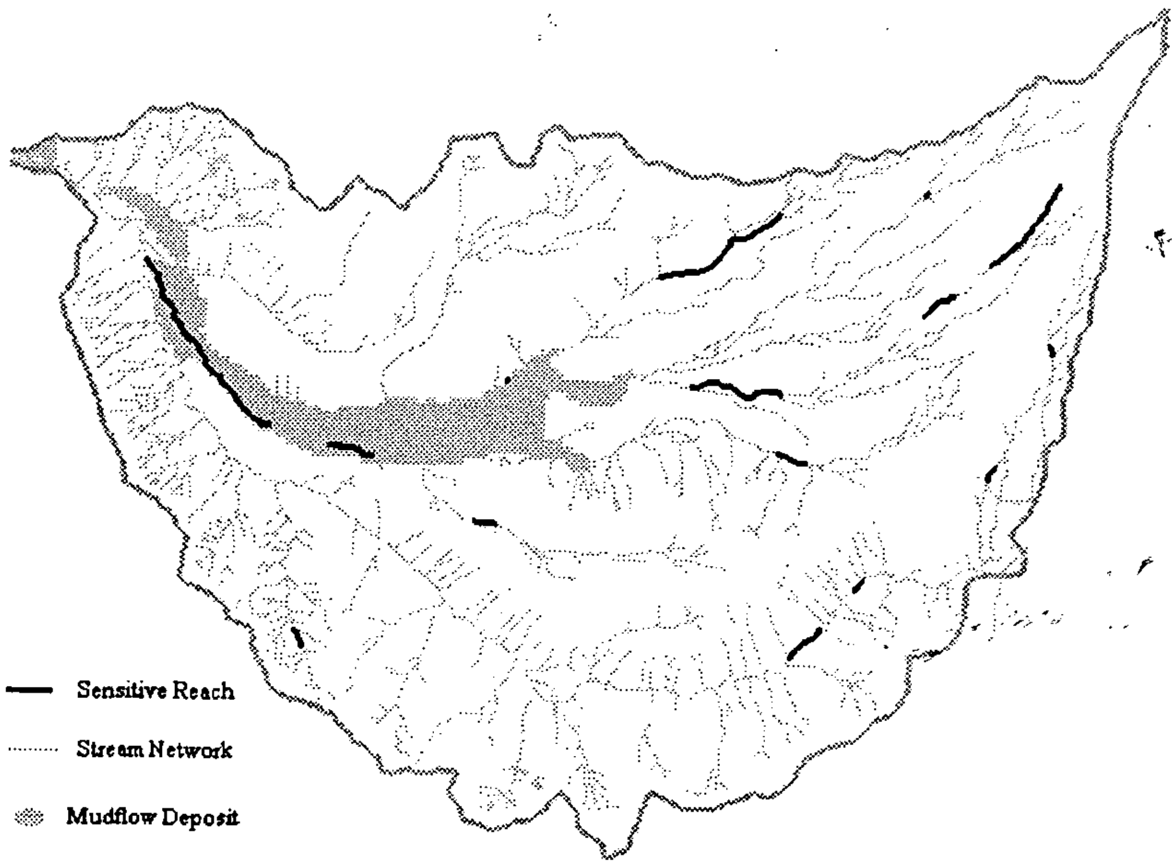
Table 4-24 -- Rosgen Level II Stream Types

	Percent of Total																		
	A1	A1a+	A2	A3	A3a	A3a+	A4	A4a	A4b	A5	B2	B3	B3a	B4a	C2	C3	C3b	E4b	F3b
CAMP CREEK 94			2	35								42					8		13
COOL CREEK 92			77			23													
DEVIL CANYON 95	19	22											18	12				18	12
HENRY CREEK 95		7				16							54	23					
LADY CREEK 92				100															
LITTLE ZIGZAG R				51						49									
STILL CREEK 93				5			16	9			5				64				
WIND CREEK 94		18							19				22	41					
ZIGZAG RIVER 91				44	10								27			18			

Table 4-25 -- Management Interpretations of Stream Types

Stream Type	Sensitivity to Disturbance	Sediment Supply	Streambank Erosion Potential
A1	very low	very low	very low
A2	very low	very low	very low
A3	very high	very high	high
A4	extreme	very high	very high
A5	extreme	very high	very high
B2	very low	very low	very low
B3	low	low	low
B4	moderate	moderate	low
C2	low	low	low
C3	moderate	moderate	moderate
E4	very high	moderate	high
F3	moderate	very high	very high

Figure 4-69 -- Sensitive Reaches (Rosgen Level II A3, A4, A5, E4, or F3 Channels)



Many of the stream reaches that are sensitive to disturbance in Zigzag River and Camp Creek are associated with mudflow deposits consisting of poorly-sorted pebbles, cobbles, and boulders in a gray sandy matrix. This landform is about 2,000 years old with the most recent surface deposit 200 years ago. Sensitive stream reaches in this area are also in areas that were cleaned of woody debris and straightened after the 1964 Flood. The channel modifications associated with the cleanout activities may have resulted in unstable channel types. Areas of unstable channels within volcanic mudflow deposits that have been straightened have the potential to be very unstable due to the compounding effects of the unstable landform on the unstable channel type

Sensitive stream reaches with sensitivity to disturbance, sediment supply and/or streambank erosion potential, have been identified in Little Zigzag River, Camp Creek, Wind Creek, Still Creek, and the Zigzag River. Of most concern would be the Zigzag River from river mile 2.2-7.3. -- immediately upstream of an area that has been identified as high quality habitat for anadromous fish.

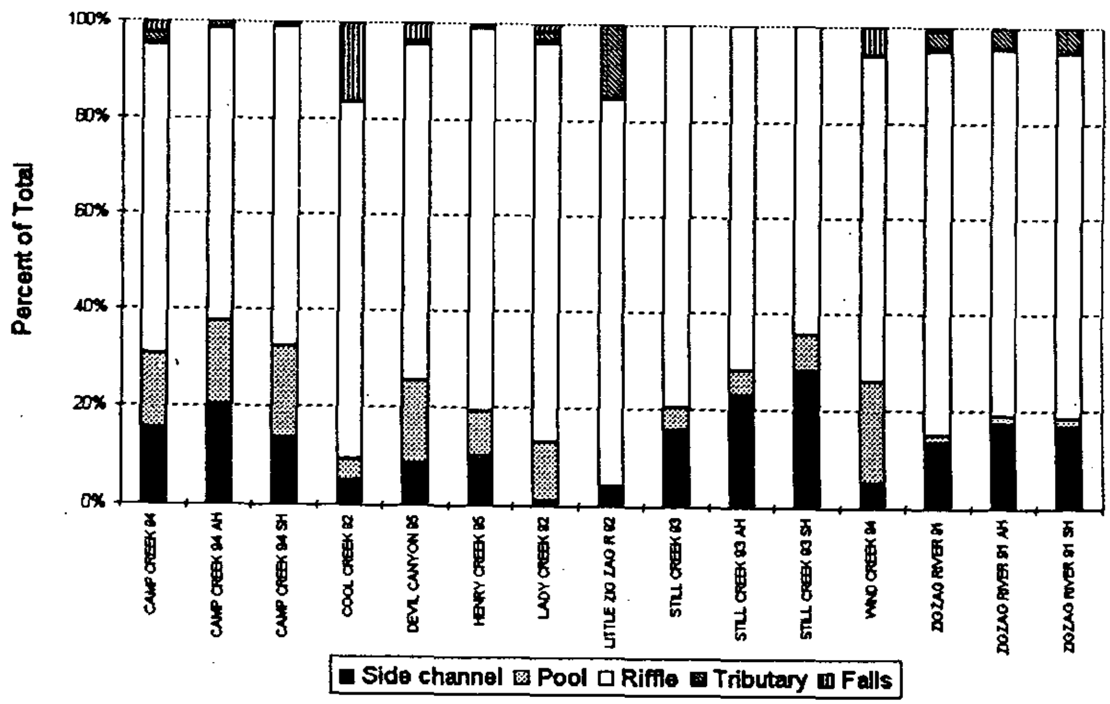
Aquatic Habitat Types

Pool, riffle, glide and side channel habitat types provide critical habitat for salmonid species. Different habitat types are preferred by different species at different stages of their life cycle.

- Fast water habitats (riffles and glides) -- trout and steelhead
- Large mainstem glides and pools -- chinook salmon
- Side channels -- coho salmon
- Small meandering streams with glides and pools -- resident cutthroat and brook trout

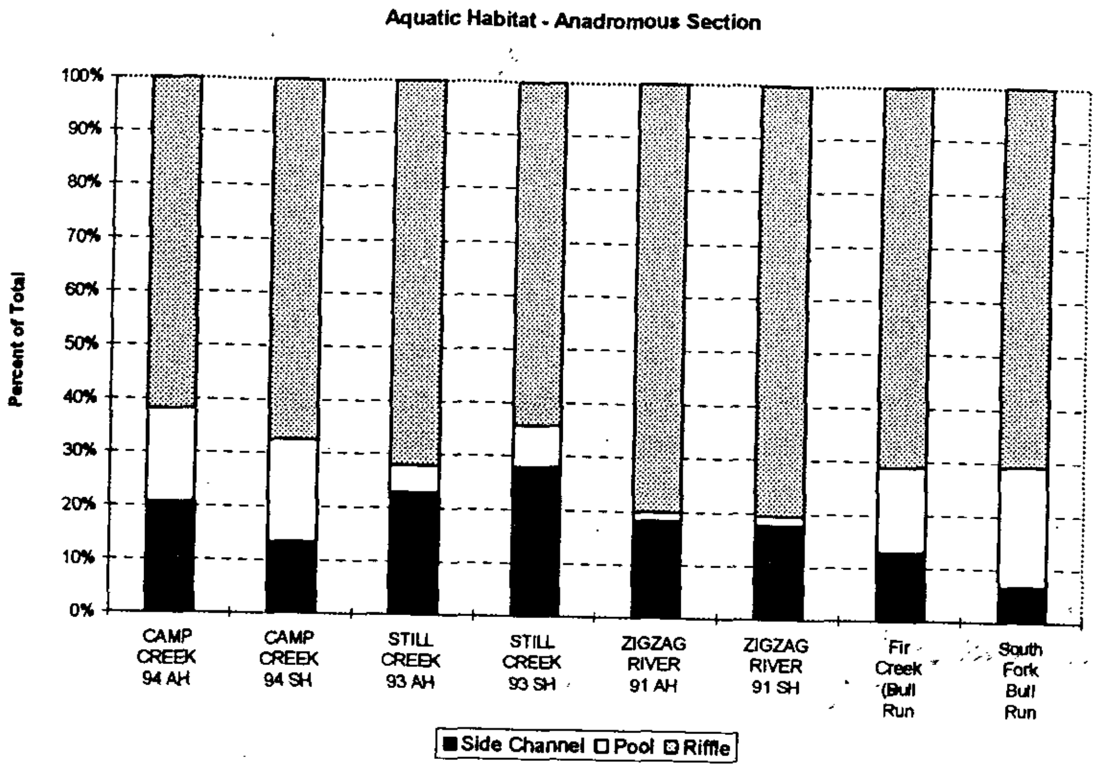
Habitat types for the Zigzag Watershed were evaluated to assess habitat quality for different anadromous and resident fish. This analysis was completed utilizing the habitat type from the Stream Management, Analysis, Reporting and Tracking (SMART) database.

Figure 4-70 – Aquatic Habitat Types Entire Watershed



SH=Recreational Residence Area
AH=Anadromous Habitat

Figure 4-71-- Aquatic Habitat Anadromous Reaches



Riffle habitat is the dominant habitat type for both resident and anadromous reaches. To determine how habitat types for the anadromous sections of the Zigzag Watershed compare to unmanaged or less-disturbed areas, habitat types from the Zigzag Watershed were compared to streams from the Bull Run Watershed (where cleanout of large woody debris and channel straightening has not occurred). Fir Creek is an unmanaged basin within the Bull Run Watershed where roading or timber harvest has not occurred.

This comparison indicated:

- Riffles were in the same range for the two basins, with the exception of the Zigzag River, which has slightly more riffle habitat than the stream in the Bull Run.

- Pool habitat appears to be lower than the undisturbed condition, with the exception of Camp Creek.

- Side channel habitat within the watershed is at or above levels within the Bull Run, and is well above levels for the lower Salmon River.

A limiting factors analysis for coho salmon was completed for the Salmon River Watershed (OSU 1990). This analysis concluded that side channels are the primary limiting factor to coho production within that watershed. Similar conditions exist within the Zigzag Watershed (even though levels of side channel are higher than the Salmon River's). Therefore, high quality side channel habitat (side channel habitat that includes large wood) may be one of the factors limiting coho production within the Zigzag Watershed.

Based on comparisons to Bull Run streams, the mix of habitat types within the anadromous reaches is similar to an undisturbed stream system. The major difference appears to be that pool habitat is lower within the Zigzag Watershed. This change has altered the watershed's habitat to favor steelhead over coho and chinook salmon.

Within the portion of the watershed that supports resident fish, a mix of habitat types provides adequate habitat for existing species (riffles and glides for resident rainbow trout, and glides and pools for cutthroat and brook trout).

Pool Levels

Pools provide resting habitat for adult salmonids on their spawning migrations, baseflow thermal refugia, protective cover, and slow water-rearing and overwintering habitat for juvenile steelhead and salmon, resident fishes, and amphibians. The capability of individual pools for cover and habitat partitioning increases with depth, volume, substrate complexity, and large woody debris.

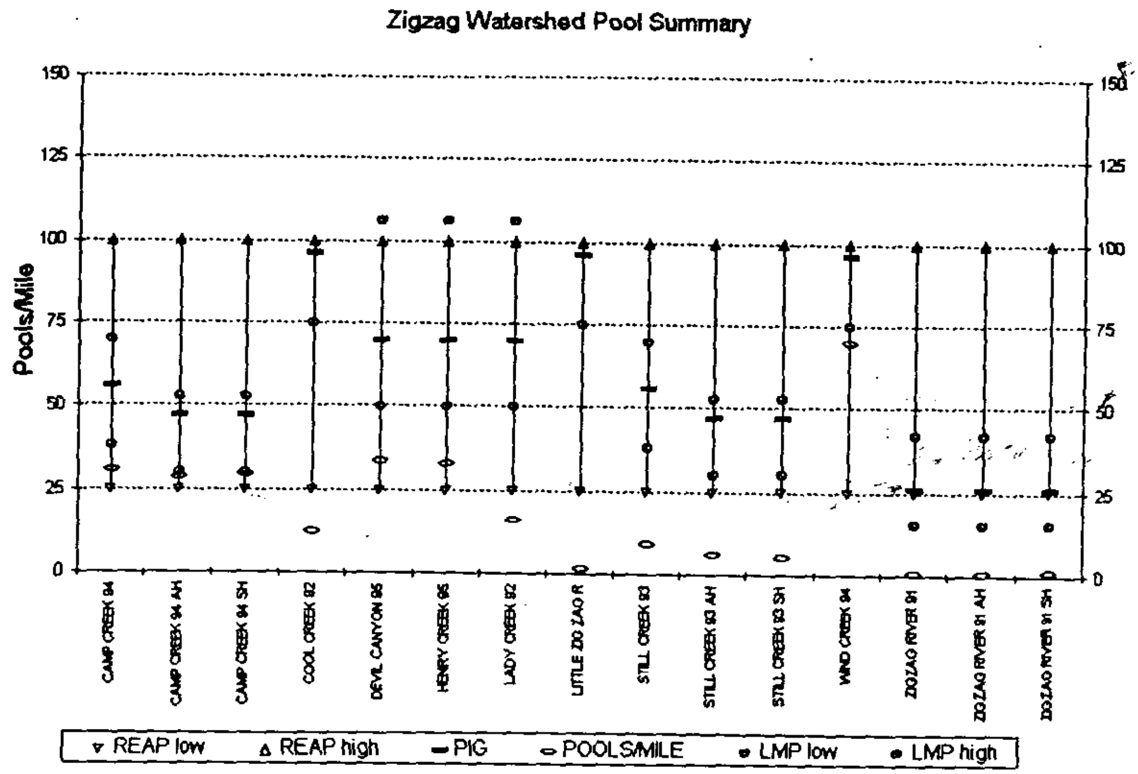
The natural range of pool frequencies is highly variable and dependent on gradient, confinement, and stream width. Habitat complexity and the number of pools per mile increases with decreasing stream order and width.

In low gradient depositional C channel types, the lateral scour pools on the outside of meander bends are the primary pool form (Rosgen, in prep.; Montgomery and Buffington 1993). Channel straightening and entrenchment within the lower watershed has decreased the natural meander pattern of C reaches. Large log jams in C reaches tend to create high amounts of pools and cover and therefore are key habitats for fish production. Virtually all log jams have been removed from the lower Zigzag Watershed (Still Creek, Camp Creek and Zigzag River).

Pool levels were calculated from queries of the SMART database. The assessment was completed to compare pool quantity to the range of natural variation, LRMP, and Columbia River Policy Implementation Guide/Salmon Summit (PIG) standards.

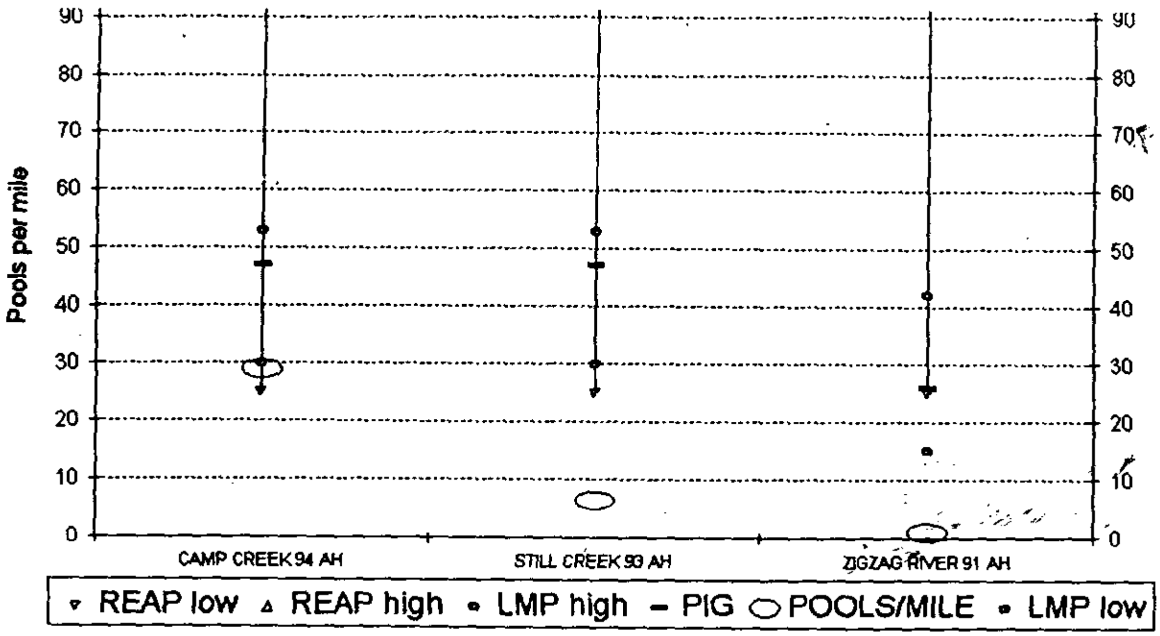
The range of natural conditions was approximated from data on the Lewis River, located on the Gifford Pinchot National Forest. Of all the watersheds evaluated as part of the Regional Ecosystem Assessment Project (REAP), the range of natural variation for the Lewis River best approximates conditions within the Zigzag River due to similar stream types and vegetative conditions..

Figure 4-72 – Pool Levels for Entire Zigzag Watershed



Excluding Wind Creek, the watershed's pool levels are at the low end of the range of natural variation, or below the range of natural variation. Levels within Still Creek, Cool Creek, and the Little Zigzag and Zigzag rivers are well below the range of natural variation, as well as below LRMP and PIG standards.

Figure 4-73-- Pool Levels for Anadromous Reaches



Within the anadromous portion of the watershed, Camp Creek pool levels are inside the range of natural variation, and are close to meeting LRMP standards. Low levels of primary pools within the Zigzag River and Still Creek are most likely associated with stream cleanout and channel straightening triggered by the 1964 flood (Figure 4-74).

To assess the quality of primary pools throughout the watershed, pool volumes were also determined for stream reaches.

Figure 4-74 -- Stream Cleanout

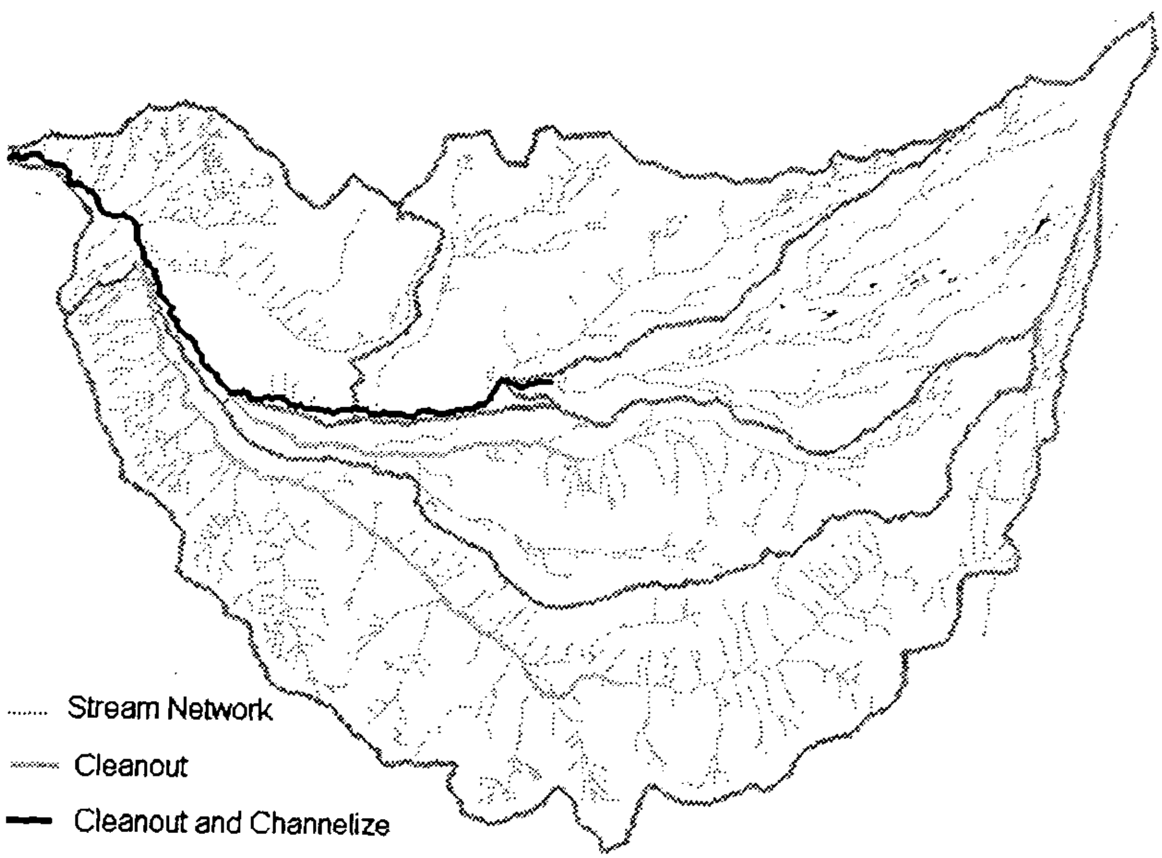
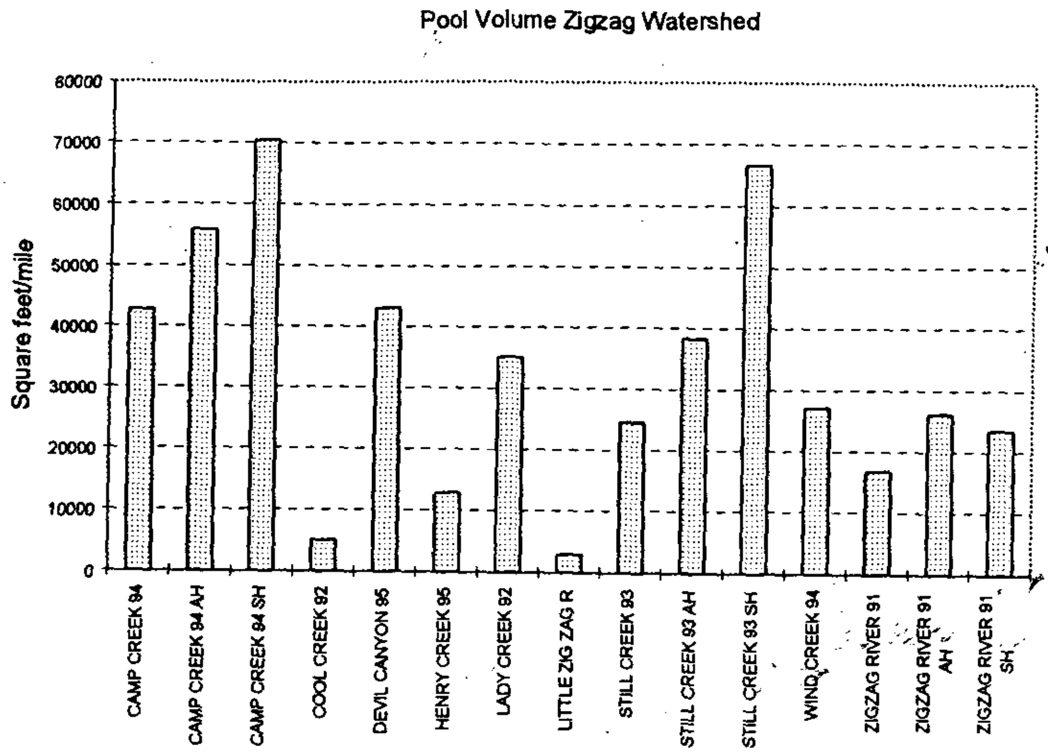
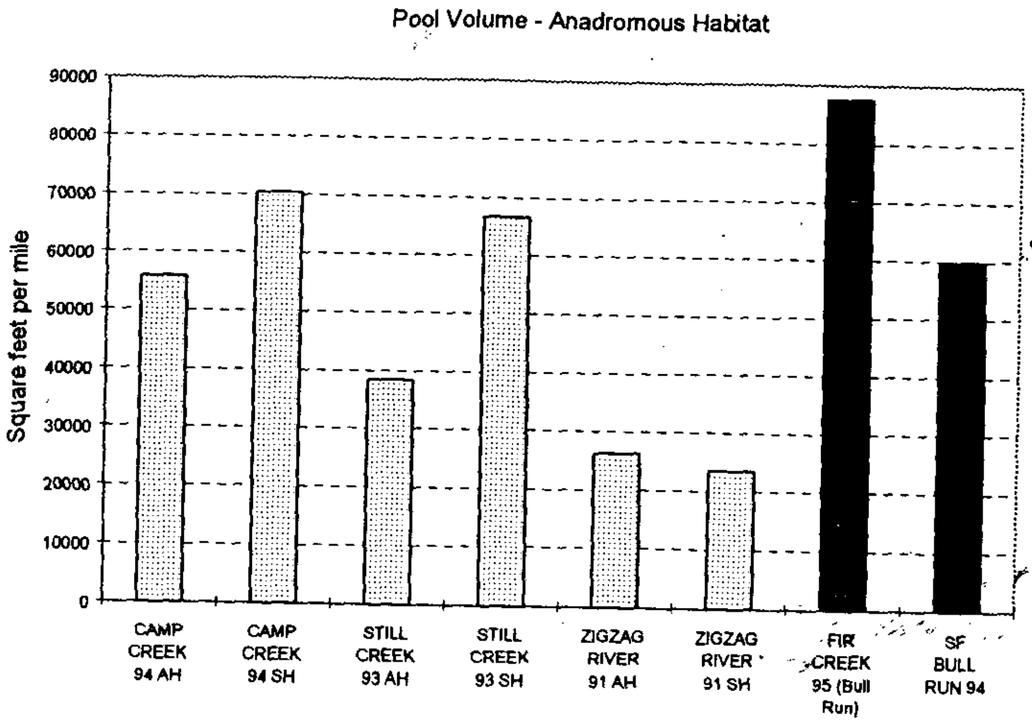


Figure 4-75 -- Pool Volumes for Entire Watershed



Pool volumes are greatest in the larger streams (Camp Creek, Still Creek and Zigzag River) within the anadromous reaches. It is notable that pool volumes are greatest within the Recreational Residence tracts, where placement of large woody debris has resulted in increased pool volume. The smaller, steeper gradient streams within the watershed (Cool Creek, Little Zigzag River, Henry Creek and Wind Creek) had the lowest pool volume. Wind Creek, which had the watershed's highest frequency of pools, has one of the lowest pool volumes (27,205 sq ft/mile).

Figure 4-76-- Pool Volume Anadromous Reaches



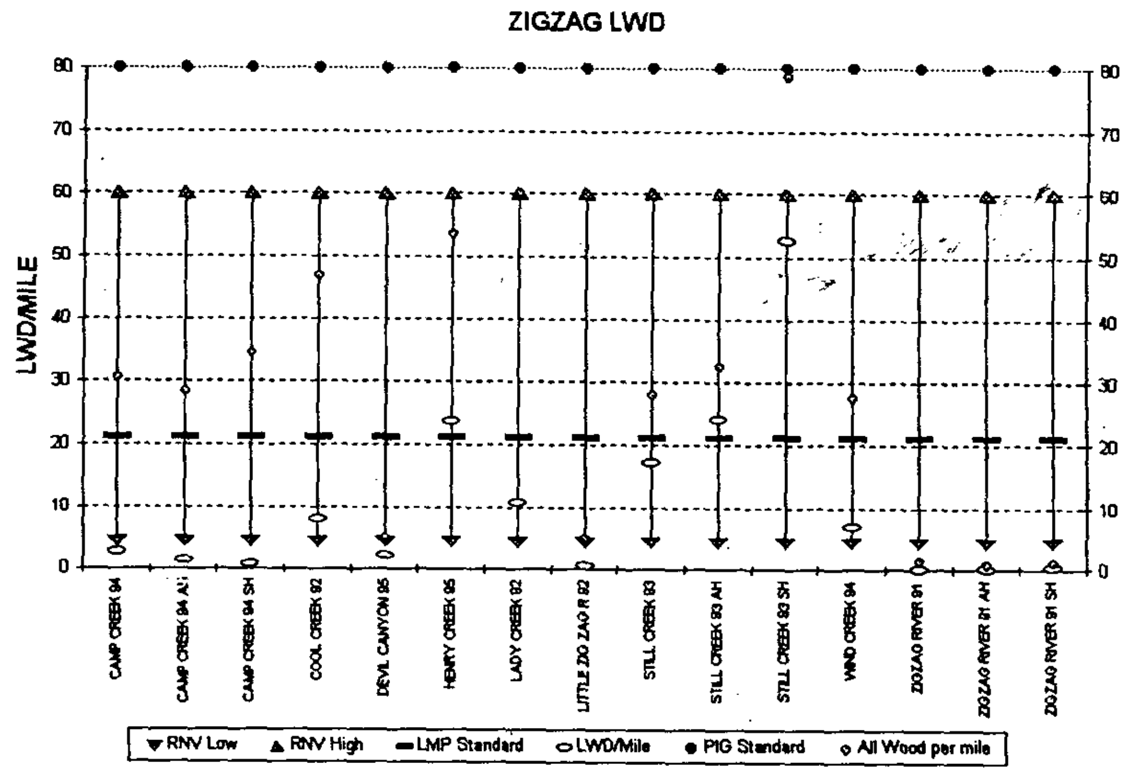
To assess the effect of management activities (stream cleanout and channelization) on pool volumes, pool volumes within the watershed's anadromous section were compared with pool volumes from similar streams within the Bull Run Watershed. Fir Creek and South Fork Bull Run River were felt to reflect the undisturbed condition of a similar stream type within the Sandy basin. It appears that pool volume has been reduced from an undisturbed condition, particularly in the Zigzag River. The low level of pools in this area is attributed to stream cleanout and channelization activities. Pools volumes are greatest within the Recreational Residence tracts along Still Creek and Camp Creek, where they reflect the effects of recent fish habitat enhancement efforts.

Large Woody Debris

Large woody debris provides: pool structure, sediment storage, substrate, partitioning of space, cover, nutrients, channel roughness, and velocity refuge for aquatic plants, fish, macroinvertebrates, and amphibians. As explained earlier in this chapter, large floods in 1964 and 1972 scoured the channel and swept much of the large woody material out of the system. Following these floods, the U.S. Army Corps of Engineers, the Forest Service and other public agencies and private individuals removed any remaining large logs and boulders from Still Creek, Camp Creek and the Zigzag River.

The current levels of large wood were queried from the SMART database. Large woody debris has a diameter of 36 inches or greater, and length of 50 feet or greater. The range of natural variation was established for the Zigzag Watershed by examining levels of large woody debris in unmanaged stream reaches in the Salmon River and Bull Run watersheds.

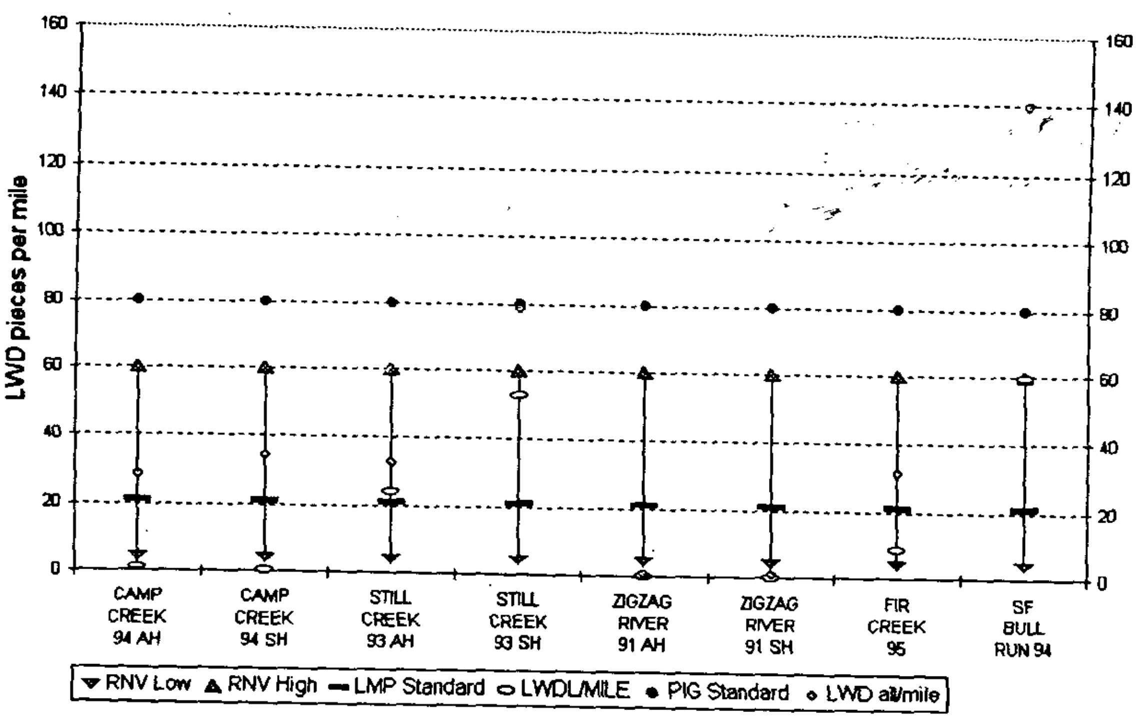
Figure 4-77-- Large Woody Debris Levels



With the exception of Still Creek and Henry Creek, large woody debris levels throughout the watershed are below or at the low end of the range of natural variation. When the LRMP standard 20 pieces per mile was compared to Pacific Silver Fir Zone stands within the watershed, the average was determined to be approximately 1.5 pieces of large woody debris per mile (pers comm, Jeff Reis). Eighty-six percent of the watershed has been impacted by fire at least once since the turn of the century, which may account of this lack of large woody debris. If small woody debris (>=24" diameter and >=50' long), is added to large woody debris, then compared against a standard of 20 pieces of large and small woody debris per mile -- the majority of streams in the watershed meet this standard. Streams within the anadromous section of the watershed are fairly narrow (Camp

Creek = 19.9', Still Creek = 21.9' and Zigzag River = 40.7'), compared with anadromous reaches along the mainstem of the Salmon River (approximately 60'). Therefore, pieces of large woody debris with a diameter of 24-36" may provide the same function as larger wood does in other systems. The exceptions to meeting this standard are Devils Canyon, Little Zigzag River and the Zigzag River. Because Devils Canyon and Little Zigzag, for the most part, are located within designated Wilderness lands, this may be these streams' natural condition. The Zigzag River has been channelized, and large woody debris was removed after the 1964 floods -- which may explain for the low levels of large and small woody debris in this area.

Figure 4-78 -- Large Woody Debris Anadromous Reaches



Levels of large woody debris within the anadromous reaches in Zigzag River and Camp Creek are outside the range of natural variation and well below LRMP standards. Still Creek is within the range of natural variation and above LRMP standards, especially within the Recreational Residence tracts. Fir Creek and the South Fork of the Bull Run were compared to anadromous reaches within the Zigzag Watershed to assess conditions against an undisturbed system. Fir Creek, an unroaded and unharvested watershed, has levels of large wood that are below LRMP standards, and are similar to levels in Camp Creek and in the Zigzag River. If large woody debris and small woody debris are combined, levels within Fir Creek and Camp Creek are similar. The Zigzag River is well below the undisturbed condition for the Sandy Basin. Based on the range of natural variation established for the Sandy Basin, and for levels of large wood in Fir Creek, it is a concern that PIG standards may not be achievable.

Even though it was outside the scope of this analysis, it nonetheless remains a concern that levels of large woody debris in intermittent streams -- which serve as an ecologically important link between aquatic and terrestrial ecosystems -- may be low.

Riparian zones associated with intermittent streams function as habitat for: amphibians, travel corridors, microclimate refugia, and water and food sources for terrestrial wildlife. At the same time, intermittent streams convey terrestrial inputs of large woody debris, nutrients and sediment downstream to fish-bearing streams (Reid and Ziemer unpub.).

Large Woody Debris Recruitment Potential

To assess the trend in in-channel large woody debris, the large woody debris recruitment potential of Riparian Reserves was assessed using the methodology from the DNR Standard Methodology for Watershed Analysis. Large woody debris recruitment potential was rated as high, moderate, or low based on the following matrix:

Dominant Tree Type	Young/ Sparse	Young/Dense	Mature/ Sparse	Mature/ Dense	Old/Sparse	Old/Dense
Conifer	Low	Moderate	Moderate	Moderate	Moderate	High
Deciduous	Low	Low	Low	Moderate	Low	Moderate

"Young" is defined as seedlings, saplings and poles; "Mature" is closed small conifer, closed variable structure, open small conifer and open variable structure; and "Old" is open and closed large conifer. "Sparse" is less than 70% canopy closure.

Figure 4-79 -- Distribution of Large Woody Debris Recruitment Potential Classes

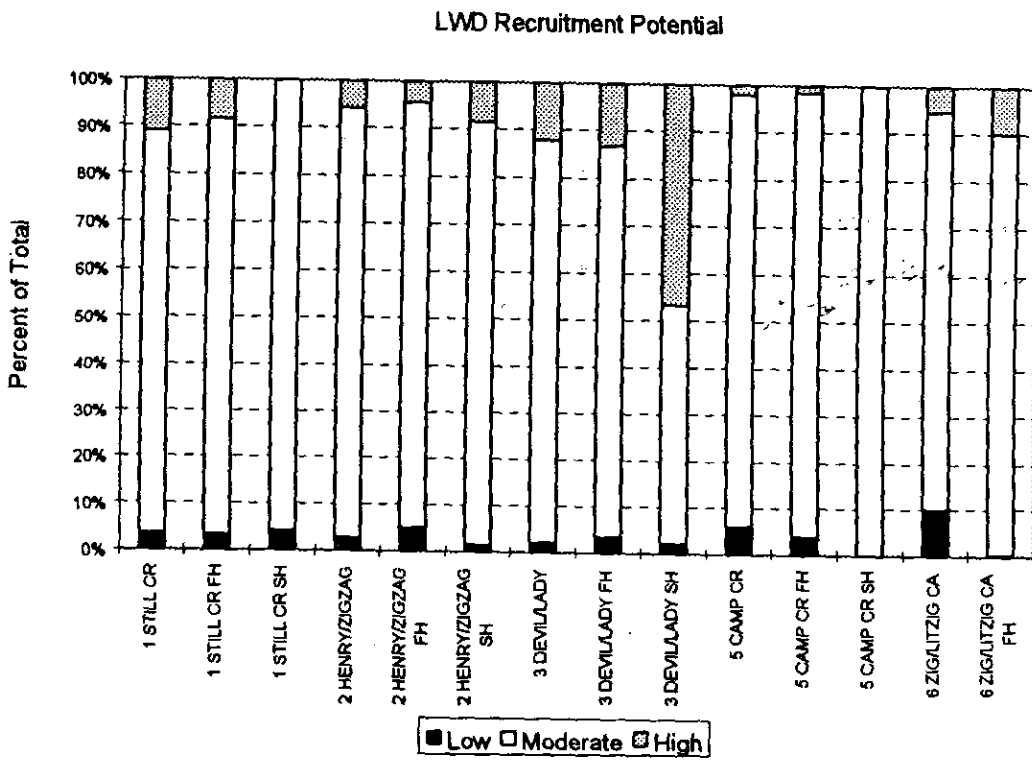
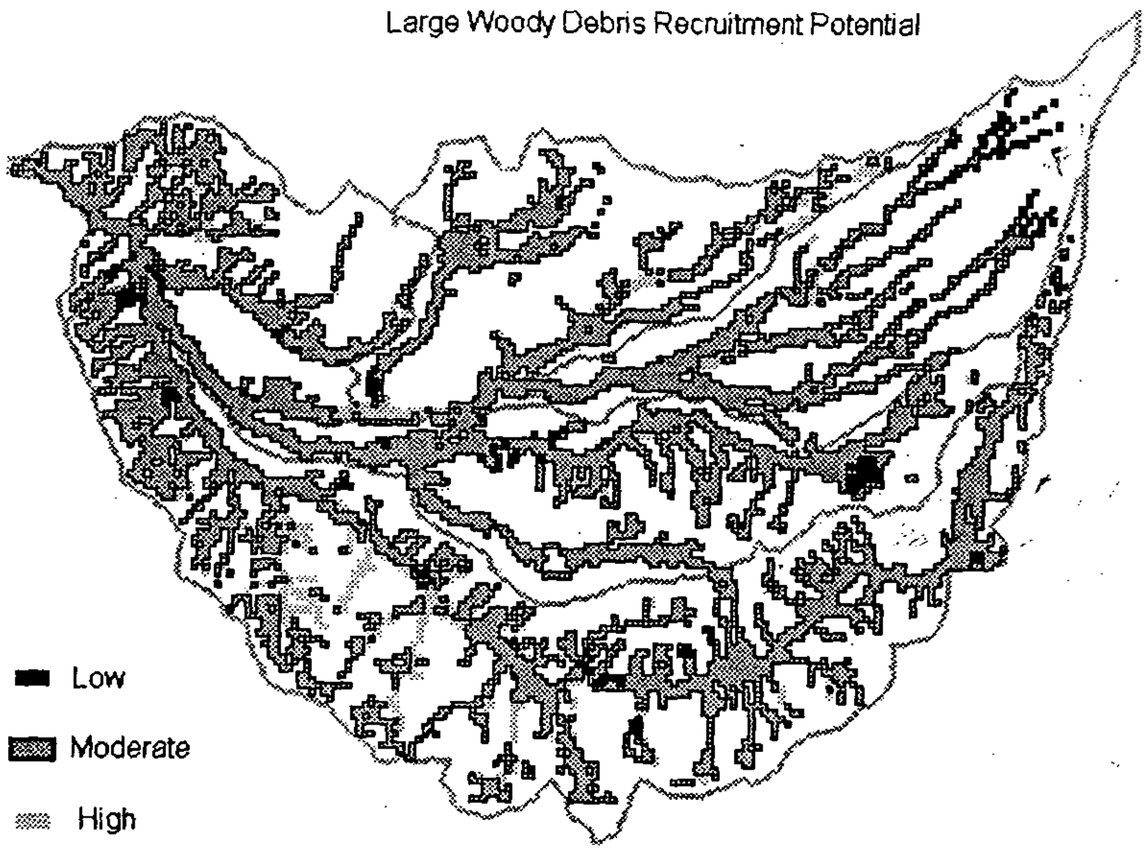


Figure 4-80 -- Spatial Representation of Large Woody Debris Recruitment Potential Classes



	Percent of Total		
Stream	Low	Moderate	High
1 Still Cr	4	85	11
1 Still Cr FH	4	88	9
1 Still Cr SH	4	96	
2 Henry/Zigzag	3	91	6
2 Henry/Zigzag FH	5	90	5
2 Henry/Zigzag SH	2	90	8
3 Devil/Lady	2	86	12
3 Devil/Lady FH	3	83	13
3 Devil/Lady SH	2	51	47
5 Camp Cr	6	92	2
5 Camp Cr FH	4	95	2
5 Camp Cr SH	0	100	0
6 Zig/Litzig Ca	10	85	5
6 Zig/Litzig Ca FH	0	90	10

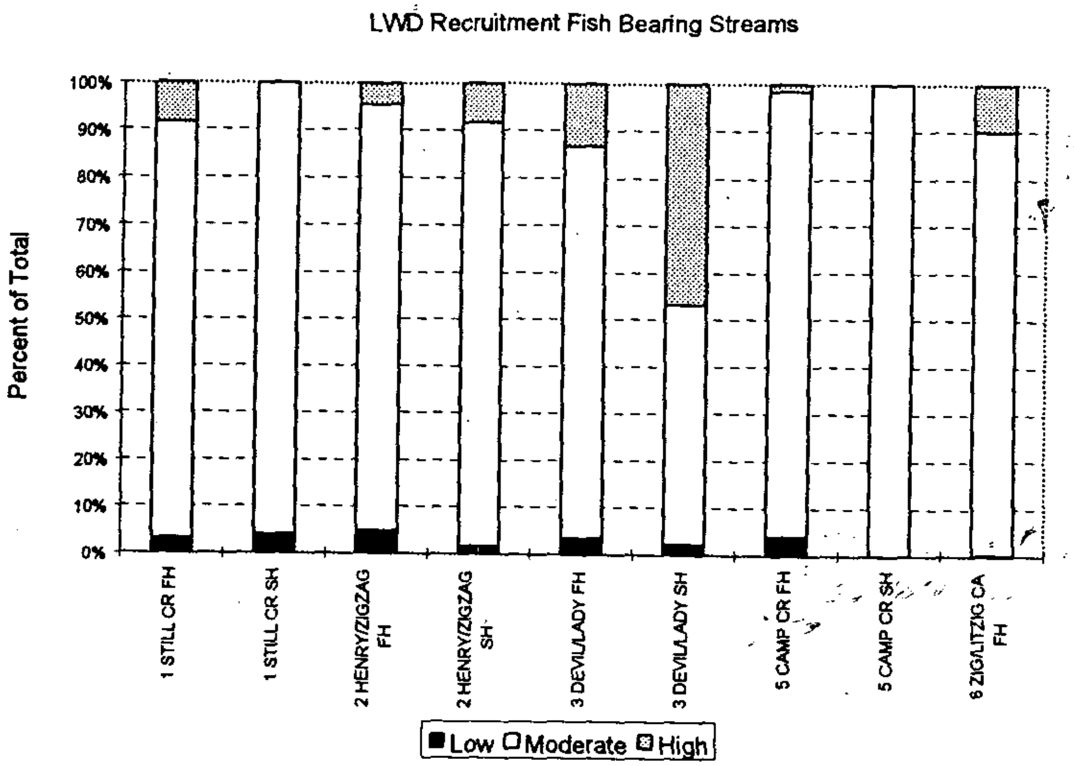
With the exception of the Devil/Lady subwaterwhed, the other subwatersheds within the Zigzag Watershed have a high concentration (80-100%) within the moderate large woody debris recruitment potential class. (The Devil/Lady subwatershed within the Recreational Residence tracts has a higher large woody debris recruitment potential.) This condition reflects the stand structure of the upland areas in the watershed. This would indicate that fires that burned through the watershed between 1901 and 1952 impacted both the uplands and the riparian areas. Approximately 85% of the watershed has been burned at least once since the turn of the century, reflected in the relatively even distribution of the moderate large woody debris recruitment potential class across the subwatersheds.

Most of the subwatersheds have from 5-15% of the riparian reserves in the high large woody debris recruitment class. This reflects the condition in the uplands, and also appears to be tied to the watershed's fire history. Camp Creek has 2% of the riparian reserves in the high large woody debris recruitment, much lower than other areas. This condition is attributed to the influence of U.S. Highway 26 -- the roadway and clearing of hazard trees -- in the upper subwatershed, and the presence of the mudflow and harsh site conditions in the lower watershed.

Zigzag/Little Zigzag Canyon subwatershed has more area in the low large woody debris recruitment potential class, which reflects the amount of unvegetated alpine area within this subwatershed.

Because classes used to classify large woody debris recruitment potential and in-channel large woody debris are different, this is not an "apples and apples" comparison. The high large woody debris recruitment potential class only requires 30% of the stand to be over 21" diameter, and >=50% of the stand to be greater than 8" diameter -- while in-channel large woody debris requirement is 36" diameter and 50' long.

Figure 4-81 -- LWD Recruitment Potential in Fish Bearing Streams and Recreational Residence Area



FH=Fish Habitat
SH=Recreational Residence Area

Table 4-26 LWD Recruitment Potential Recreational Residence Area

	% of Total		
Stream	Low	Moderate	High
1 Still Cr FH	4	88	9
1 Still Cr SH	4	96	0
2 Henry/Zigzag FH	5	90	5
2 Henry/Zigzag SH	2	90	8
3 Devil/Lady FH	3	83	13
3 Devil/Lady SH	2	51	47
5 Camp Cr FH	4	95	2
5 Camp Cr SH	0	100	0
6 Zig/Litzig Ca FH	0	90	10

Within Riparian Reserves associated with fish bearing streams, lower levels of the high large woody debris recruitment potential class occur adjacent to the Recreational Residence tracts. This condition may be a result of clearing around the Recreational Residences, or even the presence of laminated root disease in this area.

Subwatershed	Percent of Riparian Reserves in laminated root rot areas
Still Creek	62%
Henry/Zigzag	39%
Devil/Lady	93%
Camp Creek	85%

The expected relationship of more area with laminated root disease resulting in less area of high large woody debris recruitment potential class is not validated by the data. While the Devil/Lady subwatershed has the greatest amount of laminated root disease pockets, it also has the greatest area in the high large woody debris recruitment potential class.

Lakes

Many lakes within the Zigzag Watershed provide a unique habitat niche for aquatic and riparian dependent species including lesser bladderwort, pond dwelling amphibians and brook trout. There are eight named lakes within the watershed including Hidden, Enid, Mirror, Devils, Veda, Collins, Wind and Five. Mirror, Devils, Enid and Hidden lakes were all formed by glacial activity.

Figure 4-82 -- Zigzag Watershed Lakes

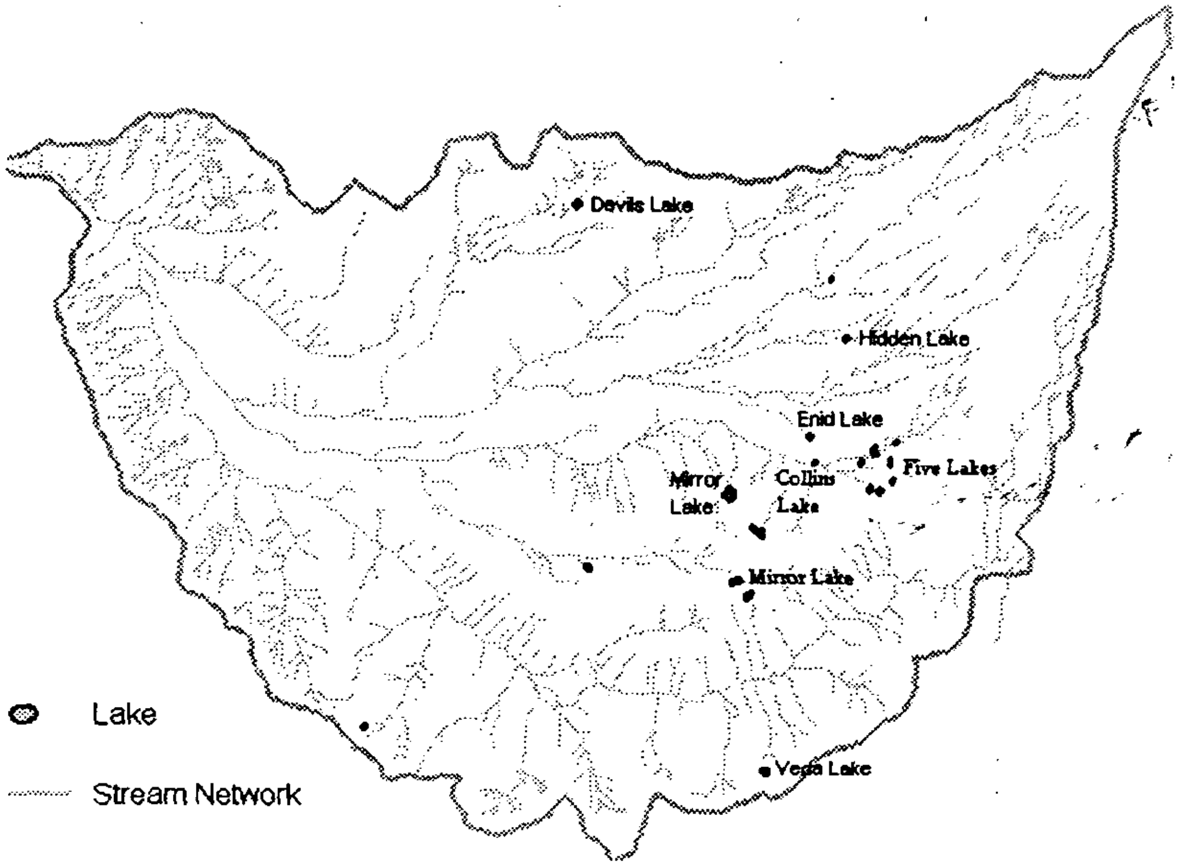


Table 4-27 -- Summary of Habitat Conditions for Mirror, Devils, Enid and Hidden Lakes

Lake	Area	Depth (max)	Geomorphology	Trophic Status	Fish Species Present	Plankton Data	Macroinvertebrates	Fish Stocking	Habitat Summary
Mirror	7 acres	18 feet	Natural, formed by glacial activity	Mesotrophic	Rainbow, cutthroat and brook trout	Healthy populations of zooplantion and phytoplankton	No data	1989-brook, rainbow 1990-rainbow 1987-cuttroat, rainbow 1985-cutthroat, rainbow 1983-cutthroat, rainbow 1982-cutthroat, rainbow 1981-cutthroat, rainbow 1980-cutthroat, rainbow	Fish cover is above average for cascade lakes on Mt. Hood; limited spawning habitat and reduced vegetation; some bare ground on the northwest side of the lake associated with recreation use.
Devils	2 acres	6 feet	Natural, formed by glacial activity	Oligitrophic	Brook trout	Zooplanktin populations of adult *Daphnia* were small (an indicator of overgrazing by the trout population), phytoplanktin was not sampled.	3-4 functional groups present	Brook trout last stocked in 1955	Diverse mixture of aquatic vegetation, woody debris and undercut banks; spawning habitat has been enhanced by beaver dams on the north side of the lake.
Enid	1 acre	3 feet	Natural, formed by glacial activity	Oligitrophic	Brook trout	Composition characteristic of epibenthic and eutrophic habitat. May be due to the lake having more characteristics of a pond than a lake.	2 functional groups present (collectors and predators)	No record of fish stocking by ODFW	For the size of the lake, cover characteristics appear good; spawning habitat is limited to the outlet; exposed soil and wheel ruts at the trailhead adjacent to the lake.
Hidden	0.6 acres	13 feet	Natural, formed by glacial activity	Ultra-oligitrophic	Brook trout	Phytoplankin was sparse in the lake with an indication that there is continual flushing associated with streamflow.	3 functional groups present	No stocking since 1979	Limited woody debris for cover; no spawning gravel; lake appears to have a high diversity of organisms and should be considered as a quality wetland.

Habitat Effectiveness

Habitat effectiveness, especially for anadromous species, has been heavily influenced by development on private land and on National Forest lands (Recreational Residences, Organization Camps, and campgrounds). Additionally, streamside roads provide easy access to large reaches of stream outside these areas. These developments not only attract use of the streams by the homeowners/users, but provide easy access to anglers visiting the area. Very high recreational use and fishing activity are present in 90% or more of the anadromous habitat, likely resulting in increased harassment and mortality of both juvenile and adult anadromous fish in the area. Catch and release of undersize resident trout, smolts and wild adult steelhead and spring chinook salmon may result in incidental mortality from handling stress. High levels of human activity may affect the distribution of both juvenile and adult salmonids in key spawning and rearing areas like lower Still Creek. Figure 4-83 details the miles of habitat affected by different recreational uses and development.

Figure 4-83 – Habitat Effectiveness

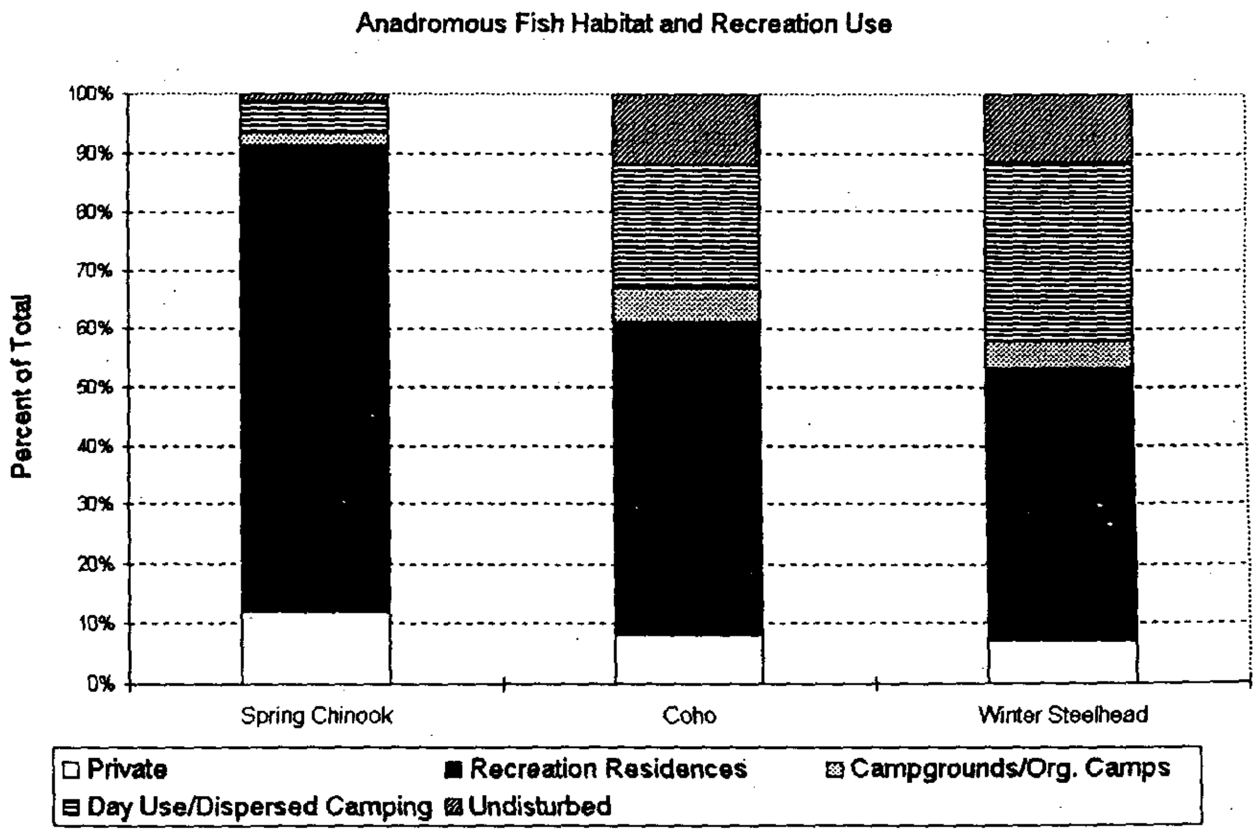
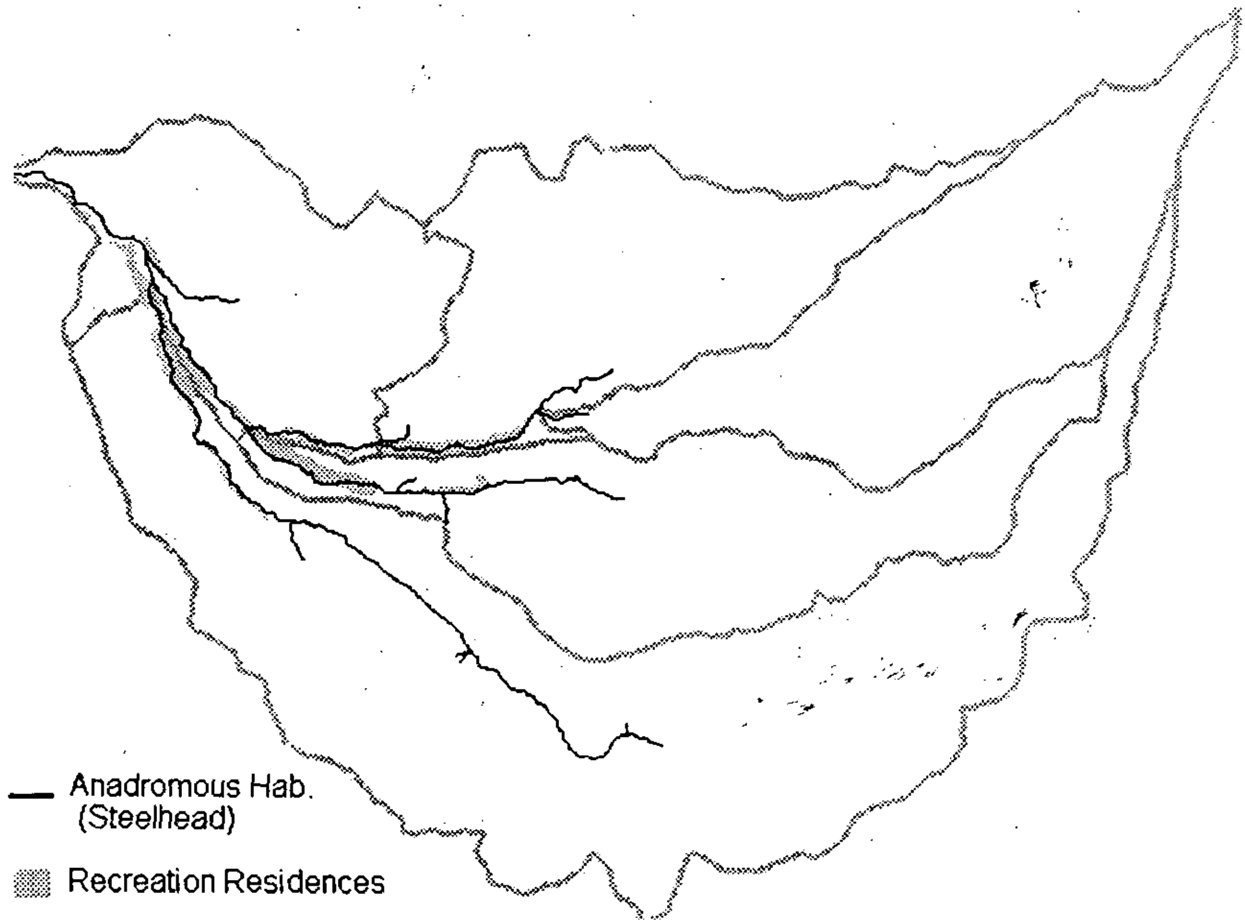


Figure 4-84 -- Anadromous Fish Habitat and Recreation Residences



Although the protection and management of fish populations is the responsibility of the Oregon Department of Fish and Wildlife, the Forest Service should recognize that harvest pressure and population status are to some degree a function of accessibility for anglers. Because a very high percentage of the anadromous habitat is currently easily accessible, the importance of the remaining areas of limited accessibility should be recognized. Where feasible, road access to riparian areas should be eliminated.

Over 25 miles of anadromous fish habitat are available in the watershed. However, at least 3.5 miles of this habitat is partially to fully blocked by barriers to migration for resident and anadromous fish. Culvert barriers exist on Little Zigzag (one mile), Still Creek tributaries (one mile), and Henry Creek (about one-half mile.) Lady Creek is partially blocked by old dams and fill material at the mouth of the stream (one mile), although passage has been improved in the area by the addition of some step pools.

Low spawning escapement of salmon is likely not only affecting the numbers of eggs and fry created as the next generation of fish, but it may be affecting the survival and growth of those fish as they spend 1-2 years in the freshwater environment. Carcasses of coho salmon have been shown to be a critical source of nutrients for the stream ecosystem food web, and directly tied to fingerling/smolt production (Bilby, et al., in press). Coho numbers appear to be 20% or less of populations documented in the 1890's, when populations were already significantly reduced by commercial fishing. Comparisons with fully seeded, unimpacted populations elsewhere in the Pacific Northwest indicate that existing populations may be less than 5% of pre-1850 populations. The importance of this nutrient source should be evaluated to determine whether there is a need to supplement existing salmon escapement to "fuel" recovery of salmon populations in the watershed. This could be accomplished by test "seeding" an area with excess carcasses from the Sandy Hatchery, and evaluate fish population and stream ecosystem response to the nutrients.

Fish Habitat: Conclusions

Anadromous Reaches

- Unstable stream reaches in lower Camp Creek and the lower Zigzag River appear to be associated with stream cleanout activity that occurred after the 1964 Flood in the area of volcanic mudflow deposits.
- Pool habitat is outside the undisturbed condition.
- Side-channel habitat approximates the undisturbed condition.
- Pool levels are below, or at the low end, of the range of natural conditions.
- Pool volumes within Camp Creek approximate the undisturbed condition, Still Creek is slightly lower, and Zigzag River is well below the undisturbed condition.
- Still Creek and Camp Creek approximate the undisturbed condition regarding in-channel woody debris (large and small). Zigzag River is well below the undisturbed condition.
- There is very little area in the high large woody debris recruitment potential class, especially within the Recreational Residence tracts.

Resident Reaches

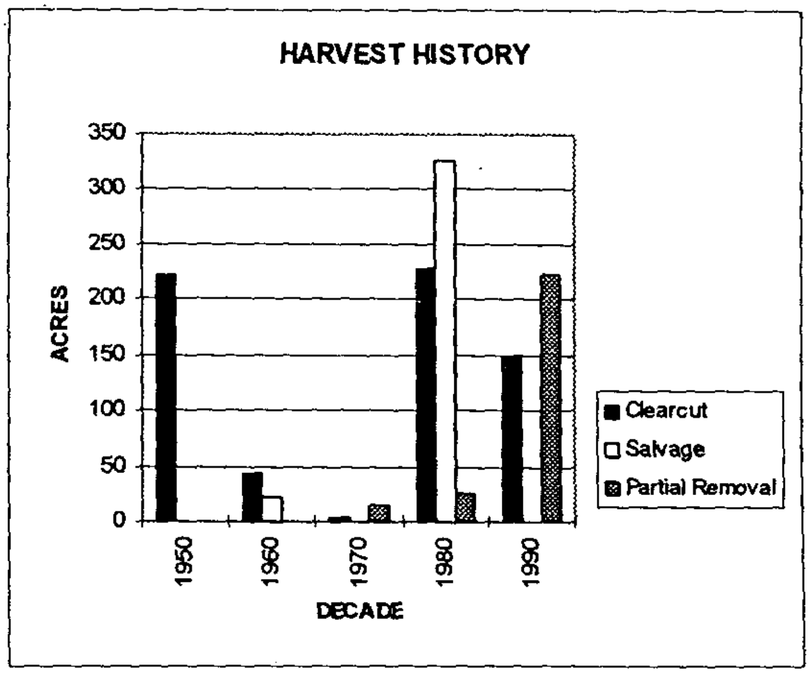
- Unstable stream reaches in the upper watershed are associated with unstable landforms (volcanic mudflow deposits).
- Pool levels across the entire watershed are below Mt. Hood National Forest Land and Resource Management Plan (LRMP) and Columbia River Policy Implementation Guide/Salmon Summit (PIG) standards, and are at the low end or are outside the range of natural variation.
- Pool volumes across the watershed (with the exception of the anadromous portions of Still and Camp creeks) are well below the undisturbed condition.
- Levels of woody debris within most of the watershed approximate those of the undisturbed condition, however, Zigzag and Little Zigzag rivers have very low levels of woody debris.
- Most of the subwatersheds have limited area (5-15%) in the high large woody debris recruitment class. This reflects the condition in the uplands, and appears to be tied to the watershed's fire history.
- Camp Creek has 2% of the Riparian Reserves in the high large woody debris recruitment, which is much lower than other areas. This condition is attributed to the influence of U.S. Highway 26 -- both the roadway and clearing of its hazard trees -- in the upper subwatershed, and the presence of the mudflow and harsh site conditions in the lower watershed.

Commodities

Timber

According to available total resource inventory (TRI) and harvest layer data for the 1950-95 period, timber harvest has occurred on 883 acres within the Zigzag Watershed. Harvest activities began here in the 1950s when 222 acres of salvage was taken after the 1952 Zigzag Burn. Total harvest in the 1960s and 1970s was less than 100 acres. The majority of harvest in the 1980s was associated with stands affected by laminated root disease. In 1992 and 1993, 150 acres of private land in the Henry/Zigzag subwatershed were harvested. Not included in Figure 4-85 are 255 acres of harvest planned for 1995 and 1996 in stands affected by laminated root disease.

Figure 4-85 -- Timber Harvest History Within the Zigzag Watershed



Trends

No Timber Emphasis (C1) lands are located within the watershed. Regulated timber harvest is limited to B Lands, which encompass 15% of the watershed.

Timber harvest may be planned on B Lands when primary resource objectives can be met. (For additional information on opportunities for future timber harvest, see Chapter 6, Key Question #4.)

Special Forest Products

A variety of forest products are harvested within the Zigzag Watershed. The following table summarizes the principle resources gathered. The availability of these products is dependent on forest seral stage and vegetation community. In most cases, future product supplies are expected to meet demand. Firewood, post and poles have historically been limited within the watershed. These wood products are generally a secondary product of timber harvest. Demand for firewood and round-wood products continues to grow, while supplies within the watershed are not expected to increase.

Table 4-28 -- Miscellaneous Products - Current Demand and Supply Trend

FOREST PRODUCT	CURRENT DEMAND	TREND
HUCKLEBERRIES	Moderate personal use and small commercial demand.	Continued moderate demand. Availability expected to meet demand.
MUSHROOMS	Moderate personal use and commercial demand	Continued moderate demand. Availability expected to meet demand.
BEARGRASS	Moderate commercial demand	Continued moderate demand. Availability expected to meet demand.
FIREWOOD POST AND POLES	Moderate to high demand	Continued moderate to high levels of demand. Supply has been historically limited in Zigzag Watershed. Future demand is expected to exceed supply.
TRANSPLANTS	Low demand for personal use.	Continued low demand. Availability expected to meet demand.

Mineral Resources

Two National Forest land rock quarries are located within the Zigzag Watershed. Laurel Hill Quarry, a five-acre site, contains an excess of 200,000 cubic yards of high quality rock. Interim rehabilitation of this quarry is scheduled for 1995. Rehabilitation measures include: removing garbage, logging slash and road waste material; installation of waterbars; and placing boulders to block access. Spotted knapweed is providing ineffective erosion control at the Laurel Hill site. Tupper Quarry, located in the Henry/Devils Creek subwatershed, is inactive. No commercial rock resources remain at Tupper Quarry. Access to the pit has been blocked. To date, limited rehabilitation of this quarry site has occurred.

Grazing

There are no livestock allotments within the Zigzag Watershed.

Recreation/Social

Introduction

The Zigzag Watershed serves as a key area for providing year-round recreational opportunities within the Mt. Hood National Forest, particularly for Portland metropolitan area residents. Historically, the watershed has provided a variety of recreation opportunities since the 1800s. As roads were constructed and access to the watershed increased, use of the area has been rising at rates higher than the population growth for Portland and the entire state.

Prior to European settlement, American Indians relied on the watershed for hunting, fishing, and gathering foods such as huckleberries and white bark pine nuts. While huckleberries were found in a variety of locations throughout the watershed, the white bark pine was limited to higher elevations near timberline on Mt. Hood.

Primary access to the watershed is provided via U.S. Highway 26 (US 26), a major travel route between Portland and central Oregon, and Oregon State Highway 35. US 26 comprises part of the scenic Mt. Hood Loop. For the most part, it also follows the historic Barlow Road, the final overland leg of the Oregon Trail used by settlers coming from Independence, Missouri to the Willamette Valley. The Barlow Road, which dates back to 1845, has been identified as an historic district, and is listed on the National Register of Historic Places. The Barlow Road Historic District includes all known traces of the Barlow Road located on Forest lands, as well as associated features such as graves of settlers who died on their journey to the Willamette Valley.

The beauty of Mt. Hood began luring recreationists to the area around the turn of the century. Recreational use has grown steadily ever since. In 1925, the Mt. Hood Loop Highway was completed, allowing visitors to drive around the mountain and enjoy its character and beauty. The importance of recreation in the watershed and surrounding area was further highlighted in 1926 when the Secretary of Agriculture established the Mt. Hood Recreation Area.

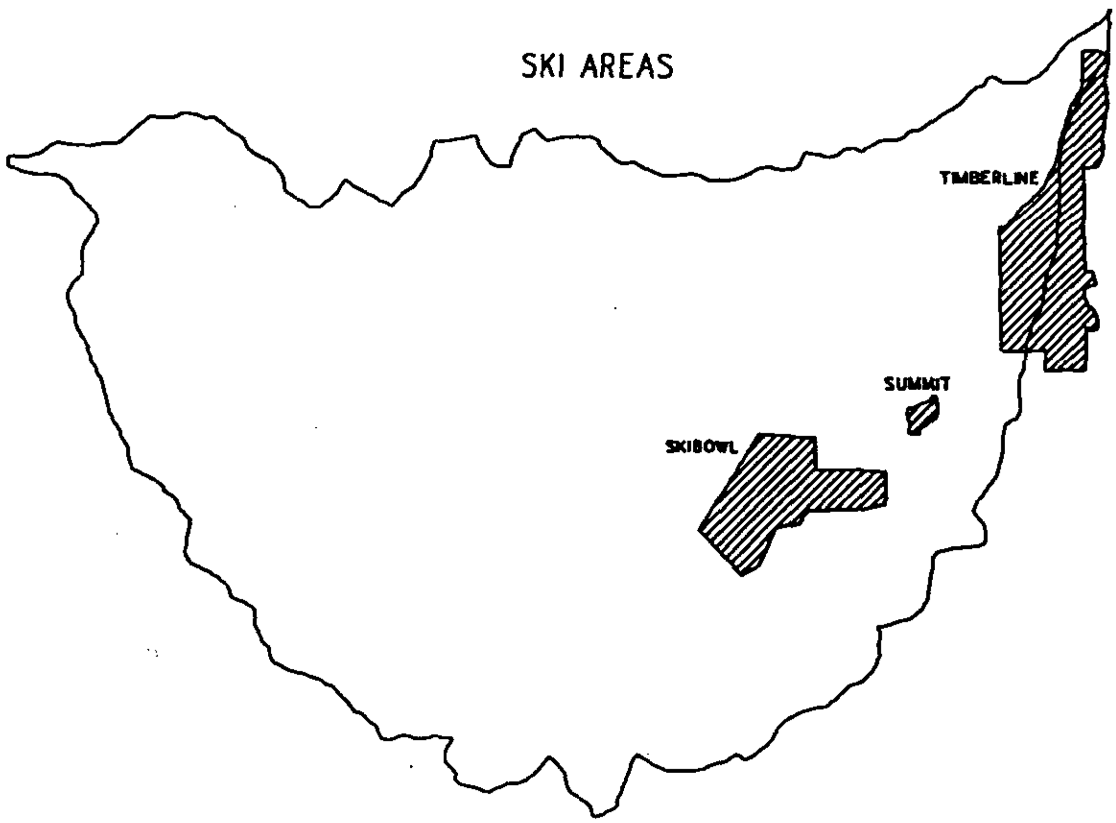
The designation, intended for the general Mt. Hood area and adjacent Mt. Hood Loop Road, stated: "All National Forest lands therein are held for the use and enjoyment of the general public for recreation purposes" (emphasis is original). "A proper and orderly utilization of timber, forage, water power, and other economic resources shall be allowed within the area, but such utilization shall not be permitted to impair the value of the area as a site for public campgrounds, municipal or health camps, sanitaria, club houses, hotels, summer homes, or public utilities, requisite for the comfort and convenience of the people using the area for recreational purposes."

Most of the Zigzag Watershed is located within National Forest lands, providing an array of recreational opportunities, including: Nordic and alpine skiing, developed and dispersed camping, hiking, mountain biking, fishing, nature study, and sightseeing. The communities of Rhododendron and Government Camp, also located within the watershed, offer additional recreational opportunities and services such as motels, groceries and restaurants.

Ski Areas

There are three ski areas located within the watershed. They are Timberline, Summit, and Multorpor Ski Bowl ski areas and are shown on the following map.

Figure 4-86 -- Ski Areas Within the Zigzag Watershed



Timberline Ski Area -- Located within both the Zigzag and Salmon River watersheds, it covers 1,422 acres, 580 of which are inside the Zigzag Watershed. ~~The watershed contains only one ski lift and associated runs. The area's associate~~ ski runs and other improvements, including the historic lodge, water system, sewer plant and other support facilities, are inside the adjacent Salmon River Watershed. Proposed future improvements within the Zigzag Watershed are limited to: slope grooming and maintenance projects, removal of hazard trees, and upgrading/maintenance of existing ski lifts. The entire Timberline area, popular for climbing, skiing, sightseeing and hiking, hosts more than 1,000,000 visitors annually. It is one of the most visited recreation sites in Oregon. Furthermore, the area is used by approximately 69,000 skiers during summer months on the Palmer Snowfield, primarily in the Salmon River Watershed, though a small portion of the snowfield drains into the Zigzag River Watershed. Approximately 150,000 to 200,000 skiers use the area during the winter on ski runs in both watersheds.

Summit Ski Area -- This small, beginner-skier area covers 51 acres directly east of the community of Government Camp. Developed in 1927, it served as Mt. Hood's first commercial downhill ski area, and is the second-oldest continuously operating ski area in the entire United States. The area provides gentle-sloped ski runs that meet the needs of beginner skiers, as well as a heavily used commercial snow-play hill. Recently, seven kilometers of ski trails were constructed outside the permit area to provide machine groomed Nordic trails for the public. As part of the area's master development plan process, the area's operator is considering making additional proposals for further expansion of its Nordic trail system and areas to the north and west of its current permit. Other proposed future improvements include possible moving and upgrading the current day lodge, extending the ski lift, and increased parking for the area. Visitor use during the 1994-1995 season is over 7,000 skier visits and 9,000 non-skier visits.

Multorpor Ski Bowl -- This area provides a wide variety of year-round recreation opportunities in addition to alpine skiing. It covers 932 acres of the watershed, 13 of which are on private lands adjacent to the community of Government Camp. The ski area was originally two separate facilities, one on Multorpor Mountain and the other adjacent on Tom Dick and Harry Mountain. In 1964, the two areas combined and ski trails were constructed to link them together. Winter use is limited primarily to skiing and snowboarding. In the summer, the area manages and administers approximately 10 miles of developed mountain bicycle trails and roads, an "alpine slide," and equestrian use, all located primarily on National Forest Lands. A miniature golf course, go-cart track, horse rentals (for use on National Forest trails), and other amusement park type activities, (such as a "bungee jump"), are located on private lands within the ski area.

Development proposals for Multorpor Ski Bowl include new ski run development on the south side of Tom, Dick and Harry Mountain in the Wind Lake area; improvements to existing runs and lifts; upgrading base area facilities; developing additional mountain bike trails; expanding parking; and construction of a restaurant near the top of the mountain. These facility development proposals are from the current master development plan approved 15 years ago. Recreation visits in the 1994-1995 season were over 142,000 skier visits and over 188,000 non-skier visits.

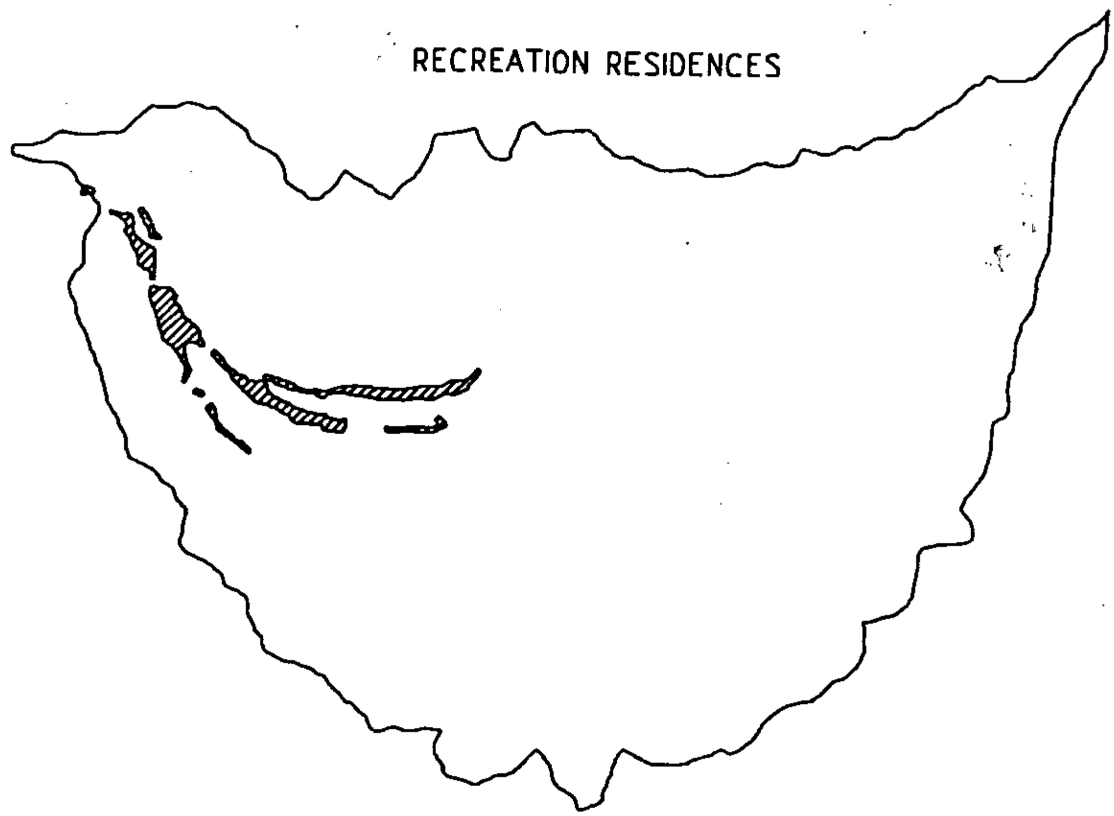
The ski area also contains a warming hut constructed in 1937, owned by the Forest Service, but used by the ski area under a separate permit. This structure has been determined to be eligible for the National Register of Historic places.

Both Summit and Multorpor Ski Bowl ski areas are located at an elevation which provides variable snow conditions that greatly affects the quality and availability of snow for winter recreation. Both areas have considered mechanized snow making (when weather temperatures permit) to provide additional snow for ski runs in times of low snow levels. Limited mechanized snow making already takes place at Multorpor Ski Bowl.

Recreational Residences

The watershed contains 557 privately owned National Forest land Recreational Residences, cabins permitted on federal lands by a special-use permit. This grouping of residences is the largest for one ranger district in the Oregon/Washington region, and is among the largest groupings in the nation for a single ranger district. The purpose of the cabins is to provide additional recreation opportunities on National Forests. They are not to be used as permanent residences. The special-use permits are issued for up to a 20-year-period, with the current permits expiring Dec. 31, 2008. The location of the recreational residence tracts is shown on the following map.

Figure 4-87 – Recreational Residence Tracts Within The Watershed



The residences are administered using direction within the special-use permit and district policy guidelines. These guidelines provide additional direction on size limitations, vegetation management, color, acceptable improvements, and other permittee responsibilities. Overall management objectives for the residences are to provide an enjoyable recreation setting and opportunity for residence owners and guests, to protect and maintain a natural forested setting, to assure safety of the permittee and general public, to minimize resource damage, to gain compliance with permit requirements and manage the tracts in accordance with national and regional policies.

The Recreational Residence program began on the Zigzag District in 1915. New permits for construction were issued through the early 1960s when the Forest Service discontinued issuing permits for undeveloped lots. With the presence of water being a strong drawing factor for recreation, most of the lots for the residences were located adjacent to streams. Thus, approximately 87% of the residences in the watershed are within the Riparian Reserve areas delineated by the Northwest Forest Plan.

A large percentage of users come from the Portland metropolitan area, using the cabins for weekend retreats, and, less frequently, for longer vacations. Most use occurs during the summer season. However, with increasing interest in winter recreation activities, more cabins are also being used during the winter season. Average use at the residences is estimated at two to three weeks annually, although some cabins receive more extensive use.

Three community water systems provide water service to approximately 95% of the residences. Cabins without community water service are located along Still Creek Road #2612. These cabins receive water by pumping directly out of Still Creek, or tapping into small streams to the south of Still Creek Road.

A sample of the residences shows that approximately 71% of them have some type of septic system for sewage disposal. The remainder of the sewage disposal systems are either unknown (13%), or have outhouses or cesspools. Some residences (7%) have elected to retain their outhouses even with septic systems in case water is not available to operate the septic system, particularly during wintertime. Any new septic system installations must be approved by Clackamas County and meet all current building and water quality requirements.

Vegetation management guidelines for the residences require maintaining a natural forested setting using native vegetation. Overall, this requirement is well followed, however, a few residences do have some non-native plantings. Trees which pose a hazard to residences are the responsibility of the permittee. Depending on the size and type of this potential hazard-tree, the permittee may be allowed to use the tree for firewood, or to leave it on site to provide for downed woody debris for wildlife habitat. There are also occasions when the Forest Service may remove the hazard trees for use as fish habitat structure in streams elsewhere on the Forest.

One concern that has been identified within the watershed and Recreational Residence tracts area is the presence of laminated root disease (*Phellinus weirii*) a disease that affects the roots of the infected trees, greatly increasing their susceptibility to windthrow and eventually killing the trees. An estimated 65% of the Recreational Residences are located within areas affected by this disease. The largest concentrations of these areas are located along the Zigzag River and Still Creek.

Organization Camps

There are a total of six special-use permits for "Organization Camps" within the watershed. Organization Camps are camps for organizations of a public or semi-public nature. The organizations are usually non-profit organizations or other government agencies. The permits allow for the organization to develop facilities and other improvements that will meet the mission of the organization for providing recreational opportunities in a naturally forested setting. As with other special-use permits on the National Forest, there is also direction to insure that the natural resources of the area are being protected.

Organization Camps located within the Zigzag Watershed:

Nanitch Point Boy Scout Lodge -- Located on West Leg Road one mile north of Government Camp, covering 1.1 acres. Improvements consist of a three-story lodge that can simultaneously accommodate five Scout troops. Use is primarily during the winter months when more than 1,500 Scouts use the lodge. Currently, there are no plans for any expansion of the facilities. Up to 50% of the permit area is within a Riparian Reserve. The district recently completed a Future Use Determination (FUD), recommending a new permit to be issued to the Boy Scouts for continued use of the site.

Trails Club of Oregon -- Consists of a small lodge and storage building, as well as an access road and parking area on a two-acre permit area. Located just to the south of Nanitch Point Boy Scout Lodge, off West Leg Road. Use is year round and is estimated at approximately 900 visitors annually. Currently, there are no plans for future expansion of facilities. Almost the entire permit area is contained within a Riparian Reserve.

Mazama Lodge -- Constructed in 1960, operated by the Mazamas, a mountaineering organization from the Portland metropolitan area. Located on a two-acre permit area. The lodge is used year round by members of the Mazamas and other not-for-profit organizations. In recent years, it has also been used by ski camp organizations during the summer. This use, however, because of its commercial nature does not fit the definition of an Organization Camp and will be discontinued at the end of the 1995 summer season. In addition, a 1 1/2-acre area adjacent to the lodge with a rope tow and small ski run cleared of trees and brush is also operated by the Mazamas. The Zigzag District is considering combining these areas into one permit rather than the current two permits. Use at the lodge is estimated at 30,000 visitors annually. None of the permit area is within a Riparian Reserve. A recently completed FUD recommended the permit for use of the site be re-issued.

Mt. Hood Kiwanis Camp -- Located on a permit area of approximately 20 acres, the camp's primary purpose is to provide an outdoor camping and learning experience for individuals who are physically and mentally challenged. There is also some use by other non-profit groups. The camp has approximately 6,000 visitors annually, primarily during summer months. Many of the visitors are at the camp for one to two week sessions. The camp consists of a main lodge, camper/counselor cabins, camping area, classroom areas, an obstacle course, camp fire area, as well as parking and other support facilities such as water and septic systems. The camp has expressed an interest in further expansion of facilities to better accommodate campers and provide additional recreation opportunities.

Approximately 65% of the permit area is within the Little Zigzag River's Riparian Reserve.

Paradise Trail Christian Camp -- Consists of one lodge used by various churches for conferences and other recreational activities. It is located on an approximate two-acre permit area. The building was originally constructed in the 1920s to serve as a road tavern along the Mt. Hood Loop Highway. A three-acre parcel located just east of the camp area provides a ropes and obstacle course operated under an outfitter guide permit. Most use takes place during summer weekends, although some midweek day-use of the ropes and obstacle course also occurs. Approximately 10% of the permit area is within the Riparian Reserve of a small non-fish bearing stream. The camp has approximately 6,000 visitors annually, most visiting for one to two days at a time.

Portland Post Office Community Club -- This permit covers approximately two acres and consists of one cabin and access road. The permit was originally issued in 1924 to members of the Portland Post Office. The current permit is held by 12 families. Use at the site is low, with an estimated 400 visits annually. Because the permit is now held by 12 families, its use may not fit the "Organization Camp" parameters. Thus, the Zigzag District is currently conducting a Future Use Determination to decide if the permit should be reissued as an Organization Camp. The site is located at the confluence of Zigzag River and Devils Creek. Most, if not all, of its permit area is within the Riparian Reserve of these two rivers.

Dispersed Recreation

The watershed provides a wide variety of dispersed recreational activities. Some of these, such as camping, fishing, and hiking, are activities which generally take place in or adjacent to Riparian Reserve areas that are easily accessed by roads and trails. There are a number of popular dispersed camping areas, located: along the middle portion of Still Creek, near Laurel Hill Quarry on Camp Creek, Mirror Lake, Enid Lake, and some other isolated sites within the watershed. Currently, a high level of dispersed camping, often for extended periods, is also taking place to the north of the community of Government Camp.

The most popular hiking trails within the watershed are the Mirror Lake Trail, the "mountaineering trail" above Timberline Lodge, and the Pacific Crest Trail to the west of Timberline Lodge. Trails receiving moderate levels of use are the Pioneer Bridle Trail (constructed in the 1930s by the Civilian Conservation Corps [CCC] when the Forest Service recognized how highway improvements were impacting the historic value of the Barlow Road); Hunchback Trail from Kinzel Lake to Devils Peak; Little Zigzag Falls Trail; Camptown and Crosstown trails (Nordic and mountain bike); and Burnt Lake, Paradise Park, and Hidden Lake trails which provide access to the wilderness. Other trails within the watershed receive lower use levels.

Mountain bicycling is increasing in popularity. Locations that receive the highest levels of mountain bicycle use are the area north of Government Camp on non-system access roads, the Crosstown Trail, Alpine and Glade trails, and the Pioneer Bridle Trail from Enid Lake to Tollgate Campground. Nordic skiing is also a popular sport outside the developed ski areas. Sno-Parks, which provide parking for access to Nordic trails, are located at: the Summit Ski Area, Multorpor Ski Bowl parking area, Government Camp highway maintenance yard, and Enid Lake. While the parking areas for Summit Ski Area and Multorpor Ski Bowl are primarily used by ski area visitors, Nordic ski trails can also be accessed from those parking lots.

Developed National Forest Campgrounds

The three campgrounds located within the watershed:

Still Creek Campground -- One-half mile east of Government Camp, south of U.S. Highway 26. The campground is located near the historic site of the "Swim" hot springs resort, Oregon Trail pioneer graves historic site, and Trillium Lake. It contains 27 campsites. In 1994, approximately 17,000 visits were recorded at the campground. Almost 100% of the campground is within Riparian Reserve lands.

Camp Creek Campground -- Constructed in the 1930s by the CCC crews, this popular campground is located approximately three miles east of Rhododendron on Camp Creek. It contains 24 single and double campsites, as well as a picnic area and trailhead to the Still Creek trail. In 1994, the campground recorded more than 29,000 visits. The campground is almost totally within Riparian Reserve lands.

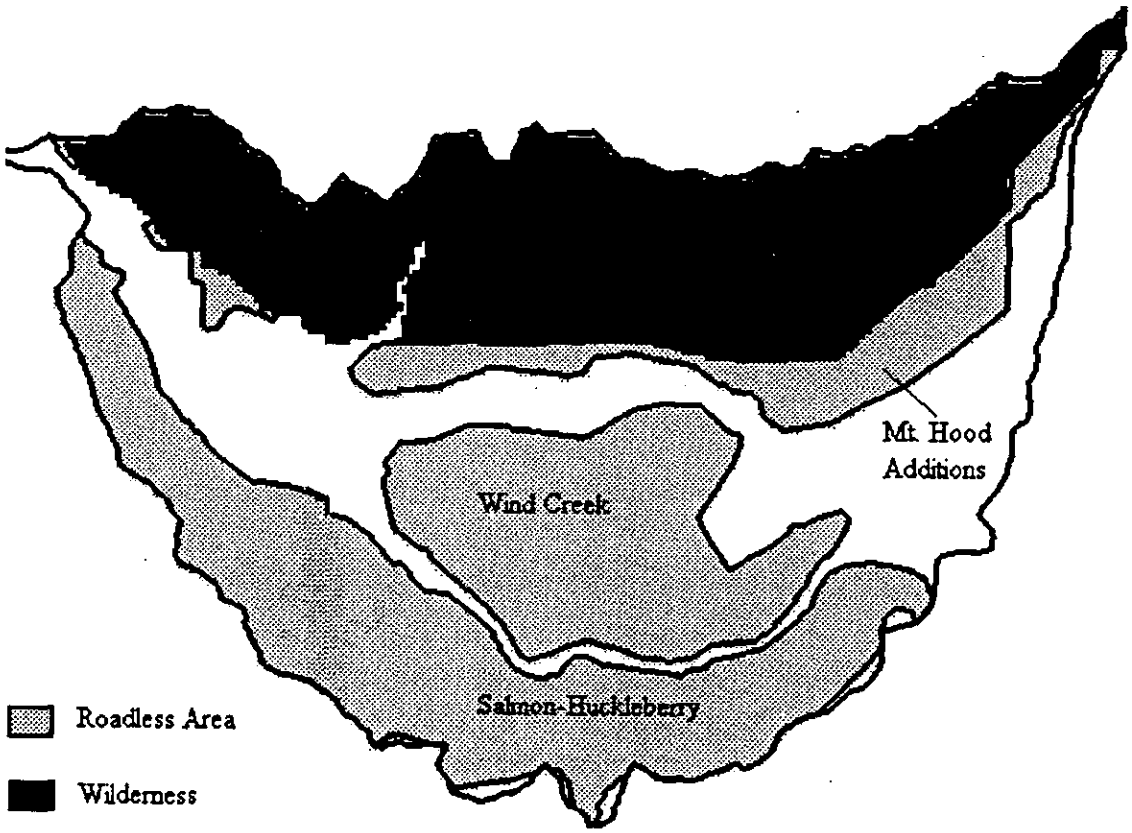
Tollgate Campground and Replica Site -- Located just east of Rhododendron, the replica site contains a replica of the original west Barlow Road Tollgate. It was constructed by CCC crews in the early 1930s in the location of the original tollgate. The campground contains 15 sites and picnic area. Approximately 12,000 visitors were recorded at the campground in 1994, with more than 8,000 visitors at the replica and picnic sites. The campground, picnic area, and replica sites are totally within Riparian Reserve lands.

Wilderness and Roadless Areas

Approximately 10,986 acres, or 29% of the watershed is located within the Mt. Hood Wilderness. Actual use for most of the wilderness areas within the Zigzag Watershed is low, except for day hike use along access trails entering the wilderness, particularly the Pacific Crest Trail west from Timberline Lodge. The remainder of the area is extremely rugged, limiting off-trail cross-country travel.

Three Roadless Areas have also been identified in the LRMP within the watershed: the Mt. Hood Additions, Wind Creek and Salmon-Huckleberry areas. They total approximately 16,530 acres, representing 44% of the watershed. These areas were originally considered in the 1979 Roadless Area Inventory (RARE II) which evaluated areas for their potential to be designated wilderness. Figure 4-88 shows the Mt. Hood Wilderness and the location of the 3 roadless areas within the watershed.

Figure 4-88 -- Wilderness and Roadless Areas



In 1984, the Oregon Wilderness Bill designated additional wilderness areas on the forest, including the Salmon Huckleberry Wilderness to the south of the Zigzag Watershed. That act released other Roadless Areas evaluated in the RARE II process, including the three inventoried Roadless Areas in the watershed, to other non-wilderness uses on the Forest, leaving future land allocation decisions to the LRMP. Completed in 1990, the LRMP allocated the areas within the Roadless

Areas to differing non-wilderness land management allocations. These allocations have since been amended by the Northwest Forest Plan. Riparian Reserves have been designated in all three of the areas, as well as a Late Successional Reserve in the Salmon Huckleberry Additions' western half. Current land allocations by inventoried Roadless Areas are summarized in the following table.

Table 4-29 -- Acres by Land Allocation within Inventoried Roadless Areas in the Zigzag Watershed

Land Allocation	Roadless area acres by land allocation			Total Acres
	Mt. Hood Additions	Wind Creek	Salmon-Huckleberry	
A-4 Special Interest Area	67			67
A-5 Unroaded Recreation		2,813	173	2,986
A-9 Key Site Riparian		47		47
A-11 Winter Recreation	1,079	131		1,210
B-2 Scenic Viewshed	853		847	1,700
B-3 Roaded Recreation			406	406
B-6 Special Emphasis Watershed		412	1,356	1,768
B-12 Back Country Lake			149	149
Late Successional Reserve			4,394	4,394
Riparian Reserve	811	2,031	961	3,803
Total	2,810	5,434	8,286	16,530

Non-Federal Lands

The Government Camp and Rhododendron areas provide a variety of recreation facilities and services adjacent to National Forest lands. These include motels, stores, restaurants, some Multorpor Ski Bowl facilities, and other support infrastructure to meet the needs of the area's visitors as well permanent and part-time residents. Many of the business in these communities are dependent on meeting the needs of these visitors and residents.

A study conducted in 1988 revealed that nearly one-third of the businesses in the Mt. Hood Corridor, including the communities of Government Camp and Rhododendron, indicated that over 80% of their business is tourism-related. In 1987, tourism accounted for more than 70% of the gross revenue for Mt. Hood Corridor-area businesses.

Both Government Camp and Rhododendron are surrounded totally by National Forest lands, limiting their potential for growth and development. Most of the private lands within Rhododendron are already developed and the existing rural character of the community is not expected to change significantly in the future.

Because Government Camp contains undeveloped private lands, a potential exists for additional development within this community. At this time, the community's water treatment system, however, serves as a limiting factor for any additional development. The system is currently operating at its maximum capabilities and needs to be upgraded/ expanded before significant new development could occur. A study is currently underway evaluating alternative sewer plant expansion, or new plant development. Several alternatives have been considered, ranging from no change to existing facilities, developing a new sewer plant at various locations in the watershed, and connecting to the Hoodland sewer system.

Of the alternatives identified, four have been recommended for further consideration:

1. Upgrading the existing sewer plant to increase its capacity and meet current water quality standards, relocating the discharge for the plant's treated effluent to the west of Multorpor Ski Bowl's western parking area. This is expected to meet the community's demand for the next 10-20 years. This plant is located in the Riparian Reserve for a tributary to Camp Creek.

2. Constructing a new plant near the old Glacier View Campground that would meet current water quality standards, discharging treated effluent near the Yocum Falls area. This would also meet the community's demand for the next 20+ years. This plant would not be located in a Riparian Reserve area, but would be located within the Barlow Road Historic District.

3. Construction of a pipeline to Rhododendron to connect to the Hoodland sewer system.

4. Constructing a new treatment plant to the west of Multorpor Ski Bowl that would meet current water quality standards, discharging treated effluent at the plant's location or farther to the west, near Yocum Falls. This is expected to meet the community's demand for the next 20+ years. This plant would be located within the Riparian Reserve for Camp Creek.

All of these treatment options would involve National Forest lands and would require further site-specific analysis. Any selected alternative would need to meet all applicable LRMP and Northwest Forest Plan Standards and Guidelines. (For more detailed information, see Draft Engineering Report for the Government

Camp Sanitary District Wastewater Facilities Plan -- available for review at the Zigzag Ranger District.)

Future Recreation Trends

Population growth -- especially in the Portland metropolitan area -- serves as the driving factor influencing recreation-use trends within the Zigzag Watershed. As an "urban forest" within a one to two-hour drive from the Portland metropolitan area, population growth affects both demand for recreation resources as well as the condition of those resources. Oregon's population grew 8% from 1980 to 1989, the majority in metropolitan areas. Rural populations during this period declined. Based on population estimates from Metro, the economy of the Portland metropolitan region's four-county area (Clakamas, Multnomah, and Washington counties in Oregon; and Clark County in Washington) is expected to add more than one million new residents and a half-million new jobs during the next 50 years.

Information from the State Comprehensive Outdoor Recreation Plan (SCORP) shows a projected 57% increase in Recreational Visitor Day demand for the Mt. Hood National Forest from 1987 to 2000. No studies are available to show how much of this increase would take place within the Zigzag Watershed, but it is assumed that the demand could be even greater within the watershed due to its current high-use level.

The following SCORP information summarizes potential growth projections for the 1987-2000 period for activities which take place within the watershed. This information is for the Portland metropolitan region which includes Clackamas, Columbia, Multnomah, and Washington counties. It is based on a demand survey conducted in 1987. While many of the activities may take place in other areas on the Forest or around the state, those activities dependent on consistent snow conditions (such as downhill skiing, sledding, and snowplay) have increased significance within the watershed because those opportunities are limited to very few areas within the state. This increased significance also applies to climbing and mountaineering -- activities tied directly to the Mt. Hood area.

Table 4-30 -- Recreational Activity Projected Growth from 1986-2000

Recreational Activity	Percent projected growth 1986-2000
Bicycling on designated trails	93%
Day hiking	67%
Recreational vehicle camping	55%
Nature/wildlife observation	52%
Sledding/snowplay/snowboarding	51%

Recreational Activity	Percent projected growth 1986-2000
Off-road bicycling	38%
Downhill skiing	37%
Tent camping with a motorized vehicle	35%
Picnicking	35%
Cross country skiing	33%
Overnight hiking on trails	29%
Climbing/mountaineering	23%
Freshwater fishing from banks	21%

In addition to user demand, the SCORP study also indicated a shortage -- both regionally and within the Mt. Hood National Forest -- of the semi-primitive Recreational Opportunity Spectrum (ROS) setting. Of the semi-primitive acreage found in the watershed, almost two-thirds is within the Mt. Hood Wilderness. The remaining third is split between the Wind Creek Basin area in the middle of the watershed, and the watershed's southern border adjacent to the Salmon Huckleberry Wilderness. Its presence in the watershed helps to meet some of the demand for that type of recreation setting. Management actions which could further limit access to dispersed camping sites, could further limit supply. The following figure shows the ROS classes on National Forest lands within the watershed.

Figure 4-89 -- Recreation Opportunity Spectrum classes within the Zigzag Watershed

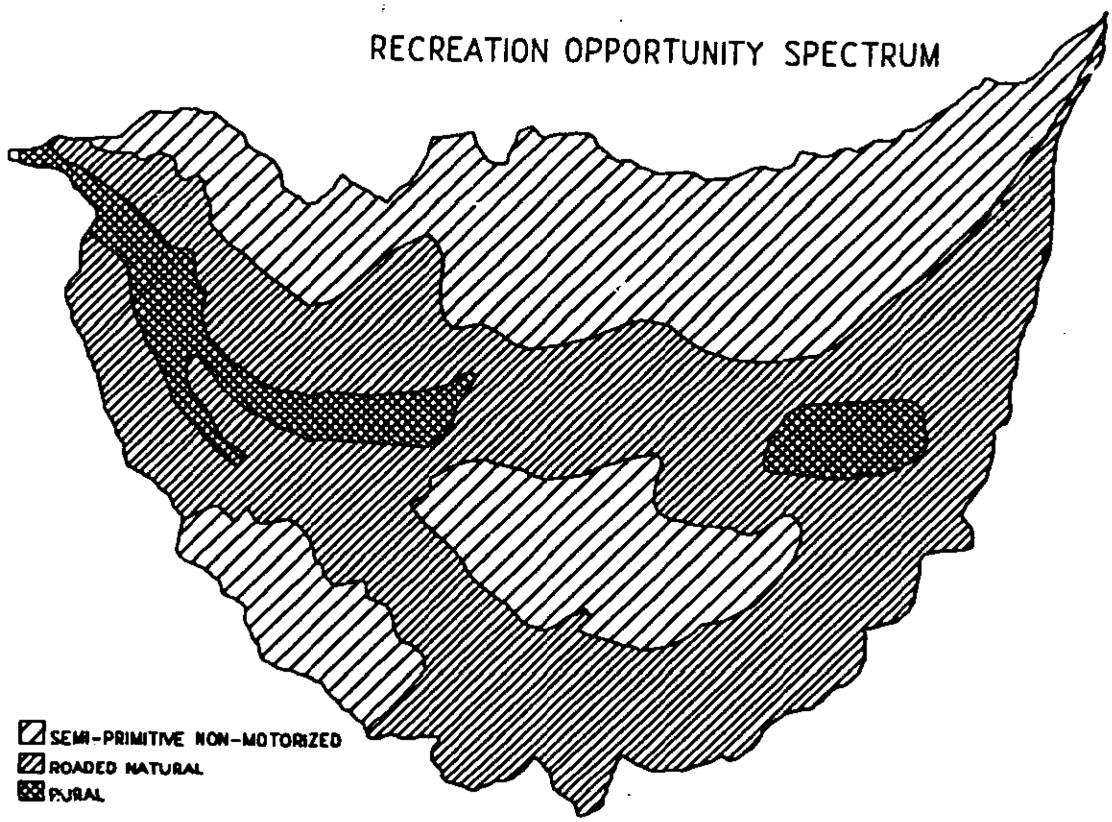


Table 4-31 -- Acres by ROS class within the Zigzag Watershed

ROS Class	Acres by ROS Class	Percent of Watershed
Semi-Primitive Non-Motorized	15,395	41%
Roaded Natural	19,635	52%
Rural	2,724	7%

Within the Zigzag Watershed, because water is so closely tied to many recreational activities, preferred settings for most recreation activities are located in or adjacent to Riparian Reserves. These areas can be expected to be under even greater demand as the Portland metropolitan area grows simultaneously with the demand for additional recreation opportunities. Because the existing landscape features (rivers, lakes, and vistas) are in limited supply, the recreational use at the limited number of these areas is expected to increase.

As population increases, the popular perception of the Forest's proximity to the Portland metropolitan area may also change. Activities such as mountain biking that currently receive relatively low to moderate use in the watershed because of driving distances from Portland, may increase at greater rates as people drive even farther to recreate in their preferred setting.

Additional residential development is also anticipated in the Government Camp area, with both vacation and primary residences being developed for those seeking less crowded conditions than Portland's metropolitan area offers. Associated future additional infrastructure such as roads, stores, and other services is therefore also expected to satisfy this projected increase in local population. These individuals, in turn, will be relying on areas within and adjacent to the watershed to meet many of their recreational needs and desires.

Increased use in the watershed can also increase the number of social encounters and user-conflicts, which can increase the need for additional law enforcement personnel as violence and crime increases. In summary, the increased population growth of the metropolitan area can be expected to lead to an increase within the existing pattern of recreation use in the Zigzag Watershed.

Barring any large-scale changes in the forest cover from natural events such as fires and insect epidemics, changes in scenic quality will primarily be a function of tree growth and future timber harvest. The progression of early-seral stands, particularly those created by timber harvest, to mid-seral would serve to improve scenic quality over time as the forest canopy closes and blends in with adjoining stands.

U.S. Highway 26

US 26 serves as an important commercial and recreational travel route, connecting the Portland metropolitan area to central Oregon, as well as to recreational facilities around Mt. Hood. It is also part of the scenic Mt. Hood Loop, a popular drive around Mt. Hood. Use of the highway has been increasing steadily over the years. The highway currently receives extremely heavy use, particularly during summer and winter weekends. A draft Environmental Impact Study prepared by the Federal Highway Administration and the Oregon Department of Transportation that analyzes alternative methods of addressing the highway's current traffic problems was released in June, 1995. The study area covers from the community of Rhododendron to the highway's junction with Oregon State Highway 35.

The need for the study is identified as:

- The highway provides an important connection to recreational facilities around Mt. Hood, Kah-Nee-Ta, and central Oregon. Commercial traffic between Portland and central Oregon also use it extensively. The 1991 Oregon Highway Plan classifies US 26 as a statewide highway which should be capable of providing safe and efficient high-speed continuous flow operations. Summer and winter weekend traffic flow in the study area currently experiences slow to moderate speed operations with interruptions in flow.

- US 26 in the study area has numerous deficiencies based on current highway design standards.

- Existing traffic volumes either approach or exceed the capacity of US 26 in the study area during peak summer and winter periods. The volumes also exceed the Minimum Tolerable Conditions listed in the 1991 Oregon Highway Plan for a statewide, rural highway in mountainous terrain.

- Future Travel demand will exceed the existing capacity of US 26 in the study area for extended periods of time during summer and winter weekend days.

- The existing accident rate for the study area is two times higher than accident rates for other primary, rural, non-freeway highways.

Four primary alternatives were studied in detail:

1. No building or no change from current conditions.

2. Widen all two-lane segments to three lanes, and provide a moderate Traffic Demand Management (TDM) program.

3. Widen all two and three-lane segments by one lane, and provide a moderate TDM program.

4. Widen the entire study area to four lanes and provide a moderate TDM program.

The Traffic Demand Management strategy is intended to maximize the highway's people-moving capability. This can be achieved by either increasing the number of people in a vehicle, or by influencing the time or need to travel. (See draft EIS for more detailed information on purpose of study, alternatives evaluated, and estimated environmental effects from the alternatives. Available for review at the Zigzag Ranger District.)

Chapter 5 - Landscape Analysis and Design

Chapter 5 - Landscape Analysis and Design

Introduction

The Landscape Analysis and Design (LAD) process (Diaz and Apostol, 1992) unites forest planning with the principles of landscape ecology. It emphasizes the conscious design of patterns in the landscape. LAD's objective in watershed analysis: to synthesize current management direction into a spatial plan of vegetative patterns and forest structures. More specifically, LAD assists in synthesizing information about physical, biological, and social processes. In addition, LAD functions together with management direction, recommendations, and expectations.

Understanding the watershed was facilitated by answering a series of spatial questions. For instance: What are the elements present in the landscape -- patches, corridors, Matrix? Where do flow-phenomena like wildlife, people, and water occur? What has been the historic disturbance pattern from fire, insects, floods, and windthrow? What is current management direction for lands throughout the watershed?

In LAD's initial step, long-term, conceptual landscape vegetative patterns were identified. This conceptual landscape design becomes an integral and essential step in answering the Key Questions, especially regarding future trends.

After completion of watershed analysis, additional Landscape Analysis and Design work should be completed for the watershed:

1. To develop an interim landscape design and identify the infrastructure in terms of roads and other facilities necessary to manage the developed areas and desired vegetative patterns.

2. To graphically display where future management activities can occur to serve as a bridge between analysis and site-specific project development.

3. To evaluate how different management actions will affect the growth and structure of forest over time by using the Scheduling and Network Analysis Program (SNAP) or other modeling systems.

Landscape Analysis and Design Mapping Process

Using the LAD process, a **Conceptual Landscape Pattern Map** was developed for the Zigzag Watershed. This map depicts how the landscape will appear from 50 to 200+ years into the future. The design was based on direction from the Northwest Forest Plan (The Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl), the Mt. Hood Forest Land and Resource Management Plan (LRMP), information concerning physical and biotic characteristics of the landscape, and social desires gained during the watershed analysis process. Design elements were developed which ensure the desired landscape structure meets management goals for the area. The terms that are used attempt to describe how these landscapes would appear in their future condition. (See Figure 5-1 for the Conceptual Landscape Pattern.)

Figure 5-1 -- Conceptual Landscape Pattern

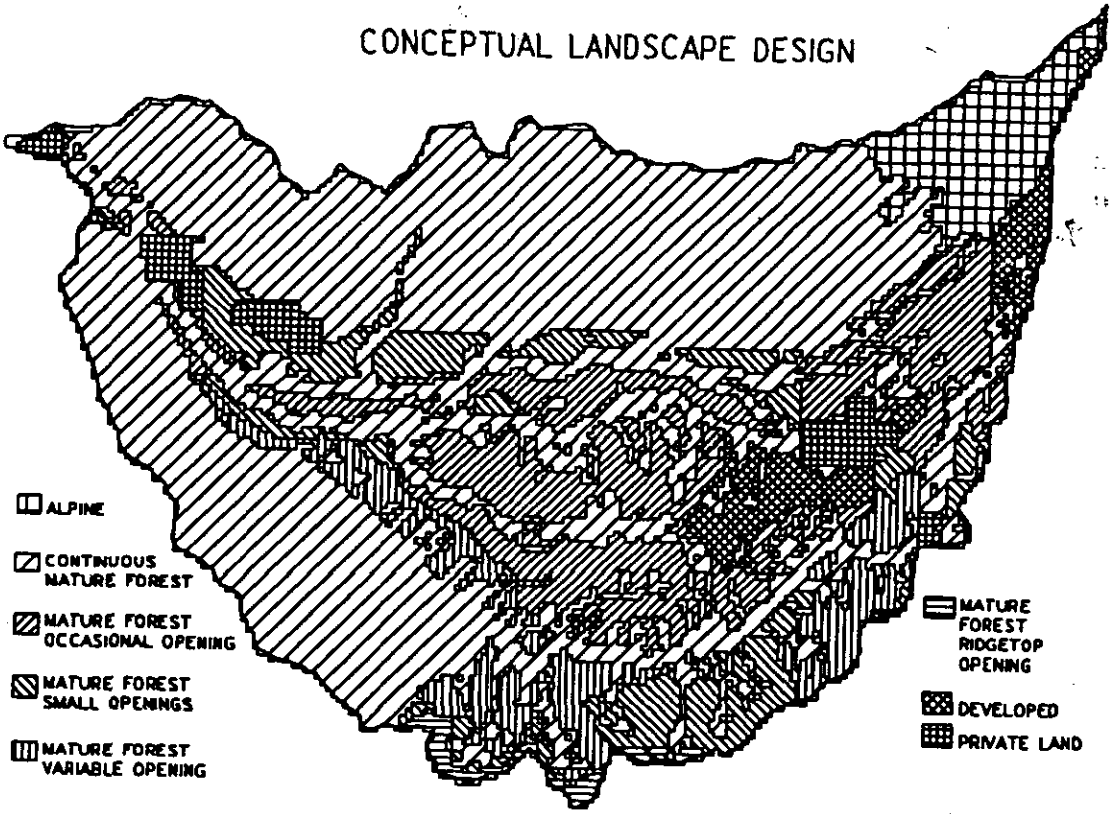


Table 5-1 -- Acres by Design Cell

Design Element	Acres	Percent of watershed
Continuous Mature Forest	22,281	59%
Alpine	1,690	4%
Mature Forest / Occasional Openings	5,676	15%
Mature Forest / Small Openings	3,010	8%
Mature Forest / Ridgetop Openings	346	<1%
Mature Forest / Variable Openings	2,491	7%
Developed	1,248	3%
Private	988	3%

The **Continuous Mature Forest** (Late Seral) design element includes all areas that would be considered terrestrial and riparian reserves in the future. This pattern covers approximately 59% of the watershed and contains 22,281 acres.

The assumptions which guided the development of this element:

1. The Mt. Hood Wilderness, excluding the alpine non-forested upper elevation areas, will function as late seral habitat.

2. Riparian Reserves will provide late seral structure as well as connectivity corridors for terrestrial species.

3. Riparian Reserves in the alpine zone will be managed to protect hydrological values downstream.

4. The Key Site Riparian allocation and Late Successional Reserve will be managed as late seral.

The **Alpine** design element includes all upper elevation non-forested alpine areas outside the special permit ski area boundaries within the watershed. This pattern covers approximately 4% of the watershed and includes 1,690 acres.

The **Mature Forest / Occasional Openings** (Mid to Late Seral) design element provides the type of structure described in LRMP allocations for Unroaded Recreation, Special Interest Areas, Recreational Residences and Winter Recreation. This pattern covers approximately 15% of the watershed and contains 5,676 acres. The structure suggested would be mostly late seral, including occasional small openings created for scenic vistas and for huckleberry production.

The assumptions which guided the development of this element:

1. The entire Barlow Road Historic District outside Riparian Reserves will be managed for mid to late seral structure to maintain historic vegetative qualities, scenic vistas, and provide interpretive opportunities.

2. The Recreation Residence tracts and winter recreation areas, including lands outside the ski runs that are within the developed ski areas and outside Riparian Reserves, will be managed for mid to late seral structure.

The **Mature Forest / Small Openings** (Mid seral--Perforated Forest) design element was created to provide a similar structure to that caused by natural disturbance factors (gap dynamics) of lightning-strike fires, root diseases, wind, etc., all of which create small openings in the forest canopy. This pattern covers approximately 8% of the watershed and contains 3,010 acres. It provides the type of structure described in LRMP allocations for Scenic Viewsheds and Backcountry Lakes, as well as a portion of Roaded Recreation.

The assumptions which guided the development of this element:

1. Small openings can be created for special silvicultural needs such as sites with regeneration problems, and scenic viewsheds where created opening size is limited.

2. Open patch size will range from less than one to five acres, depending on site limitations and resource objectives, and will be dispersed over approximately 20% of the area at one time.

3. Unstable and potentially unstable lands will be protected by riparian reserves.

The **Mature Forest / Ridgetop Openings** (Mid Seral--Perforated Forest) design element was created to provide structure similar to the gap dynamics discussed above, but allow a slightly larger open patch size to facilitate huckleberry production. It also compliments and connects with the same design element in the adjacent Salmon River Watershed. This pattern covers less than 1% of the Zigzag Watershed and contains 346 acres.

The assumptions which guided the development of this element:

1. Huckleberries will be managed in created openings and under sparse canopy areas.

2. Created openings will be designed to meet Roaded Recreation objectives.

3. Open patch size will range from 5-20 acres, and will be dispersed over as much as 50% of the area.

4. No harvest activities will occur on lands identified as unsuitable for timber harvest.

The **Mature Forest / Variable Openings**.(Mid Seral--Perforated Forest) design element was created to provide a healthy forest condition that improves riparian and aquatic habitat conditions and water quality through a variety of silvicultural and timber management practices. This design element provides the type of structure described in LRMP allocations for Special Emphasis Watershed. This pattern's 2,491 acres covers approximately 7% of the watershed.

The assumptions which guided the development of this element:

1. Provide for human-created openings from 5 to 60 acres in size.

2. No more than 33% of this design element will be comprised of these human-created openings.

The **Developed Areas** (Human Patch/Infrastructure) design element provides for the places of human habitat. This pattern, which covers approximately 3% of the watershed and contains 1,248 acres, is found in the following locations:

- Roads and trails
- U.S. Highway 26
- Developed sites
- Special-use areas
- Special Permit Ski Areas (Timberline Lodge, Summit and Multorpor-Ski Bowl)
- Utility corridors

Due to their small size, not all features that would fit into this category were included in the Conceptual Landscape Pattern map. They will need to be considered in more site-specific analysis in the future. These include roads and trails, as well as some smaller developed sites, such as Still Creek, Camp Creek and Tollgate campgrounds.

The **Private Land** design element provides for the private land parcels surrounded by U.S. Forest Service lands within the Zigzag Watershed. This pattern, which covers 3% of the watershed and contains 988 acres, includes:

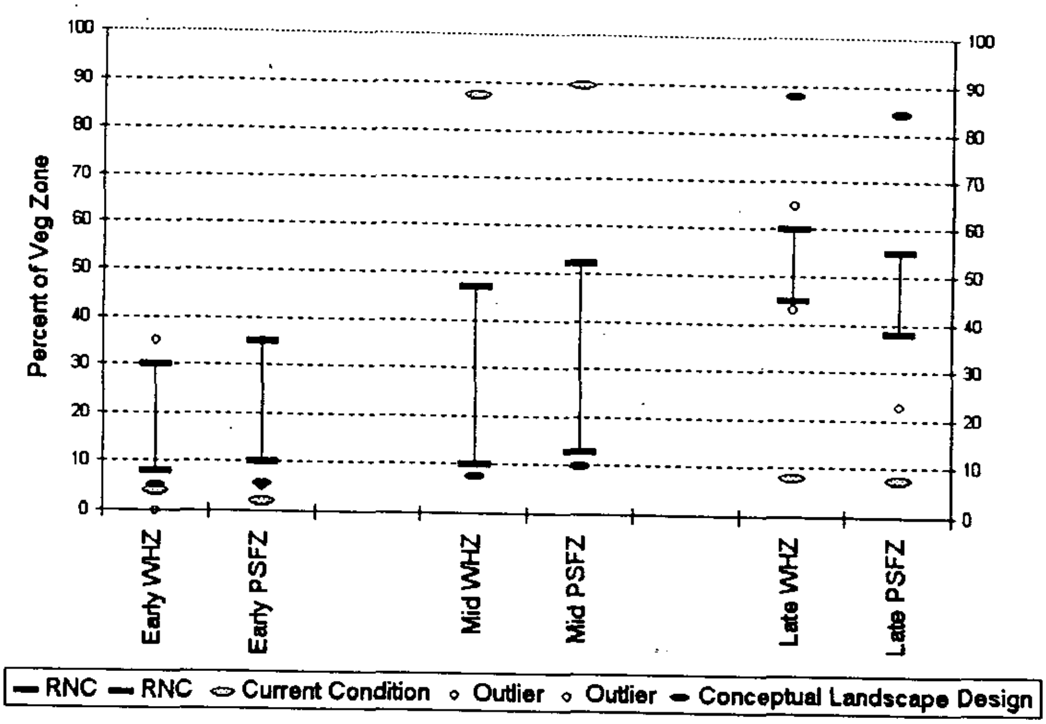
- Community of Government Camp
- Community of Rhododendron
- Private lands located on Enola Hill; west of Summit Meadows; southeast side of Eureka Peak; and in the Zigzag-Faubion area

Future Seral Stage

The conceptual landscape design was used to calculate the future condition of the watershed in terms of seral stage. The following chart compares seral stages by vegetative zone against the range of natural conditions, both currently and in the future. Current seral stages and range of natural conditions were described previously in Chapter 4- Vegetation. To summarize, however, the range of natural conditions (RNC) for seral stages is based on the Regional Ecosystem Assessment Project (REAP), scaled down to the watershed level. REAP determined pre-European management conditions at a landscape level and an RNC for the time period of 1750-1930. Current conditions are based on corrected 1995 vegetation data.

Seral stage affects a variety of ecosystem functions, including: wildlife species use and migration, hydrologic function, production of snags and coarse woody debris, nutrient cycling, and disturbance processes such as fire, insects and disease. The conceptual future condition for seral stage is used in addressing many of key questions in Chapter 6.

Seral Stage Distribution ZZ WSD



Implementation of the NW Forest Plan results in a future landscape of 80-90% late seral forest. This stand structure is outside and well above the range of natural conditions, by approximately 35%, in both the western hemlock zone and pacific silver fir zone. Future mid and early stand structure is outside (below) the range of natural conditions in both vegetative zones.

Future vegetative conditions on national forest lands within the watershed are largely defined by land allocations. Actual conditions may not reach the "desired conditions" of very high percentages of late seral forest because of natural disturbance mechanisms such as fire and insect infestations. Therefore, the ability of the watershed to maintain late successional and old growth species habitat and ecosystems is discussed below.

Ability to Maintain Late Successional Forest

There is uncertainty in reaching or maintaining desired late successional ecosystems in the future based on 1) the range of natural conditions, 2) historic fire evidence, and 3) current vegetative conditions. Consequently, whether or not the intent of the Northwest Forest Plan for old growth associated species in these areas can be met, is uncertain.

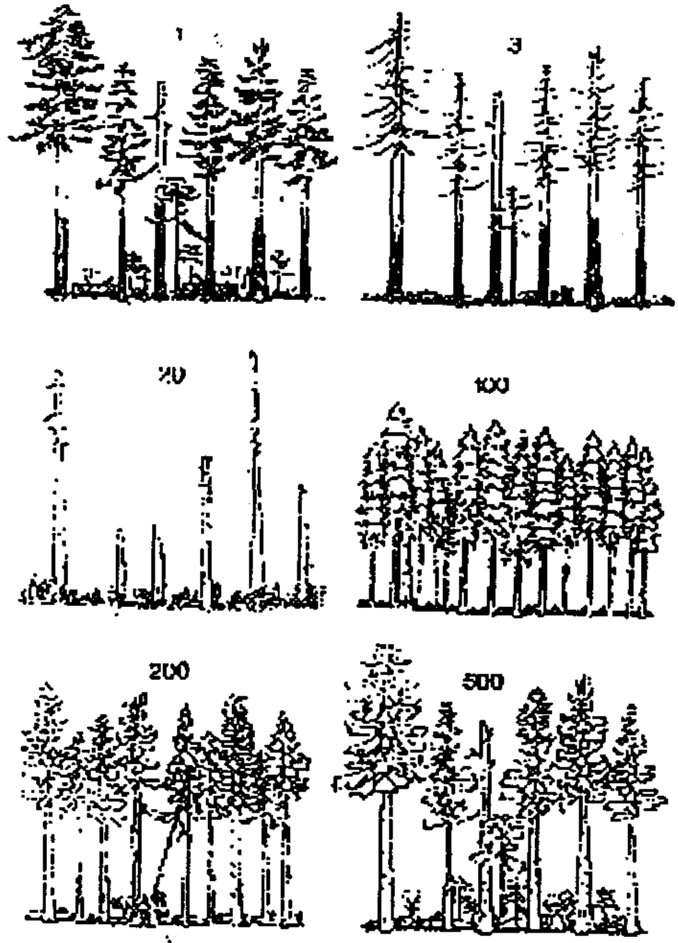
As described previously, implementation of the NW Forest Plan results in a future landscape of 80-90% late seral forest. This stand structure is outside and well above the range of natural conditions, by approximately 35%, in both the western hemlock zone and pacific silver fir zone. Future mid and early stand structure is outside (below) the range of natural conditions in both vegetative zones. Since the desired landscape is outside ranges achieved in the past, this raises the question as to whether or not late successional forests can be maintained outside of historic levels through time.

Intense and repeated historical wildfires throughout the majority of the watershed has limited stand differentiation and habitat and the majority of the Zigzag Watershed is in even aged, mid seral stands. Only 7% of the watershed currently has late seral size and structure. Figure 5-2 on the following page illustrates forest development in western hemlock/Douglas-fir forests after stand replacement fire. Each number above the stand refers to the postfire age of the stand. The typical fire regime is a high-severity fire, and is associated with ecosystem instability.

The mid seral structure within the Zigzag watershed is well illustrated by the 100 year stand schematic in Figure 5-2. These stands have relatively even crown heights, similar stem size, dense stocking, and narrow crowns. It is estimated that it will take at least an additional 100 years before stand differentiation begins to develop old growth characteristics. Sites with decreased productivity from degraded soils associated with fire may take even longer.

Mapping and analysis of historic fires (Ch. 4) displayed several, large, stand replacement fires throughout the watershed within the last century. Some areas had repeated burns. This is strong evidence that large scale fires cannot be ignored in assessing risk to future stands. Furthermore, limited access and remoteness in areas such as the Mt. Hood Wilderness and other roadless areas increase the risk of fire spread.

Figure 5-2 - "Chronosequence of forest development after fire



Current vegetative conditions are also contributing to a higher risk of natural disturbance mechanisms such as fire, insects and disease. Large patches of even-aged post-fire stands show reduced vigor due to low site productivity and off site plantations. Western spruce budworm and Douglas-fir beetle have taken advantage of these conditions further weakening the stands and causing some mortality. In addition, insect defoliation and mortality has increased the availability of crown and ladder fuels. Current stand conditions indicate a moderate risk of large-scale, stand replacing fire.

In addition, approximately 15% of the watershed is infected with laminated root disease. The trend for the spread of laminated root disease is an exponential increase within the watershed. This is due to the level of known infections, and large contiguous acres of highly susceptible host types in even aged, closed canopy stands with high root to root contact. Infection centers will remain "out of production " for host conifers which will also reduce the ability to achieve late successional conifer forest in the future.

Chapter 6 - Key Questions/ Synthesis

Chapter 6 - Key Questions/Synthesis

Introduction

In this chapter, Key Questions are answered by assessing the effects of processes and functions on the key attributes addressed in each question. This approach synthesizes the analysis by considering the relevant processes and conditions in formulating answers to the Key Questions. It also identifies and documents significant shifts from the range of natural conditions and desired conditions. Thus, the results provide a basis for identifying and prioritizing methods to maintain or restore the key attribute.

Question 1 -How do conditions of the watershed contribute to the habitat needs for species of concern in aquatic, riparian, terrestrial and special habitats?

Aquatic/Riparian Habitats

Table 6-1 -- Species of Concern within the Zigzag Watershed

Species	Concern
Coho salmon	Forest Service and State sensitive species; high risk of extinction; under review for Federal T & E listing.
Spring chinook salmon	High risk of extinction; status under review by State.
Winter steelhead	Moderate risk of extinction; petitioned for Federal T & E listing.
Sea-run cutthroat trout	Forest Service and State sensitive species; moderate risk of extinction.
Bull trout	Candidate for Federal T & E listing; Forest Service sensitive.
Resident cutthroat trout	Public interest; Mt. Hood National Forest management indicator species; possible unique stock in Still Creek and other drainages.
Resident rainbow trout	Public interest; Mt. Hood National Forest management indicator species
Redband trout	Forest Service sensitive
Pacific lamprey *Entosphenus tridentatus*	State sensitive species
Mt. Hood brachycentrid caddisfly *Eobrachycentrus gelidae*	Fish and Wildlife category 2 species; Oregon Natural Heritage Program taxa of concern; Forest Service sensitive
Mt. Hood farulan caddisfly *Farula jewetti*	Fish and Wildlife category 2 species; Oregon Natural Heritage Program taxa of concern; Forest Service sensitive
Columbia dusky snail *Lyogyrus sp.*	ROD survey and manage species (no records)
Red-legged frog	Forest Service sensitive species
Copes Giant Salamander	Forest Service sensitive species
Harlequin duck	Oregon State and Forest Service sensitive species, USFWS C2 species
Fir Clubmoss *Huperzia occidentale*	Forest Service sensitive species

Coho and Spring Chinook Salmon

The coho salmon run in recent years has returned in very low numbers. This species is listed by the State of Oregon and the Forest Service as a sensitive species. The National Marine Fisheries Service is currently reviewing status of the stock for possible listing as a threatened and endangered species.

The spring chinook salmon run in the upper Sandy Basin is composed of two stocks, a native "early-run" and a later run derived from and supplemented with Willamette stock. The native run is presently very small and may be extinct. Natural reproduction of the introduced run is increasing over time in the watershed.

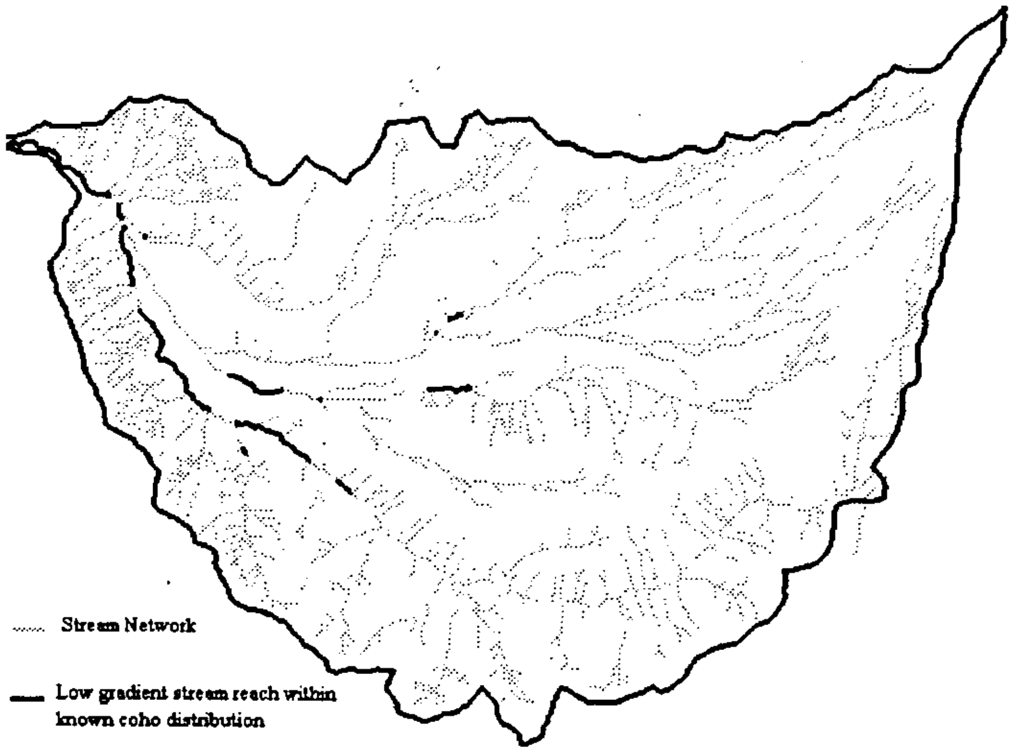
Fall chinook may have been present historically, and spawning adults were observed in the Salmon River in 1994. There are no records of fall chinook in the Zigzag Watershed.

Coho salmon prefer areas with low water velocities such as low gradient small to medium sized streams, side channels, and the margins of mainstem rivers (Meehan and Born 1991; Groot and Margolis 1991). Large woody debris frequently acts as the roughness element creating the protected low velocity margins of the river that coho prefer to utilize.

Chinook salmon utilize larger streams and river systems. Chinook prefer large pools with large woody debris in low gradient areas along the mainstem and do not usually venture into tributaries or side channels.

These low gradient areas would be characterized by Rosgen C type channels which are defined as low gradient, meandering, point-bar, riffle dominated channels with broad, well defined floodplains. For the most part, this type of channel exists in the Zigzag River and in the Still and Camp Creek subwatersheds.

Figure 6-1 -- Coho Preferred Habitat

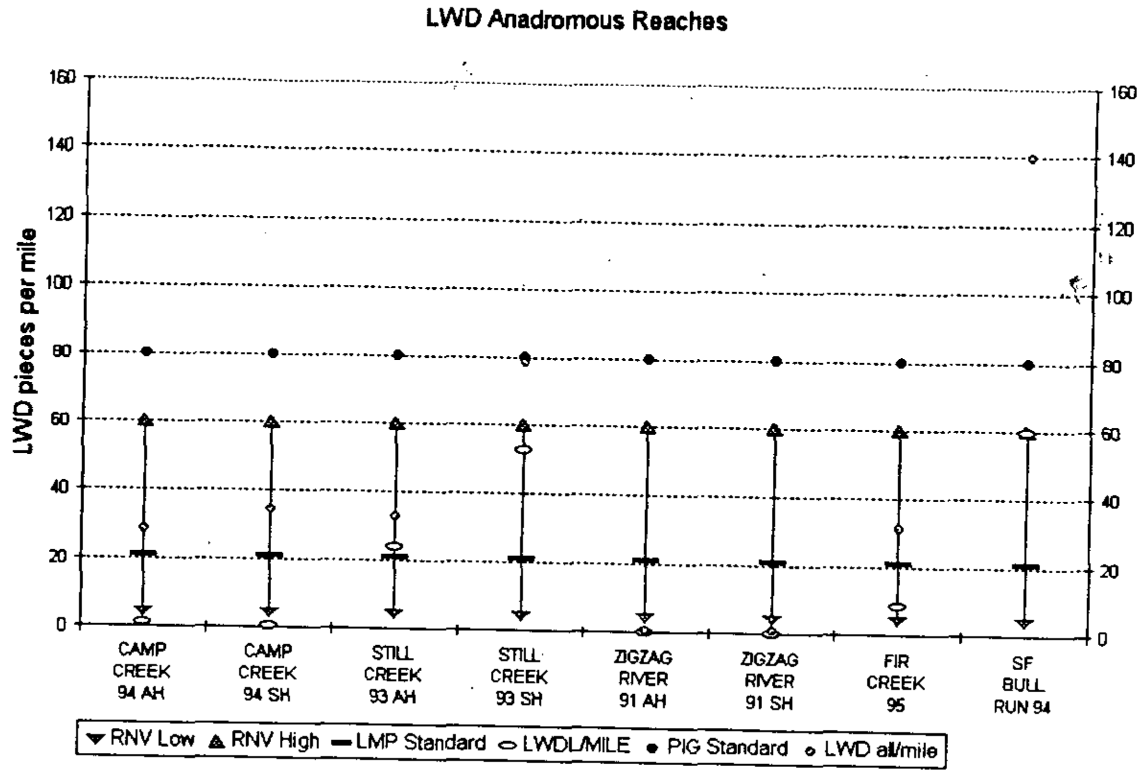


The figure above indicates low gradient stream reaches within the known range of coho salmon. The majority of the habitat for this species is located in Still Creek.

Key habitat components for coho and chinook salmon include pools and side channels with incorporated large woody debris.

Large woody debris within the anadromous portions of Camp Creek and Zigzag River are outside the range of natural variation and Columbia River Policy Implementation Guide/Salmon Summit (PIG) and Mt. Hood National Forest Land and Resource Management Plan (LRMP) standards. Still Creek is within the range of natural variation and meets PIG and LRMP standards. If large and small woody debris are combined for an indication of total woody debris within these streams, Camp Creek and Still Creek meet or exceed levels within an unmanaged subwatershed (within the Bull Run Watershed). This indicates that these areas are within the range of natural variation. Zigzag River is very low in combined levels of woody debris (0.8 pieces per mile) and well below levels within the Bull Run.

Figure 6-2 -- In-channel Woody Debris

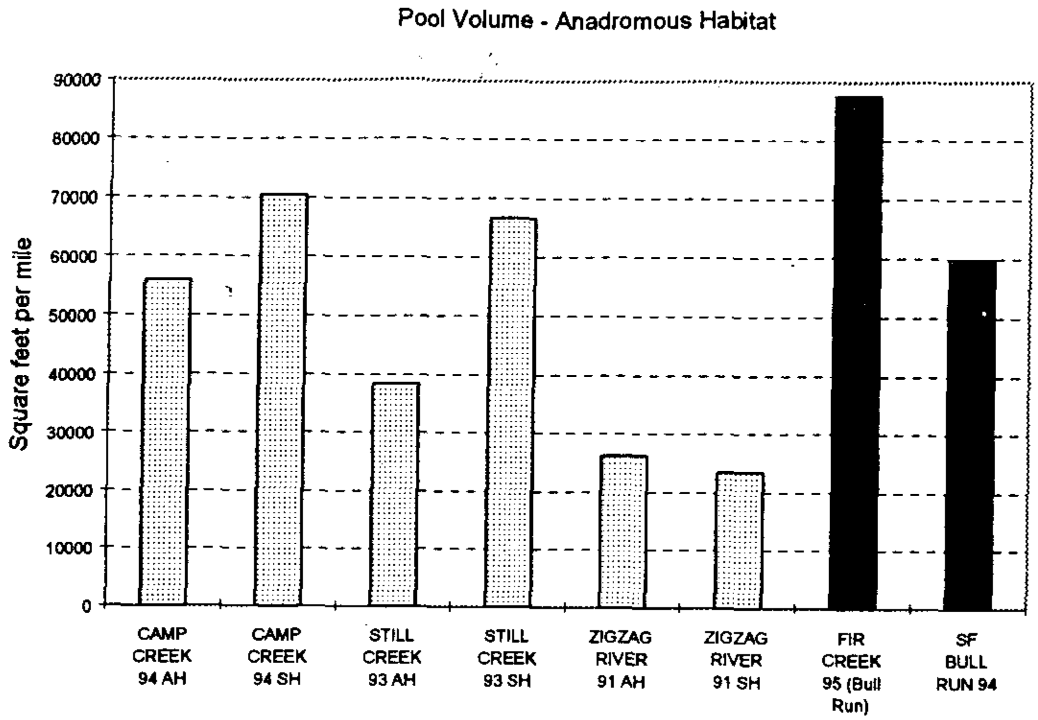


AH=Anadromous Habitat
SH=Recreational Residence Area

Levels of pools within the anadromous sections of Camp Creek, Still Creek and Zigzag River are below LRMP and PIG standards and are outside or at the low end of the range of natural variation. However, pool volumes for Camp Creek are within the same range as streams in the Bull Run Watershed. Still Creek is slightly lower and Zigzag River is well below levels in the Bull Run. This would imply that pool volumes within Camp and Still creeks are within or near the range of natural variation.

Pool volumes are greater within the Recreational Residence tracts, which indicate the extensive rehabilitation work in this area was effective. Stream survey protocols for assessing primary pools have changed over the years. This may explain why there is not a good correlation between pool volumes and the number of primary pools. The higher pool volumes within the Recreational Residence areas in Still Creek and Camp Creek would indicate that the resulting pools are small and are located along channel margins (a preferred habitat type for coho). Current stream survey methodology does not quantify this type of habitat.

Figure 6-3 -- Pool Volumes



AH=Anadromous Habitat
SH=Recreational Residence Area

Low gradient areas are also present in more limited amounts near the mouth of Lady, Devils, Henry and many unnamed tributaries. These sites are very important for coho salmon production and support limited spawning and rearing by chinook. A culvert on Henry Creek limits access to approximately one-half mile of habitat, and old dams and fill material partially limit passage to more than one mile of habitat on Lady Creek. Erosion from a road and pit are impacting the lower mile of Devils Creek.

Another important consideration in assessing coho habitat is examining the mix of habitat types. Coho salmon prefer slow water pools and side channels. The Zigzag Watershed is outside the range of natural variation for pools within the anadromous section of the watershed. This is attributed to channelization and large woody debris removal after the 1964 Flood. These actions primarily occurred on the Zigzag River, Still and Camp creeks, and to a lesser degree on the lower reaches of the smaller remaining streams. Studies have shown that large woody debris is a critical component of good side channel habitat. Based on queries of the Stream Management, Analysis, Reporting and Tracking (SMART) database, there is no large or small woody debris associated with side channels within the andromous sections of Camp Creek, Still Creek and Zigzag River.

Habitat effectiveness in these areas has also been degraded in the lower Zigzag River, Still and Camp Creek subwatersheds due to easy access and associated fishing pressure from the Recreational Residence tract areas, and the development of private land. Almost 90% of coho habitat and 99% of the spring chinook habitat is being affected in this manner.

Recent research has indicated that carcasses of adult salmon are an important nutrient source for sustaining young salmon. Coho numbers are likely at less than 10-25% of historic levels. Low numbers of returning chinook and coho are therefore likely limiting the production of subsequent generations.

These factors indicate that the habitat for coho and chinook salmon is outside the range of natural variation and is in a degraded condition. With implementation of the Northwest Forest Plan and the Aquatic Conservation Strategy (ACS), pool numbers and volume should improve with the incorporation of more woody debris, and side-channel habitat will become more effective. These changes will result in better habitat conditions for coho and chinook salmon.

Winter Steelhead and Sea-Run Cutthroat

The existing stock of native winter steelhead is composed primarily of late-run upper Sandy stocks. Prior to 1964, early-run stocks were released throughout the upper Sandy Basin. Hatchery release of early run stocks continue in the Sandy River below Marmot Dam. The extent of straying of these hatchery stocks into the upper basin is unknown. Adult returns to the upper Sandy Basin have been fairly stable averaging approximately 3,000 fish for the past 30 years. Returning numbers, however, have declined during the last several years. It is currently under review by the National Marine Fisheries Service (NMFS) for listing as threatened and endangered species.

The sea-run cutthroat is a native stock and appears to be present in Still Creek and possibly other streams in the watershed. The sea-run cutthroat is listed as a sensitive species by the State of Oregon. The American Fisheries Society (AFS) report lists the stock in moderate danger of extinction; very few are detected passing over Marmot Dam.

Steelhead and sea-run cutthroat ranges overlap. Juvenile steelhead trout typically prefer faster water areas than coho or chinook salmon (Groot and Margolis 1991; Meehan 1991). Older steelhead juveniles prefer the heads of pools, and riffles with large boulder substrate and woody cover in the summer. During winter, older steelhead juveniles are found in pools, near streamside cover and under debris, logs or boulders.

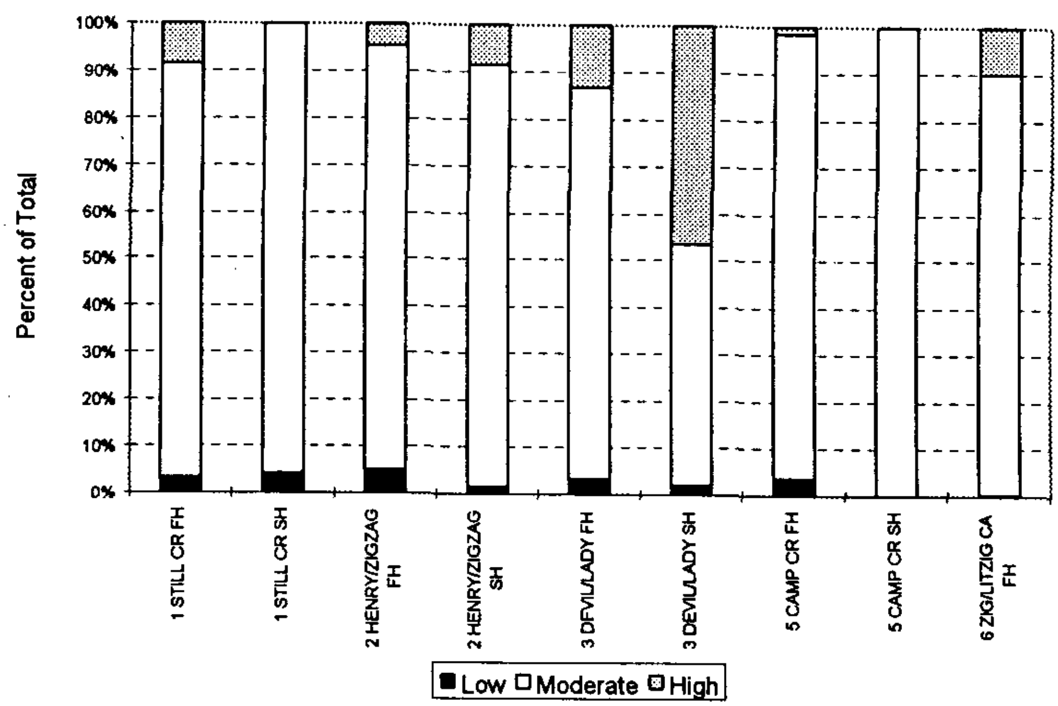
The two species either historically or presently utilize habitat in the Zigzag River, Still, Camp, Henry, Devils, Lady and other tributaries in the watershed below migration barriers. They likely utilized the Little Zigzag River prior to initial construction of Highway 26, where a barrier culvert at its mouth blocks one mile of habitat.

In-channel woody debris within Still and Camp creeks are near the same levels as streams within the Bull Run, which would indicate that they are within the range of natural variation. Zigzag River is very low in total woody debris (0.8 pieces per mile) and well below levels in the Bull Run (Figure 6-2).

Pool levels within the anadromous sections of Camp Creek, Still Creek and Zigzag River are below PIG and LRMP standards, and are generally at the low end or below the range of natural variation. Pool volumes within Camp Creek are within the same range as streams within the Bull Run; Still Creek is slightly lower; and Zigzag River is well below levels within the Bull Run (Figure 6-3). This would indicate that pool volumes in Still and Camp creeks are within the range of natural conditions.

Large woody debris recruitment is limited within most of the subwatersheds (with the exception of Devil/Lady). Less than 10% of the area in the Riparian Reserves is in the high large woody debris recruitment potential class. This is attributed to the watershed's recent fire history.

Figure 6-4 -- Large Woody Debris Recruitment Potential Fish Bearing Streams



AH=Anadromous Habitat
SH=Recreational Residence Area

Riffle habitat is the dominant habitat type in this area, with pools and side channel mixed in. Riffles compose 60-70% of the habitat, with the highest levels in the Zigzag River. Pool habitat is outside that of undisturbed streams in the Bull Run, Still Creek and Zigzag

River. It appears that the pool habitat within the range of these species has decreased through flood control activities. Habitat is now dominated by riffles. This change in the mix of habitat types would favor steelhead and sea-run cutthroat over coho salmon.

Habitat effectiveness in this area has also been degraded in the Zigzag River, Still and Camp Creek subwatersheds due to easy access and associated fishing pressure. Approximately 89% of the steelhead habitat is affected in this way. Approximately one mile of habitat is blocked in Still Creek tributaries by barrier culverts along Still Creek Road. All of the habitat on the Little Zigzag River (one mile) is also blocked. As previously pointed out, there is also a culvert barrier on Henry Creek. In addition, other barriers may exist that have not been identified. These blockages should be corrected.

Stocking of summer steelhead smolts in the Zigzag River may affect native trout populations, although the extent of interaction is unknown. The Zigzag Watershed is an important production area for native steelhead and salmon within the Upper Sandy Basin, second only to the Salmon River in the amount of high quality habitat (especially Still Creek). Because the Salmon River is heavily stocked with summer steelhead, the Zigzag Watershed could be disproportionately important as a refuge for the production of native fish.

The habitat for these species has been slightly degraded due to the lack of pools and low levels of woody debris (especially in Zigzag River). Recovery is expected with the implementation of the Northwest Forest Plan and the ACS. Habitat restoration for coho and chinook salmon will likely have some benefits for steelhead and cutthroat as well, especially in enhancing overwintering habitat. Decreasing road access to riparian areas in steelhead habitat would improve habitat effectiveness.

Bull Trout

The bull trout is currently a candidate for listing under the Federal Endangered Species Act, and is listed as a sensitive species by the State of Oregon and Forest Service. There are historic reports of bull trout in the Zigzag Watershed, however its presence has not been confirmed. Suitable habitat and isolation from other fish exists to support this species in the upper watershed. However, there have been no documented sightings.

Redband Trout

Redband trout are a Forest Service sensitive species. A stock of inland rainbow trout suspected to be redband trout have been identified in several upper Sandy River tributaries, but not within the Zigzag Watershed.

Redband trout habitat requirements are similar to those of steelhead trout. The redband prefer fast water areas (riffles) intermixed with pools and large woody debris. Riffle habitat averages 80-90% of the aquatic habitat within the watershed. This indicates a large portion of this area is in fast water habitat types favoring the species.

Large woody debris levels across the watershed are below LRMP and PIG standards, and are outside or at the low end of the range of natural variation (with the exception of Henry and Still creeks). However, if large and small woody debris are combined, levels of woody debris within most of the watershed approximate those of Fir Creek in the Bull Run Watershed. This would indicate that these areas are within the range of natural variation. Zigzag and Little Zigzag rivers are very low in combined levels of woody debris (1.5 and 4.8 pieces per mile). This condition is attributed to these streams being in the alpine area, with less vegetation and stream cleanout in the lower reaches of these streams after the 1964 Flood.

With the exception of Wind Creek, pool levels across the entire watershed are below LRMP and PIG standards, and are at the low end or outside the range of natural variation. Pool volumes across the watershed (with the exception of the anadromous portions of Still and Camp creeks) are well below those within the Bull Run.

Another concern for the redband trout is potential competition with brook trout. Brook trout have been planted in Mirror, Enid, Hidden and Devils lakes; Collins Pond and Multorpor Fen. Thus, they have spread to habitat possibly historically occupied by redband trout. Brook trout do not inter-breed with rainbow trout, but they can compete for limited habitat and food resources and prey on the eggs and larvae of other fish.

Due to a lack of pools, the habitat for redband trout is slightly outside the range of natural variation. This habitat appears to be recovering and should continue to do so under the Northwest Forest Plan and the ACS.

Resident Rainbow Trout

Rainbow trout were present historically above and below barrier falls in both resident and anadromous (steelhead) forms. There have been recent reports of large native resident rainbow trout caught in the lower mainstem Sandy River. Rainbow trout from several sources have been used by hatcheries for stock for outplanting in the upper Sandy Basin. Fingerling and catchable rainbow trout have been historically released in the lakes and in Camp Creek near the campground. In 1994, stocking of catchable rainbows was discontinued in the streams of the Zigzag Watershed. Fingerling rainbow continue to be released in the high lakes. It appears that if the catchable trout are not quickly harvested, they do not survive the following winter. Fingerling survival appears to be good, especially in Mirror Lake.

Habitat requirements for resident rainbow are similar to those of steelhead and redband trout. (For details of habitat condition, refer to discussion of habitat for these species.) Based on the previously mentioned conditions, the habitat for resident rainbow trout in the upper watershed is considered to be in a degraded condition. This is due to lack of high quality pools and large woody debris for overwintering within Zigzag and Little Zigzag rivers.

Brook trout fingerlings are also released in the lakes. Some of these hatchery fish likely pass downstream into outlet streams, and begin competing for food and space with native fish. Brook trout are present in Camp and Devils Creek The introduction of hatchery rainbow and brook trout may have affected resident rainbow through competition for food and space (and possibly through hybridization between native and hatchery stocks).

With implementation of the Northwest Forest Plan and the ACS, pool and large woody debris levels should move toward the range of natural variation. Additionally, habitat conditions for resident rainbow trout should improve.

Resident Cutthroat Trout

The resident population of cutthroat trout is a native stock, and has the widest distribution of all the salmonids found in the Zigzag Watershed. It is well distributed throughout the drainage.

The anadromous portion of the watershed has been addressed in the assessment of habitat for sea-run cutthroat. (Refer to that discussion for details of habitat condition.) The resident form is present in most of the basin's perennial tributaries. And, because a large percentage of this watershed is unroaded, a proportionately lesser amount of its habitat has been affected by road construction and other development.

Increased sedimentation in the upper watershed from road sanding activities is of concern due to: potential effects of sediment deposition on redds, loss of pool volume, and effects on macroinvertebrate communities -- an extremely important food source. Sanding impacts are greatest in Camp Creek, but also are affecting fish in Still Creek, and to a lesser degree in the Little Zigzag and Zigzag rivers. Because sediment loads from road sanding are greatest during spring runoff, this action has the greatest negative effect on reproduction of spring-spawning native trout.

Heavy recreational use along the western shoreline of Mirror Lake has eroded and compacted the shoreline, eliminating much of the riparian vegetation, resulting in habitat degradation. This habitat degradation has also occurred, to a more limited degree, at Veda Lake.

Competition with brook trout, and possible hybridization with introduced stocks of rainbow trout, are also a concern. Brook trout compete for limited habitat and food resources and prey on eggs and larvae of other fish. The introduction of rainbow and brook trout into the high lakes allowed their spread into Camp, Devils and possibly other streams. Where this has occurred, hybridization with native rainbow and cutthroat has possibly occurred; and competition for food and space has also likely occurred. Within the reaches of Devils and Camp creeks where brook trout are found, cutthroat trout are also found in very low numbers.

The above factors have resulted in degraded habitat in the watershed, especially in Camp Creek, due to sediment inputs. Implementation of the Northwest Forest Plan and the ACS should result in recovery of the physical habitat.

Pacific Lamprey

Pacific lamprey (*Entosphenus tridentatus)* are State Sensitive Species -- based on significantly depressed populations throughout their range (Weeks, ODFW 1993; Downey et al., 1993).

The historic range of the Pacific lamprey in the Columbia River Basin was coincident with anadromous salmonids. Pacific lamprey use the same spawning substrate as anadromous salmonids. Larval lamprey (ammocetes) spend 5-6 years in slow water/fine substrate freshwater habitats before migrating to the ocean. Rapid or prolonged water withdrawals that dry out edgewater stream habitat is the greatest risk to larval lamprey (Dick Beemish pers. comm.). High water temperatures, water quality, and extremely high barriers are additional risk factors.

Pacific lamprey have been documented in Still Creek, Camp Creek and Zigzag River. The habitat requirements for Pacific lamprey are similar to those of coho and chinook salmon. Therefore, a summary of large woody debris levels, pool habitat, pool levels and sediment deposition will be used to assess habitat conditions.

Levels of pool habitat within Still Creek and Zigzag River are lower than unmanaged stream systems within the Bull Run Watershed. Levels of in-channel woody debris (both large and small) and pool volumes in Camp and Still creeks are within or near the range of natural variation. The Zigzag River is well below the range of natural variation. There is the potential for sediment deposition in low gradient reaches in Camp Creek and Zigzag River from road sanding, and in Still Creek and Camp Creek from cutbanks.

Habitat conditions for Pacific lamprey are outside the range of natural conditions across the Zigzag Watershed, particularly within the Zigzag River. Conditions should improve with implementation of the ACS due to increased large woody debris recruitment with the potential to build pools and reduce sediment inputs from management activities.

Mt. Hood Brachycentrid Caddisfly, Mt. Hood Farulan Caddisfly, Columbia Duskysnail

Due to their similar habitat requirements, these three species were assessed together.

All three of these species have either been documented at cold water springs or require cold water stream or spring habitat. Mt. Hood brachycentrid caddisfly and Mt. Hood farulan caddisfly have been documented along Still Creek at the crossings of Timberline and West Leg roads. They likely occur in surrounding springs and small streams. The Columbia duskysnail has been documented in the Bull Run Watershed. While its habitat exists within the Zigzag Watershed, no documented occurrences have been reported. Two other species of macroinvertebrates are suspected in these same environments: the one-spot caddisfly (*Rhyacophila unipunctata*) and the Cascades apatanian caddisfly (*Apatania tavala*).

Habitat requirements for the Mt. Hood brachycentrid caddisfly include: moderate to high gradient, cold, narrow (1-2 feet wide) perennial spring channels with dense shade by a coniferous and deciduous overstory, and elevation range from 4,000 to 5,000 feet. Its larvae appear to be restricted to spring channels with a significant portion of bottom substrates consisting of submerged moss.

Columbia duskysnail habitat requirements are springs and spring outflows, from low to high elevations in cold, pure, well oxygenated water. This species is often found in very small springs or channel margins of larger springs, and is most common on soft substrates, in shallow slow flows. It prefers oligotrophic pristine water sources with no macrophytes (Frest 1993). Habitat requirements for Mt. Hood farulan caddisfly are similar, with preferences for woody debris substrates.

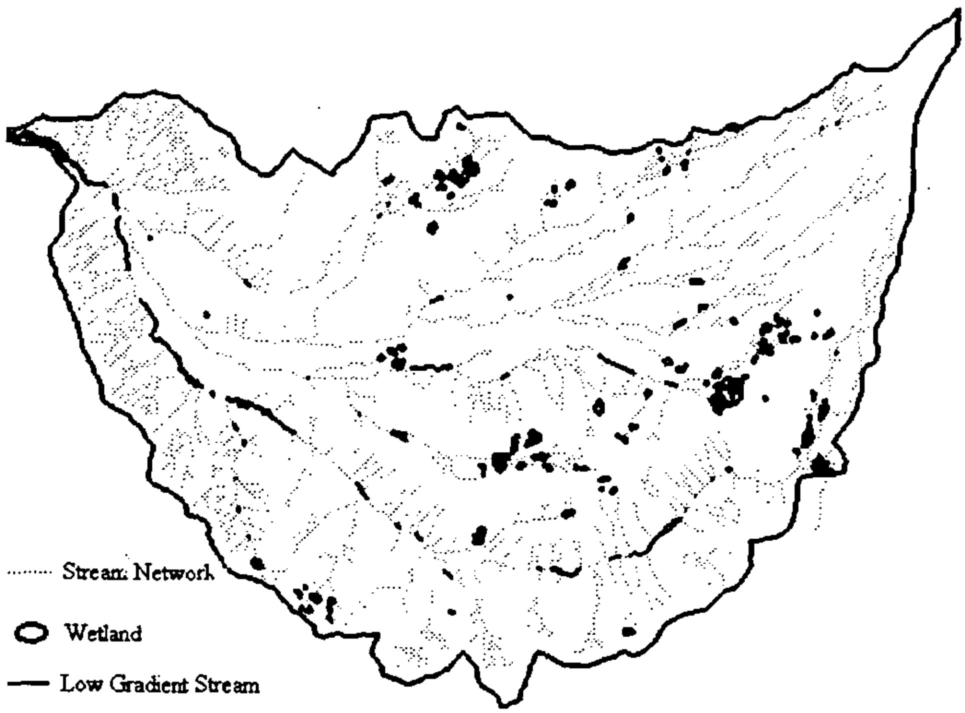
Potential effects to these species come from declining baseflows, water quality degradation, and sediment inputs. The known habitat for these species is adjacent to the Timberline and West Leg roads. This habitat, therefore, has likely received increased sediment inputs from roadside sanding and road maintenance activities in both adjacent and upstream areas. Declining baseflows and water development in neighboring watersheds has effected habitat, although this has not been documented within the Zigzag Watershed. Conductivity readings and levels of chloride in upper Still Creek indicate elevated levels of sodium and chloride associated with the salting of the Palmer Snowfield (in conjunction with the Timberline Lodge ski are operation). Even though chloride levels are below published thresholds of concern; the chronic effect on submerged mosses is a concern.

Based on these factors, the current conditions have likely resulted in degradation of habitat. However, with Riparian Reserves and Aquatic Conservation Strategy objectives, there appears to be little potential for continued adverse impacts to habitat for these species. Control of sediment from road surfaces and cutbanks is a priority for improving habitat conditions for these species.

Red-legged Frog

The red-legged frog inhabits ponds, marshes, rivers and streams in coniferous forests where vegetation at the waters' edge provides good cover. The red-legged frog requires low gradient, slow flowing water and sandy/gravely substrates.

Figure 6-5 -- Red-legged Frog Habitat



The habitat for this species was assessed by looking at two factors: low gradient stream reaches, and in-channel large woody debris levels.

The greatest identified impact to low gradient stream reaches is sediment deposition. Low gradient stream reaches are also areas where sediment deposition from natural and management activities is likely to occur. Camp Creek and Still Creek are likely to have sediment deposition above background levels associated with road sanding and cutbanks along Highway 26 and Still Creek Road. Wetlands within Wind Creek Basin, Cool Creek and Devils Creek are located away from any roads or harvest areas. The sediment regime in these areas should therefore reflect the natural condition.

In-channel large woody debris is important in the creation and maintenance of low gradient reaches in the watershed. In-channel large woody debris levels in low gradient stream reaches are summarized below.

Stream	Woody Debris Pieces/Mile
Camp Creek 94	6
Still Creek 93	31
Zigzag River 91	0

Levels of woody debris (both large and small) are very low in the low gradient reaches of Camp Creek and Zigzag River. This is most likely associated with stream cleanout after the 1964 Flood. Levels of woody debris in Still Creek reflect the extensive restoration efforts in that stream.

Habitat for red-legged frogs within the Zigzag Watershed is in a degraded condition due to sediment deposition in Camp and Still creeks, as well as the low levels of in-channel large woody debris in Camp Creek and Zigzag River. Implementation of Riparian Reserves and ACS objectives will promote recovery of habitat for red-legged frogs.

Cope's Giant Salamander

Cope's giant salamander *(Dicamptodon copei)* inhabit fast flowing 1st to 3rd order streams with clear cold water and streamside forest. Recent surveys indicate that Cope's requires cold water not exceeding 10°C (50°F) (Corkran, pers. comm., 8/28/95). Stream substrate consists of cobble and small boulders, some large logs and no silt. They occasionally occur in clear, cold mountain lakes and ponds. Their elevational ranges from sea level to 1000 m (3,500 ft.) (Corkran, pers. comm.).

Camp Creek, Zigzag River, Henry Creek, Lady Creek, and Still Creek provide suitable habitat for Cope's giant salamander.

Figure 6-6 -- Potential Cope's Salamander Habitat

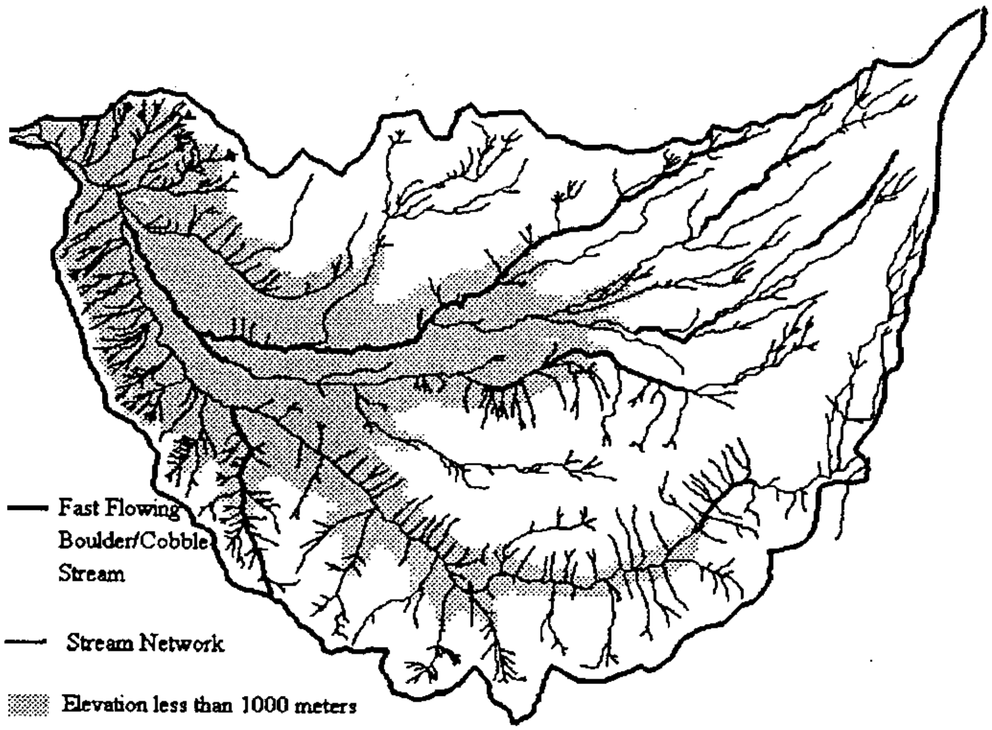


Figure 6-6 identifies potential habitat for Cope's giant salamander in the Cool Creek area, upper Camp Creek, and Zigzag River. The critical habitat components of streamside forest, stream temperature and stream substrate will be used in assessing habitat for Cope's giant salamander.

As detailed in the habitat section for tailed frogs, late seral stand structure across the watershed is well outside the range of natural conditions. The Cool Creek area, however, is composed of late seral stands.

Recorded stream temperatures within Still Creek, Camp Creek and Zigzag River range from 7.9-11.2^{0}C. Still Creek and Camp Creek at their confluence with the Zigzag River are the only areas with temperatures recorded above 10.5^{0}C . The Riparian Reserves within the subwatersheds have more than 80% of area with greater than 70% canopy closure. This indicates very limited opportunities for increasing stream temperatures exist -- due to the interception of solar radiation.

Deposition of fine sediment from road sanding and cutbanks has the potential to alter the substrate in the Camp Creek and Zigzag River areas.

Habitat conditions for Cope's giant salamander are outside the range of natural conditions due to altered stand structure and sediment deposition in Camp Creek and Zigzag River. Habitat conditions in the Cool Creek area are good. Implementation of the Northwest Forest Plan and the ACS should move stands toward late seral conditions and limit sediment deposition into Camp Creek and Zigzag River, thereby improving habitat for Cope's giant salamander.

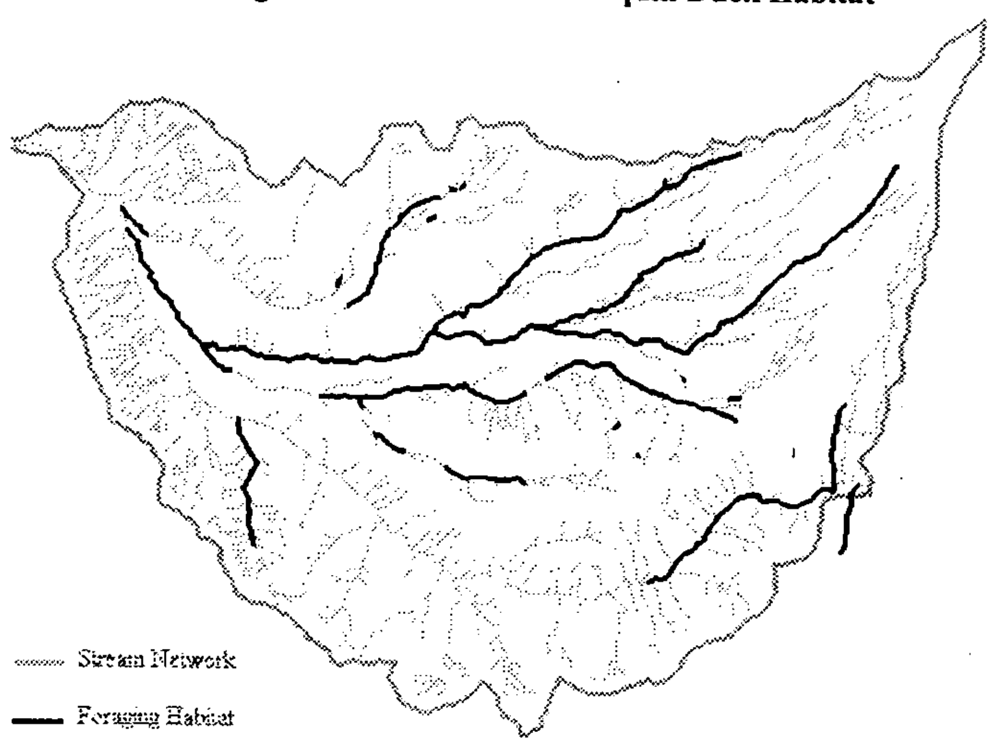
Harlequin Duck

Harlequin ducks inhabit turbulent mountain streams in coniferous forests with dense shrubby streamside vegetation. Instream structures (logs, boulders) are important for providing loafing sites for the species. Slower side channels and slower moving waters are important for brood rearing. Males and females arrive in Mt. Hood National Forest streams around March, and return to winter at the Pacific Coast by approximately September. Nests are found on the ground near streams, in tree cavities, or cliffs.

This species can be sighted regularly during spring and summer on Still Creek, Camp Creek, and the Zigzag River. Surveys have not documented young on these stream systems. While it is very likely they are breeding and rearing their young on these streams, the harlequin duck's aversion to human presence may prevent sighting its young.

A large portion of the watershed provides turbulent mountain streams within coniferous forests. Therefore, quality of the adjacent vegetation and in-channel large woody debris was used to assess this foraging habitat.

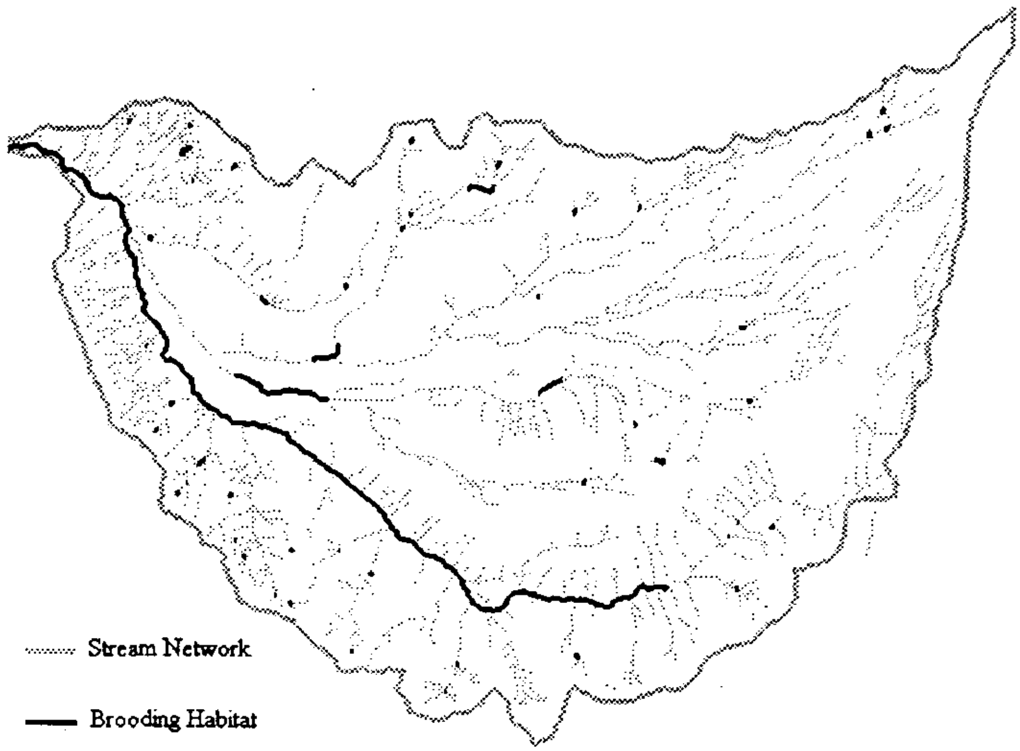
Figure 6-7 -- Potential Harlequin Duck Habitat



Due to fires between the turn of the century and 1952, ate seral stand structure within the Riparian Reserves is well outside the range of natural variation for the entire watershed.

Large woody debris levels across the watershed are below LMRP and PIG standards, and are outside or at the low end of the range of natural variation (with the exception of Henry and Still creeks). However, if large and small woody debris are combined, levels of woody debris within the watershed do approximate the range of natural variation. Even so, the Zigzag and Little Zigzag rivers are very low in combined levels of woody debris (1.5 and 4.8 pieces per mile). This condition is attributed to these streams being in the alpine area, and to stream cleanout in their lower reaches after the 1964 Flood.

Figure 6-8 – Potential Harlequin Duck Brooding Habitat



Isolated areas with dense shrubs, woody debris and meandering channels exist within the upper Devils Creek area. Still Creek and lower Camp Creek do not have the isolation characteristics necessary to meet the requirements for brooding habitat. Because levels of woody debris within the low gradient reaches of Devils Creek are very low, this area does not provide optimal brooding habitat.

Harlequin duck habitat is outside the range of natural conditions for general habitat due to limited late seral stand structure across the watershed, and to low levels of in-channel woody debris in the Zigzag and Little Zigzag rivers. Brooding habitat within the watershed is limited due to the requirement for isolation. The existing brooding habitat is in a degraded condition due to low levels of in-channel woody debris. As the ACS objectives are implemented and Riparian Reserves are established, stands should move toward late seral conditions -- thereby, improving habitat for harlequin ducks.

Fir Clubmoss

The Still Creek riparian corridor has 4 sites for fir clubmoss (*Huperzia occidentale)* within close proximity to the creek. The habitat varies from mature forest to forested wetland thickets. Decomposing mossy logs and stumps serve as the common substrate. All sites are shaded, damp, and cool. The riparian corridor generally provides good habitat conditions for fir clubmoss. In addition, a high potential for more sites exists along Still Creek and its tributaries. The amount of quality habitat in the watershed is predicted to improve over time as riparian forests mature and more down wood is recruited. Large populations exist in other westside watersheds, and the species on Mt. Hood NF appears stable. Tree removal locations in Riparian Reserves should be far enough away from fir clubmoss sites to avoid impacting the shade, moisture, and temperature elements of its microclimate.

Terrestrial Habitats

Table 6-2 -- Terrestrial Species of Concern within the Zigzag Watershed

Species	Concern
Bryoria subcana (oceanic influenced lichen)	Documented survey and manage species, rare
Loxospora sp. nova (oceanic influenced lichen)	Documented survey and manage species
Octavianina macrospora (false truffle)	Documented survey and manage species, rare
Alpova alexsmithi (false truffle)	Documented survey and manage species, rare
Rhizopogon brunneiniger, (false truffle)	Documented survey and manage species
Rhizopogon evadens var. subalpinus (false truffle)	Documented survey and manage species, rare
Pholiota albivelata (gilled mushroom)	Documented survey and manage species
Sugar stick, *Allotropa virgata*	Survey and manage species
Ground cedar, *Diaphasiastrum complanatum*	Regional Forester's sensitive species list
Red tree vole	Survey and manage species
Northern spotted owl, *Strix occidentalis caurina*	USFWS threatened species
Black backed woodpecker	Protection buffer species
Silver haired bat	Protection buffer species
Long eared myotis	Protection buffer species
Long legged myotis	Protection buffer species
Wolverine, *Gulo gulo luteus*	Regional Forester's sensitive species list

Lichens

Forest stands in the Zigzag Watershed support a diverse lichen and bryophyte flora. A broad diversity and amount of age classes, species, and patch sizes maintained on the landscape should help assure the presence of survey and manage lichens. Many lichens are sensitive, in varying degrees, to air pollution. Lichen air-quality plots have been established on the Forest which should provide information on trends.

Two survey and manage Strategy 1,3 lichens are documented in the watershed on conifers near the southeast Still Creek Recreational Residence tracts area. Both *Bryoria subcana* and *Loxospora sp. nova* are usually found in foggy coastal forests. These sites are inland extensions of their distribution. The high rainfall and clouds created by the proximity to Mt. Hood can create a climate similar to coastal forests. Preserving the stand microclimate where these two lichens are found is necessary to protect these range extension sites. No information is available on trends for these species or for local populations.

Other factors which may influence these lichen populations are possible impacts to habitat from Recreational Residence users, or loss of habitat from laminated root disease.

False Truffles and Gilled Mushroom

The four rare false truffles and one gilled mushroom documented in the watershed all grow in older mid to upper elevation forest with a well-developed humus layer or decaying wood. Fires and logging have reduced historical quality and quantity of this habitat. Currently, a low amount of late seral habitat is available for these species.

With the implementation of the Northwest Forest Plan, the following important habitat features should improve over time: undisturbed ground, large patches of mature trees for false truffles, and coarse woody debris for the gilled mushroom. Impacts from recreational use at the campgrounds may have potential effects if any ground disturbing activities or tree removal occur where these truffles are located. Protection of habitat at known sites should secure local population viability.

Sugarstick

Sugarstick, a survey and manage species, has been observed but not documented in the Still Creek Recreational Residence tracts area. This nonphotosynthetic plant may get its energy via a fungal connection. Important habitat features include an undisturbed forest floor with lots of humus and coarse woody debris, important features for many other fungi.

Currently, there is a high percentage of potential habitat for sugarstick -- 85% mid-seral and 7% late-seral in the watershed. However, the percentage of high quality habitat with undisturbed forest floor requirements is not known. Appendix J2 of the Northwest Forest Plan indicates that sugarstick may occur in areas with a fire history. Appendix J2 also suggests that the species as a whole may be declining due to fire suppression and logging. Local distribution and trends are not clear.

Habitat conditions should improve over time as more coarse woody debris is recruited, and large patches of forest are left undisturbed. However, continued fire suppression may have a negative effect.

Ground Cedar

Ground cedar is a sensitive species located on Tom, Dick and Harry Mountain within the Ski Bowl permit boundary. Sites are located both in ski runs and undisturbed areas. At Veda Lake, a very small patch occurs above the campground near the lake. Habitat elements that are common to all sites include light shade provided by a shrub or small tree overstory, northern aspect, and perhaps some moisture requirement.

Ski runs appear to provide good habitat for ground cedar; plants appear vigorous and healthy. Repeated brushing of the runs may actually enhance habitat for this clubmoss by reducing competition from surrounding vegetation. Monitoring plots were established this summer to investigate this further. In contrast, the population at Veda Lake may be decreasing due to increased canopy closure and competition from larger vegetation. This suggests the species may be an early successional colonizer.

A literature review suggests hot fires may create a favorable situation for spore settlement and germination. All locations of ground cedar within the Zigzag District are in severely burned areas. However, due to lack of surveys, the extent of ground cedar is not known in the Zigzag Watershed. Historically, many sites may have existed in burned areas. Without future large hot fires to create early seral habitat, the Mt. Hood populations may decline. The importance of a local decline with respect to the species as a whole needs further investigation.

Overall, early seral forest in the future is projected to be below the range of natural conditions. Yet, ridge top openings and open stands within the huckleberry landscape analysis design cells may contribute to potential habitat. Early seral habitats are also ideal for invasive non-native plants, especially around managed areas and roadsides. This could also have an impact on ground cedar.

Red Tree Vole

The red tree vole is a survey and manage species. There are no documented sightings within the watershed and surveys have been limited. There is a lack of information on local distribution of the species.

The red tree vole appears to be closely associated with older forests and spends most of its life in the canopy of coniferous trees, feeding on their needles. Because they are small and live almost exclusively in the canopy of conifers, they probably have limited dispersal capabilities.

Currently, habitat is low in abundance. Only 7% of the watershed provides potential habitat for the species. The late seral habitat that does occur is fragmented and scattered across the watershed. Some of this habitat may also be lost due to laminated root disease. Therefore, it is critical to this species that existing late seral habitat is maintained.

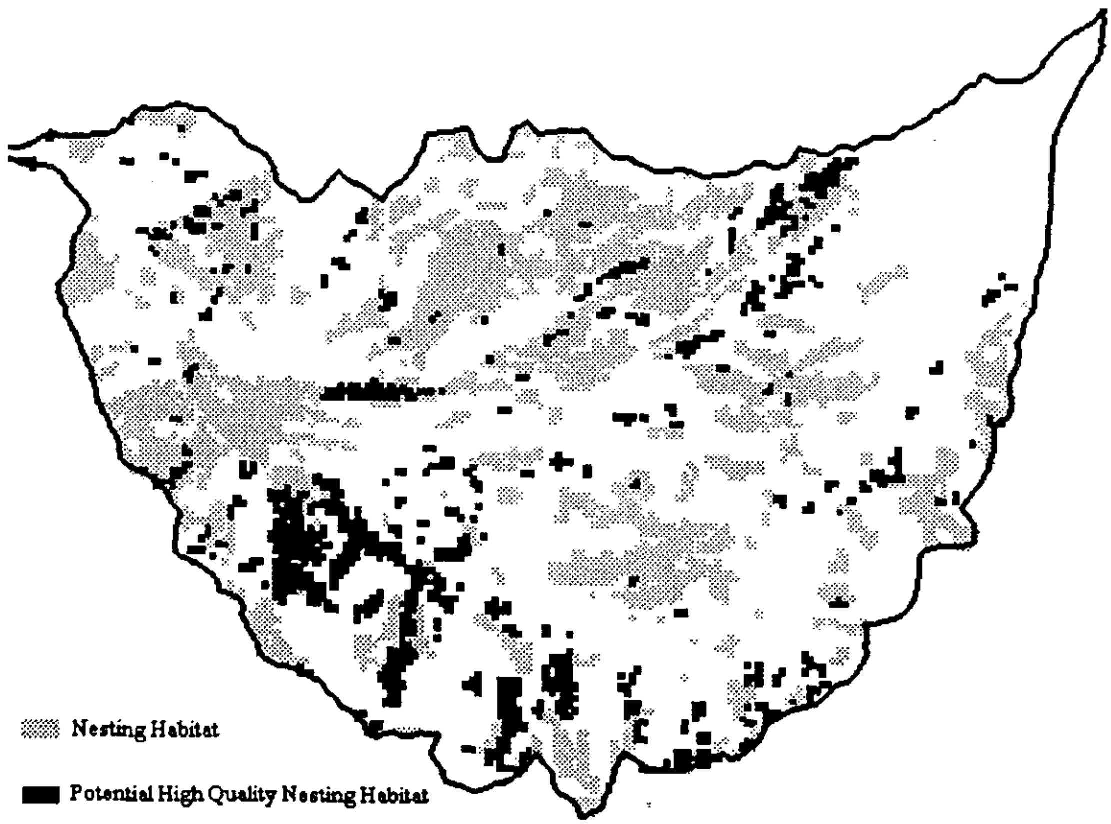
Future conditions of the watershed will allow development of late-seral habitat and may potentially allow for red tree vole population increases.

Northern Spotted Owl

Northern spotted owls are listed as a threatened species by the U.S. Fish and Wildlife Service and protected under the Endangered Species Act of 1973. No Critical Habitat Units are located within the Zigzag Watershed. There are two documented spotted owl pairs within the watershed, both within reserved areas. One pair is in the LSR and the other is in the Mt. Hood Wilderness. There are no owl centers within the Matrix, and therefore no 100-acre LSRs.

The Zigzag Watershed is currently low (7%) in late seral habitat. These 2,639 acres of late seral habitat could provide high quality nesting habitat, although this has not been field verified. Another 8,182 of mid seral or closed small conifer stands with remnant older trees could also provide potential nesting habitat. Dispersal habitat is adequate. Approximately 18,980 acres meets the stand requirements for dispersal.

Figure 6-9 Spotted Owl Nesting Habitat



Late seral forest in the future is projected to increase, potentially at a higher amount than the range of natural conditions. Therefore, owl pairs and other late seral associated species will potentially increase. Until additional late seral habitat develops, the LSR most likely does not have the capacity to support any additional pairs of owls.

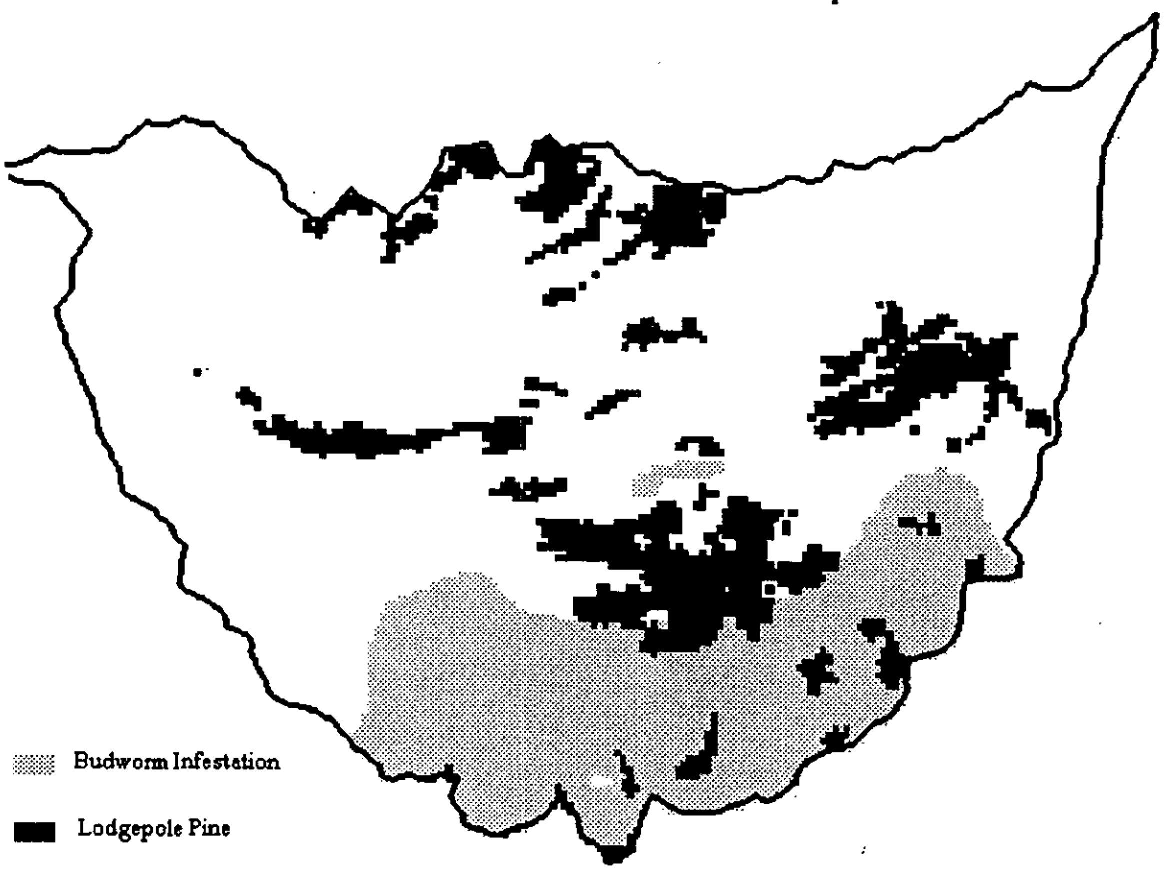
Besides habitat requirements, spotted owls can also be impacted by loud, disturbing noises. This should be a consideration as recreational and other developments increase.

Black-backed Woodpecker

The black-backed woodpecker is a protection buffer species. Although it is not documented within the watershed, it is suspected. No surveys have been conducted.

While the black-backed woodpecker is closely associated with pine forests, it is also known to follow insect infestations. Dominant and co-dominant lodgepole pine stands were mapped, along with the area of spruce budworm infestation in the Still Creek drainage. These areas may provide potential habitat. Surveys could be prioritized according to this mapping. There is currently 9% of habitat available for black-backed woodpeckers.

Figure 6-10 Potential Black-Backed Woodpecker Habitat



Woodpeckers sometimes cycle with insect infestations, and increase or decrease with insect populations. The western spruce budworm is near the end of its infestation, and bark beetles are anticipated to be short term. Therefore, the prey base for woodpeckers is also likely declining.

Pine habitat is anticipated to be similar in the future. Lodgepole pine commonly grows in cold environments and frost-prone areas. After fire, lodgepole pine is a common pioneer due to its tolerance of growing-season frost. Therefore, with succession and microclimate changes, the acres of lodgepole stands may change but only to a small degree.

Snag habitat is probably the most critical component. Current snag levels are depauperate. Snag habitat should increase in the future, however, the amount of snags in pine habitat is unknown.

Silver Haired Bat

Silver haired bats are a protection buffer species. Presently there are no documented sightings of this species within the watershed. These bats are a contrast species with a medium home range. Even so, for breeding and nesting they require snags within late seral habitat or large-diameter live trees with deep fissures or cavities. Caves are sometimes used as secondary nesting. Only 2% of the watershed is available in contrast guild habitat.

Currently, the watershed is low in snags and late seral habitat. Trees with laminated root disease may provide some short-term snag habitat, but are inevitably windthrown. Trees that have died from the budworm and bark beetle infestation in the Still Creek subwatershed could provide snag habitat, but most of these are too small in diameter.

Abundance and quality of habitat may improve slightly in the future with an increase in large-tree and snag components. However, these bats are a contrast species and also require early seral habitat adjacent to older stands. Little contrast habitat is projected for the future.

Long-Eared Myotis and Long-Legged Myotis

Both the long-eared and long-legged myotis are protection buffer species with no documented presence in the Zigzag Watershed. Even so, they could potentially occur here.

These are medium home range, generalist species that use a variety of habitats. They are associated with coniferous forests, often feeding over water, and are known to use mines, bridges, and abandoned buildings. The long-legged myotis are also known to use shrub wetlands and wet meadows.

Since these are generalist species, habitat is abundant. Future habitat should be similarly abundant. Changes in bridge structures and abandoned buildings could create potential effects.

Wolverine

The wolverine is a sensitive species on the Regional Forester's list and a candidate for listing with the U.S. Fish and Wildlife Service. There are no documented sightings within the Zigzag

Watershed yet tracks were confirmed in 1990 just east of the watershed in the West Fork of the Salmon River. These are snow-evolved animals with a large home range who could easily cross watershed boundaries.

While the wolverine occupies a variety of habitats, a general trait of areas' occupied by wolverines is their remoteness from humans and human developments. Higher quality habitat within the Zigzag Watershed would likely be areas within the Mt. Hood Wilderness or areas that have low human presence during the winter. Wolverines also avoid large clearcuts and overstocked stands, although this data is from Canada, Montana and Idaho. It is unclear whether the same holds true for the western Cascades.

The prey base for wolverines, deer and elk, is somewhat limited. Although 93% of the watershed is available habitat for deer, less than 1% is available habitat for elk. The steepness of slopes is the main limiting factor for elk. Wolverine also prey on snowshoe hare and carrion.

Future habitat for the wolverine is likely to decline due to the future condition of the watershed approaching 80-90% late seral habitat. This would reduce the potential habitat for prey species (early seral and contrast habitat for deer and elk) and could potentially affect wolverine abundance. In addition to vegetation structure, the future increase of recreation use could also increase the amount of human disturbance -- consequently reducing the amount or quality of habitat available for wolverines.

To manage for wolverines properly, local presence data and determination on whether or not a self-sustaining population exists within the Cascades is needed. Ensuring large refugia areas for the wolverine may be the best way to ensure persistence of wolverine populations. A wolverine management strategy is being drafted for the Mt. Hood NF, as well as a survey strategy to determine wolverine presence on the forest.

Special Habitats

Species	Concern	Special Habitat
Peregrine falcon, *Falco peregrinus anatum*	USFWS endangered species	cliff
Bald eagle, *Halieatus luecocephalus*	USFWS threatened species	lg. bodies of water & lg. trees with broken tops
Townsend's big-eared bat, *Plecotus townsendii*	Regional Forester's sensitive species	caves
Larch Mt. salamander	Survey and manage species	moss covered talus
Black crowned rosy finch	Regional Forester's sensitive species	alpine
Lesser bladderwort, *Utricularia minor*	Regional Forester's sensitive species	wetland with open water
Fir clubmoss, *Huperzia occidentale*	Regional Forester's sensitive species	moist talus
Bog clubmoss, *Lycopodiella inundata*	Regional Forester's sensitive species	wetland
Stiff clubmoss, *Lycopodium annotinum*	Mt. Hood NF inventory species	wetland

The following figure displays some of the special habitats referenced in the individual discussions of species that follows. (This map is available at larger scale within the Zigzag District map files.)

Figure 6-11 -- Special Habitats

Peregrine Falcon

Peregrine falcons have not been documented within the Zigzag Watershed, however the watershed has been used as a hacking site to reintroduce the falcons. Their potential cliff habitat occurs in the watershed and four cliff sites were identified as moderate to high, or high potential habitat Three of these sites were field surveyed in 1995, yet no aeries or peregrines were found.

Tom, Dick, and Harry Mountain is one of the sites identified as high potential habitat. This area was used as a hacking site from 1990-94. More than 25 birds were released during this time, yet, to date, no falcons have become established within the watershed. While Zigzag Mountain has been identified as a potential reintroduction site, no future plans to release birds has been developed.

The quality of cliff habitat was used to analyze how the watershed contributes to peregrine habitat needs and this cliff habitat is not likely to change in the future. However, peregrines are susceptible to human disturbance, which may increase in the future. This could become a concern around nest sites if the falcons became established within the watershed. Furthermore, peregrines need open areas for forage, such as the Mirror Lake area (adjacent to Tom, Dick and Harry Mountain). The habitat around lakes will move towards late seral conditions, which could decrease forage opportunities and the actual prey base. The decline of neotropical migratory birds also presents a threat to the falcon's prey base.

Bald Eagle

During both the wintering and nesting seasons, bald eagles inhabit the forests of Oregon. Bald eagles exhibit a strong preference for large, dominant or co-dominant trees in a heterogeneous stand of mature or old-growth conifers near large bodies of water. This habitat allows easy access to their preferred diet of fish.

The Zigzag Watershed does not provide a large body of water sufficient to provide suitable nesting, perching or foraging habitat for bald eagles. Even so, they may be seen migrating through the area. Since large bodies of water are the limiting component of their habitat, the watershed is unlikely to change much in terms of future habitat suitable for this species.

Townsend's Big-eared Bat

There are no documented Townsend's big-eared bats or known caves or mines occurring in the Zigzag Watershed. There are potential caves on West Zigzag Mountain, but the locations are not identified nor easily accessible. There are several bridge sites, especially along Still Creek, which may be potential habitat.

Disturbance at hibernaculum and nursery sites appears to be a main reason for this species' decline. Therefore, increasing recreational use within the Zigzag Watershed could have potential effects. Because potential cave sites are not easily accessible, this disturbance would be more likely to occur at bridge sites. Other potential effects to the bat's habitat include a possible decline in its prey base as spruce budworm populations decrease. Although not currently proposed, spray projects to treat insect infestations could also potentially affect the Townsend's big-eared bat, who uses moths as a large part of its prey-base.

Larch Mountain Salamander

While no documented presence of these salamanders has been reported within the watershed, their potential habitat does exist here. Potential habitat exists within the watershed due to the presence of andesite and basalt rock outcrops, producing moist talus and felsenmeer slopes in angular blocky gravels. Approximately 2,200 acres of talus has been mapped within the watershed, although the Larch Mountain salamander occupies only the perimeters of talus with vegetation, not open sites.

No surveys have been conducted for this salamander within the Zigzag Watershed. If found, protection buffers would protect the habitat. Potential habitat should also be field verified.

Harvest or other practices adjacent to talus could affect the microhabitat by drying the talus out, and therefore contributing to habitat decline. Some habitat could also be lost due to any road building or trail construction across suitable talus slopes.

Black Crowned Rosy Finch

Forty acres of alpine habitats occur in the Zigzag Watershed. Activities that would further impact or limit that habitat could potentially impact species' distribution and population levels. Developments within ski areas at these high elevation sites could also degrade potential habitats. Field surveys to determine distribution and to verify species are scheduled for 1996.

Lesser Bladderwort

Lesser bladderwort grows along the margins of Enid Lake. General habitat requirements include quiet, shallow waters that are often acidic and draw down in the summer. Potential habitat for lesser bladderwort exists in other shallow lakes, ponds and wetlands within the watershed, including Wind Lake Basin, Devils Lake and a number of acidic wetlands in the Camp Creek drainage such as Multorpor Fen.

Users of the Camptown/Crosstown Trail often walk to the water's edge at the west end of Enid lake, trampling the shoreline where lesser bladderwort is found. No formal assessment has been made of impacts to the population. Because the area of potential impact is small, and the plants can move around, there is low concern about impacts to the population at Enid Lake.

Trends for the whole species and Mt. Hood populations are not known. Increase in recreational use has potential for increasing impacts to this plant, even though Riparian Reserves should adequately protect this special habitat type.

Fir Clubmoss

Fir clubmoss usually favors mature old-growth riparian forest, preferring an undisturbed forest floor/streamside with well-developed humus layer and woody debris. However, it is also located on two wet talus slopes on the north side of Hunchback Mountain. These two wet talus slopes contain the important microsite features of moisture, shade and mossy organic substrate. Other similar talus areas may also provide habitat. This landscape feature should be stable in the watershed. The wet vegetated talus areas on Hunchback are headwaters for tributaries to Still Creek, and would receive protection by Riparian Reserves.

Bog Clubmoss, Stiff Clubmoss, and other Wetland Species

Two uncommon clubmosses and wild cranberry have been recorded in Multorpor Fen, a 50 acre subalpine mire currently owned by The Nature Conservancy. Bog clubmoss lives in muddy depressions that are determined by the hydrology of the fen. Stiff clubmoss inhabits the margins or hummocks. Wild cranberry grows on the sphagnum moss hummocks.

Both clubmosses and wild cranberry are probably stable on the Mt. Hood NF. Riparian Reserves should protect their habitat. However, there is a water quality concern over the effects of runoff from Hwy 26, especially after the first fall rain. There is also concern for any potential effects on water quantity in the fen, since the hydrology in this area has already been altered. Future reconstruction of Hwy 26 could also have impacts on water quality and quantity in the fen. Trends are not known for the species.

Wetlands near Devils Lake, in Wind Lake Basin, and below Devils Peak, may provide good potential habitat for these plants as well as other species of concern, such as three-leaf goldthread and scheuchzeria. Future surveys are needed to document communities in these areas.

Key Question #2: How do conditions of the watershed affect the ability to meet the Aquatic Conservation Strategy (ACS) objectives?

ACS Objective #1: Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.

The primary watershed and landscape-scale feature used to assess this objective was vegetative structure and composition. This feature was felt to best reflect watershed and landscape-scale conditions under which aquatic species, populations, and communities are uniquely adapted.

The current stand structure and composition is altered from the conditions under which species, populations and communities are adapted. Stand structure is well outside the range of natural conditions for the watershed. Late seral stand structure is well outside and below the range of natural variation, mid seral stand structure is well outside and above the range of natural variation, and early seral stand structure is just outside and below the range of natural variation.

Vegetative composition within the watershed has also been altered by the introduction of 1,952 acres of offsite stands. These stands were established after major fires in the Still Creek and Camp Creek subwatersheds. Offsite seed sources included: sites from the Gifford-Pinchot, Olympic, and Mt. Baker-Snoqualmie national forests.

Current landscape patterns are similar to patterns under natural conditions, with large patches dominating.

The altered stand structure has resulted in an altered peak flow regime outside the range in which the watershed's stream channels developed. The greatest likelihood for causing significant, long-term cumulative effects on forest hydrologic processes is through the influence of openings on snow accumulation and melt.

Early seral habitat (openings) are outside the range of natural variation, resulting in lower magnitude peak flows, including bankfull events (the high flow during two out of three years). The shape of a channel more closely reflects the bankfull width and height than it does the less frequent floods. If the bankfull flows are lower than the range of natural conditions, the stream may not have the power to move its natural sediment load, causing sediment deposition within the watershed.

Existing stand structure has affected the severity of spruce budworm outbreaks. Spruce budworm is endemic to the area. The size of this most recent outbreak was likely within the range of historic conditions. However, the effects of the spruce budworm population were probably more severe due to offsite plantings, poor stand conditions, and dense stand structure in the Still Creek area. These factors cause stressed and less resilient stands, therefore increasing defoliation effects. Offsite stands were heavily impacted, whereas nearby native stands were lightly impacted (Dick Scott, past Zigzag District silviculturist, pers comm.).

The even-aged closely spaced stands, resulting from fires between the turn of the century and 1952, have created conditions favorable to the spread of laminated root disease. The trend for the spread of laminated root disease is an exponential increase within the watershed. This is due to the level of known infections, and large contiguous acres of highly susceptible host types in even-aged, closed-canopy stands with high root-to-root contact. The rate of spread is at least one foot per year and infections usually radiate 30 feet from visible symptoms. There will be a quantifiable impact on Douglas-fir growth loss, windthrow, and mortality. Because new host seedlings will be infected, these areas will also remain "out of production" for conifers. However, areas may be restocked, naturally or artificially, with resistant conifers or hardwoods.

The Mt. Hood NF Landscape Analysis and Design (LAD) process was used to depict what the watershed's stand structure would be like in 50-200+ years in the future, based on current management direction.

Implementation of the Northwest Forest Plan results in stand structure that is different from the range of natural conditions. Late seral acreage is outside and well above the range of natural conditions in both the Western Hemlock Zone and the Pacific Silver Fir Zone. Mid seral stand acreage is just below the range of natural conditions in both the Western Hemlock Zone and the Pacific Silver Fir Zone. Early seral stand acres will be slightly below the range of natural conditions in both the Western Hemlock Zone and Pacific Silver Fir Zone.

This condition will favor late successional species and provide very limited habitat for species dependent on early seral or contrast habitat.

Because a large portion of the watershed occupies one seral stage that is outside the range of natural variation, the potential exists to exacerbate effects of natural disturbances including floods (peakflows), insects, and disease.

Landscape patterns generated under the LAD process generate similar patterns to those under natural conditions, with large patches dominating.

ACS Objective #2: Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling the life history requirements of aquatic and riparian-dependent species.

ACS Objective #7: Maintain and restore the timing, variability and duration of floodplain inundation and water table elevation in meadows and wetlands.

(Because many of the factors that influence connectivity throughout the watershed also affect the water table elevation in floodplains and wetlands, these two objectives [#2 and #7] were assessed together in this analysis.)

Habitat connectivity for aquatic and riparian-dependent species between the channel and floodplain have been eliminated through channel straightening and cleanout in the Zigzag River, Still Creek, and Camp Creek. A number of riverine wetlands associated with shrub/shrub wetlands along the lower Zigzag River were affected by channel straightening activities after the 1964 Flood. This has also had an affect on the timing, variability, and duration of floodplain and wetland inundation in this area.

Multorpor Fen and Summit Meadows have been dissected by roads (Figure 6-12 and Figure 6-13) resulting in impaired vegetative and hydrologic connectivity, and an altered pattern of wetland inundation.

Figure 6-12 -- Multorpor Fen

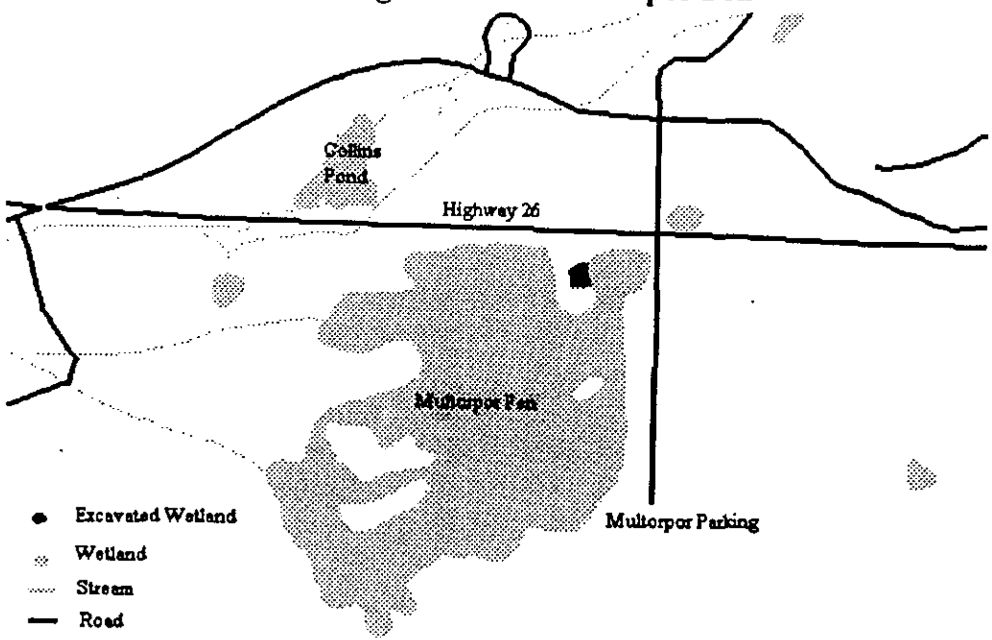
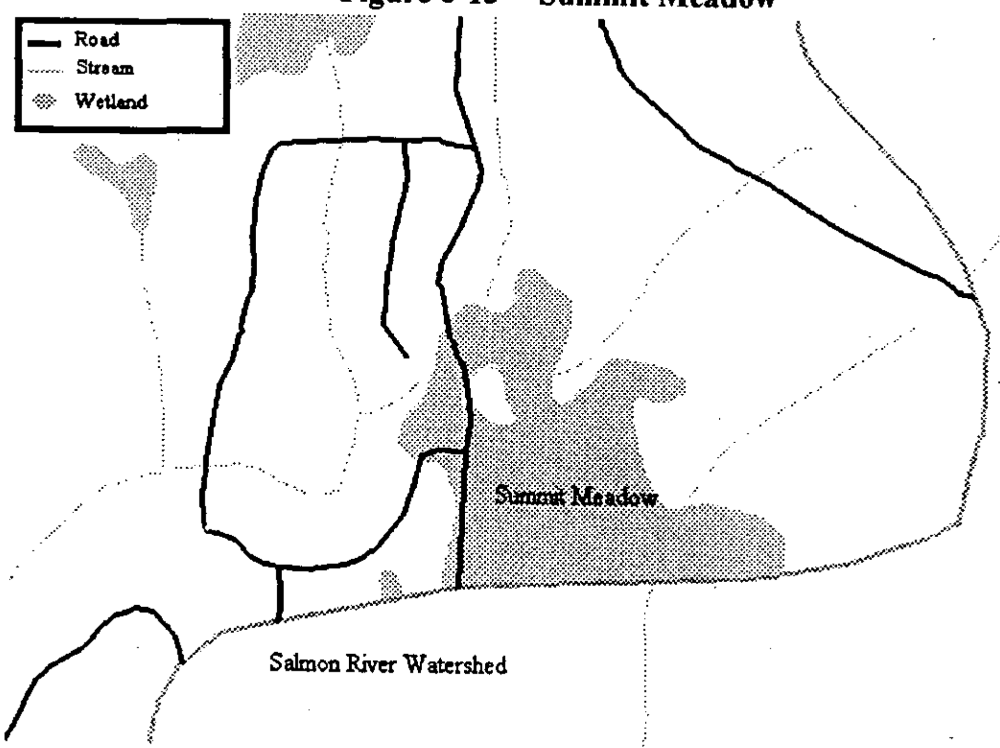


Figure 6-13 -- Summit Meadow



Historically, beaver dams were probably important components of low-gradient reaches in the watershed. Beaver dams increase habitat complexity and moderate baseflow and peakflow changes. Beaver were present historically in Camp Creek, Lady Creek, lower Still Creek and lower Zigzag River. Eradication of beaver from the lower watershed resulted in less vegetative and hydrologic connectivity of wetlands due to channel incision and a lower water table.

Baseflows are of concern in the Camp Creek subwatershed, in which approximately 10-20% of the baseflows are allocated (based on the recurrence interval of the baseflow). This potential reduction of baseflows associated with allocated uses, may reduce hydrologic and vegetative connectivity, and may result in altered patterns of floodplain and wetland inundation.

Current research indicates roads function hydrologically to modify streamflow generation in forested watersheds by altering the spatial distribution of surface and subsurface flowpaths. Observations suggest that roadside ditches and gullies function as effective surface flowpaths which substantially increase drainage density during storm events (B. Wemple, 1994). This function has the potential to quickly route stormflows off site, preventing the storage and slow release that maintains hydrologic connectivity and water table elevation in wetlands. This process is of concern in the Still Creek and Henry/Zigzag subwatersheds.

At least 3.5 miles of fish habitat within the watershed is partially to fully blocked by migration barriers for resident and anadromous fish. Culvert barriers exist on Little Zigzag (one mile), Still Creek tributaries (one mile), and Henry Creek (approximately one-half mile). Lady Creek is partially blocked by old dams and fill material at the mouth of the stream (one mile), although passage has been improved in the area by adding step pools.

Drainage network simplification, the draining of wetlands and the movement of subsurface water in pipes, has occurred in the Ski Bowl ski permit area. This has resulted in reduced hydrologic and vegetative connectivity, and has altered water table elevation in wetlands.

Highway 26 and West Leg roads are also an area of concern due to the interception of subsurface water by cutbanks in the Still Creek subwatershed. Subsurface water intercepted on the cutbanks of these roads is routed through ditchlines, resulting in altered hydrologic connectivity.

ACS Objective # 3: Maintain and restore the physical integrity of the aquatic system, including shorelines, banks and bottom configurations.

This objective was assessed by examining aquatic habitat types, levels of pools and large woody debris, and channel morphology.

Large woody debris levels across the watershed are below the Mt. Hood National Forest Land and Resource Management Plan (LRMP) and Columbia River Policy Implementation Guide/Salmon Summit (PIG) standards. In addition, these large woody debris levels are also outside, or at the low end, of the range of natural variation. (With the exception of Henry and Still creeks). However, if large and small woody debris are combined, levels of woody debris within most of the watershed approximate those of Fir Creek in the Bull Run Watershed. This indicates that these areas are within the range of natural variation.

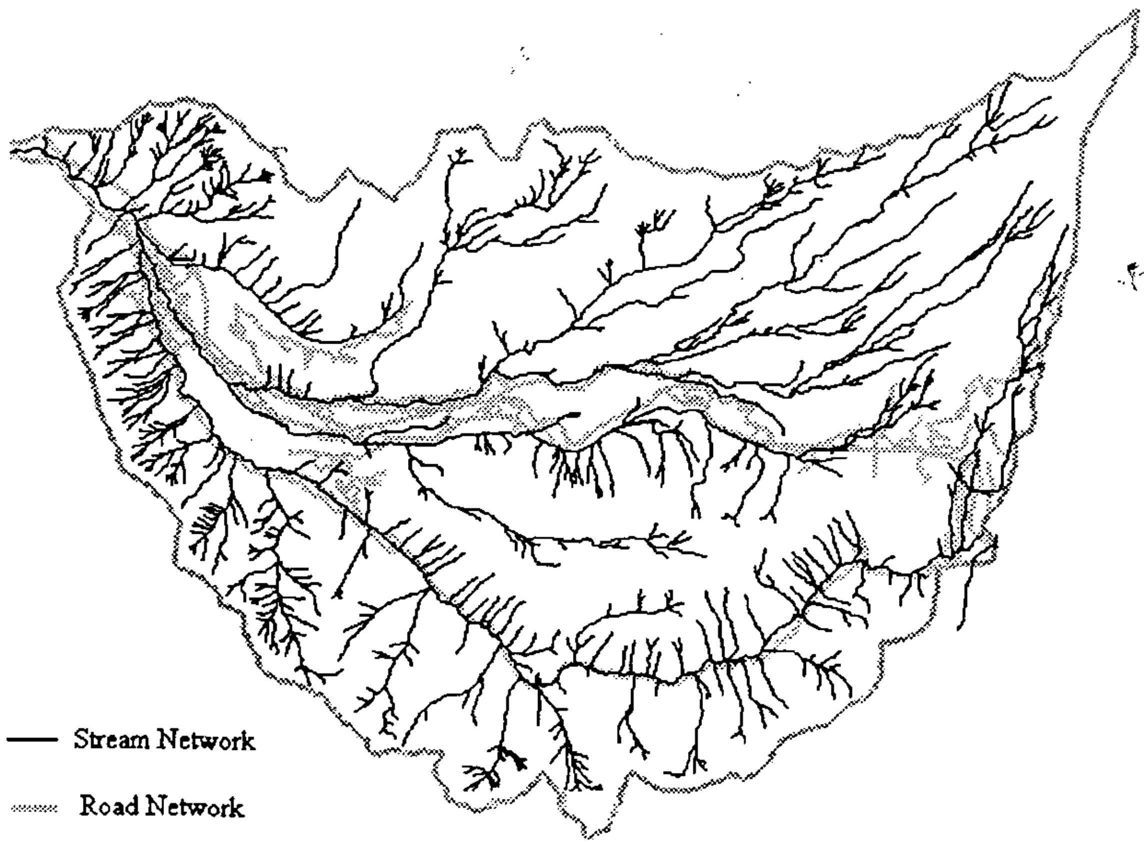
Zigzag and Little Zigzag rivers are very low in combined levels of woody debris (1.5 and 4.8 pieces per mile). This condition is attributed to these streams being in the alpine area, as well as stream cleanout in these stream's lower reaches after the 1964 Flood.

With the exception of Wind Creek, pool levels across the entire watershed are below LRMP and PIG standards, and are at the low end, or outside, the range of natural variation. Pool volumes across the watershed (with the exception of the anadromous portions of Still and Camp creeks) are well below those within the Bull Run Watershed.

Pool habitat appears to be lower than the undisturbed condition, with the exception of Camp Creek. Side channel habitat within the watershed is at or above levels within the Bull Run Watershed, and is well above levels for the lower Salmon River.

Sensitive stream reaches with respect to sensitivity to disturbance, sediment supply and/or streambank erosion potential, have been identified in the Little Zigzag River, Camp Creek, Wind Creek, Still Creek and the Zigzag River. Many of the sensitive stream reaches in the Zigzag River and Camp Creek are associated with mudflow deposits, which consist of poorly-sorted pebbles, cobbles, and boulders in a gray sandy matrix.

Figure 6-14 -- Roads and Streams



Across the watershed, many steams have been channelized to protect roads and developments. The most graphic example is Camp Creek from the Ski Bowl Parking Lot to the Mirror Lake Trailhead. In this area, Camp Creek is essentially the ditchline for Highway 26. Channel straightening has also occurred in the Zigzag River and Still Creek. This channel straightening has affected physical integrity of the aquatic system by removing large woody debris and disconnecting the channel from it's floodplain. Areas of unstable channels within volcanic mudflow deposits that have been straightened have the potential to be very unstable. This is due to the compounding effects of the unstable landform on the unstable channel type.

The bottom configuration of channels within the watershed have been altered due to deposition of sand associated with Highway 26 sanding activities. Camp Creek, Still Creek, Zigzag River and Little Zigzag River all receive a high volume of sand through direct application, ditch runoff and culvert transport.

ACS Objective #4: Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical and chemical integrity of the system and benefits survival, growth, reproduction and migration of individuals composing aquatic and riparian communities.

Suspended Sediment

The 1988 Oregon Department of Environmental Quality (DEQ) assessment of nonpoint pollution indicates moderate problems with sediment and erosion for Camp Creek, Still Creek and Zigzag River. These problems are attributed to glacial runoff, unstable channels, loss of woody structure, road cuts, and highway sanding.

Highway sanding has direct affects to streams within the watershed. Camp Creek, Still Creek and Zigzag/Little Zigzag rivers receive a high volume of sand through direct application, ditch runoff, and culvert transport. Road cuts, fills and ditchlines along Highway 26 and the Still Creek Road (#2612) also have the potential to deliver sediment to the stream system through surface erosion.

The altered sediment regime degrades habitat conditions for many aquatic species, including: coho salmon, spring chinook salmon, steelhead trout, cutthroat trout, Pacific lamprey, *Eobrachycentrus gelidae, Farula jewetti,* red-legged frog, Copes giant salamander, and tailed frog.

Fecal Coliform

Levels of fecal coliform in the sewage treatment effluent from the Government Camp Sewage Treatment Plant were assessed to determine impacts to water quality in Camp Creek. Levels of fecal coliform in the plant outfall from July, 1994 - June, 1995 are above that of background levels (Fir Creek) in early July and November.

It appears that, most of the time, fecal coliform levels in water from the sewage treatment outfall meets applicable water quality standards. However, a number of incidents of high fecal coliform discharges of short duration have occurred (six in 1993; two in 1994). Furthermore, these occurrences may exceed the National Pollutant Discharge Elimination System (NPDES) permit, as well Oregon water quality standards for the Sandy Basin and have the potential to bring water quality outside the range that maintains the biological, physical and chemical integrity of the system..

Chlorine toxicity is another concern with the effluent. Because of the low flow rates in the tributary of Camp Creek that receives the sewage treatment plant's discharge, the potential for chlorine toxicity is an appropriate concern. Although chlorine is an effective disinfecting agent, it is often difficult to achieve the correct balance of adding enough chlorine to kill harmful organisms -- without harming the beneficial ones. The dilemma is compounded when disinfected effluent is discharged into a small receiving stream, such as the tributary to Camp Creek (Curran-McLeod 1995).

The watershed's Recreational Residence tracts are another target for concerns regarding degraded water quality associated with fecal contamination. Based on macroinvertebrate monitoring in Still Creek, however, there does not appear to be a problem with water quality degradation associated with septic systems from these Recreational Residences.

Chloride Concentrations

Based on conductivity and chloride data from 1988-1992, the salting of the Palmer Snowfield with sodium chloride -- in conjunction with Timberline Ski Area's ski operations -- is having an effect on water quality in Still Creek.

Measured conductivity and chloride levels within Still Creek are below any documented threshold of concern. The EPA National Water Quality Criteria for salt-sensitive biota state that a four-day average of not more than 230 mg/L Cl and a one-hour average of not more than 860 mg/L Cl, at an average frequency of once every 3 years, will not "unacceptably affect" aquatic biota.

The maximum level recorded below the Palmer Snowfield was 44 mg/L Cl. However, conductivity levels and chloride concentrations are well above those for adjacent streams (Camp Creek and Little Zigzag River) and the Bull Run Watershed. These levels appear to be above base or background levels. In addition, they have the potential to bring water quality outside the range that maintains the biological, physical, and chemical integrity of the system. Thus, these levels have the potential to bring water quality outside the range that benefits the survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.

Salmon Carcasses

Carcasses of coho salmon have been shown to be a critical source of nutrients for the stream ecosystem food web, and are directly associated to fingerling/smolt production (Bilby, et al., in press). Coho numbers appear to be 20% or less of populations documented in the 1890s, when populations were already significantly reduced by commercial fishing. Comparisons with fully seeded, unimpacted populations elsewhere in the Pacific Northwest indicate that existing populations may be less than 5% of pre-1850 populations.

ACS Objective #5: Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate and character of sediment input, storage and transport.

Aquatic ecosystems in this watershed evolved in a sediment regime derived from geologic rates of mass wasting and surface erosion processes. Less than 20% of the lands in the watershed have high landslide potential. Mass wasting processes dominate only on a small portion of the watershed. The steep lands adjacent to Zigzag and Hunchback mountains, Eureka Peak, Wolf Camp Butte, and the south side of Tom, Dick and Harry Mountain produce debris slides and debris flows during low frequency/high return interval winter precipitation events. Streambank failures and dry ravel within the unconsolidated materials along the Zigzag and Little Zigzag rivers contribute continual low levels of sediment to these streams. Natural rates of surface erosion are low within the watershed.

Sediment yield from human disturbances within the watershed is presented in Chapter 4, Water Quality. Both highways and roads have altered the sediment regime within the watershed. Highway sanding has direct effects to streams within the watershed. Camp Creek, Still Creek and the Zigzag and Little Zigzag Rivers receive a high volume of sand through direct application, ditch runoff and culvert transport. Forty-four percent of the roads within the watershed are within the delivery zone to streams, and have the potential to effectively deliver sediment from road surfaces, cut and fill slopes. Undersized culverts along these roads contribute additional pulses of sediment during average winter storms. Roads within the delivery zone of streams have the potential to greatly alter the timing, volume and rate of sediment supply to stream channels.

In the key depositional reaches of the watershed, the sediment regime has been altered from natural rates (see Chapter 4, sediment deposition). In the Still Creek and Camp Creek subwatersheds, natural rates of erosion are quite low, yet moderate amounts of sediment derived from human activities has been added to the system.

The timing of sediment delivery under undisturbed conditions would be limited to infrequent, intense winter storms. On site and instream recovery rates would be rapid. Sediment associated with roads is delivered during season flushing flows and peaks of winter stormflows (LaHusen, 1994). Sediment from roadside sanding is delivered primarily during snowmelt events, yet winter runoff has been observed as well.

ACS Objective #6: Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient and wood routing. The timing, magnitude, duration and spatial distribution of peak, high and low flows must be protected.

Peak Streamflows

Based on analysis using the Washington Department of Natural Resources *peakflow module*, peak streamflows in the Zigzag Watershed appear to be within the range of natural variation. This analysis assumes that the greatest likelihood for causing significant, long-term cumulative effects on forest hydrologic processes is through the influence of openings on snow accumulation and melt.

Peak streamflows at the USGS gauging station on the Zigzag River are on a decreasing trend (based on data from 1981-1993). This is attributed to the increased canopy closure and size of stands after fire events between the turn of the century and 1952 -- resulting in less created openings.

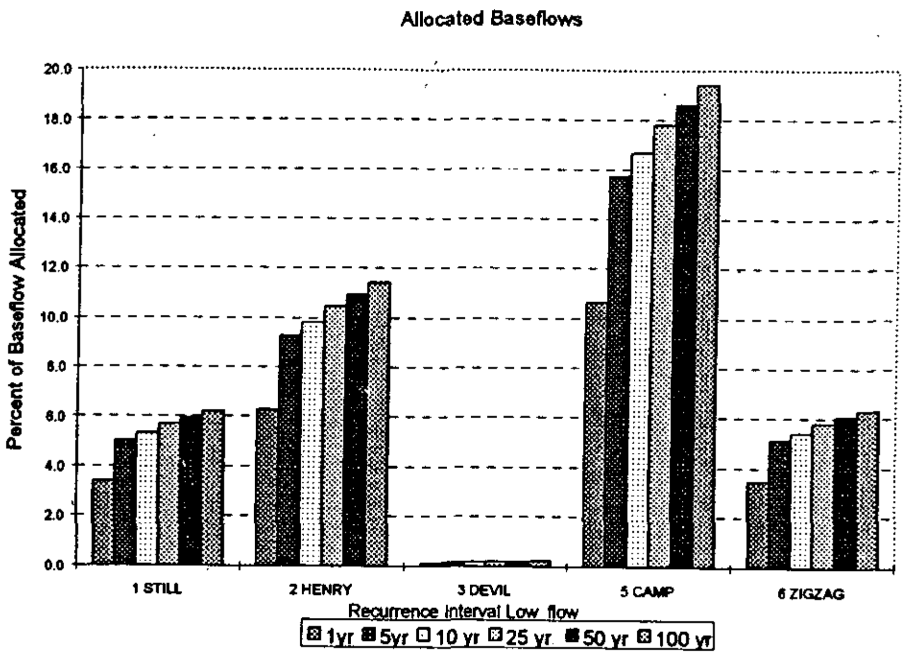
Increased peak streamflows due to stream drainage network expansion is of concern in the Still Creek area, where more than 50% of the roads are within 300 feet of streams. The stream network expansion in this area is approximately 10%. Current methodology does not predict percent increases in peak streamflows due to stream drainage network expansion. Therefore, the effect of this increase in not known.

Baseflows

While trends analysis indicates a decreasing trend in baseflows at the USGS gaging station on Zigzag River, this trend is not statistically significant at the 80% significance level. Based on the test results and limited data on baseflows (1981-1993), a conclusion about baseflow trends cannot be made.

There are a number of water rights on streams within the Zigzag Watershed for domestic water supply. These have the potential to alter the baseflow regime by removing water from streams during low flow periods.

Figure 6-15 – Percent of Baseflows Allocated



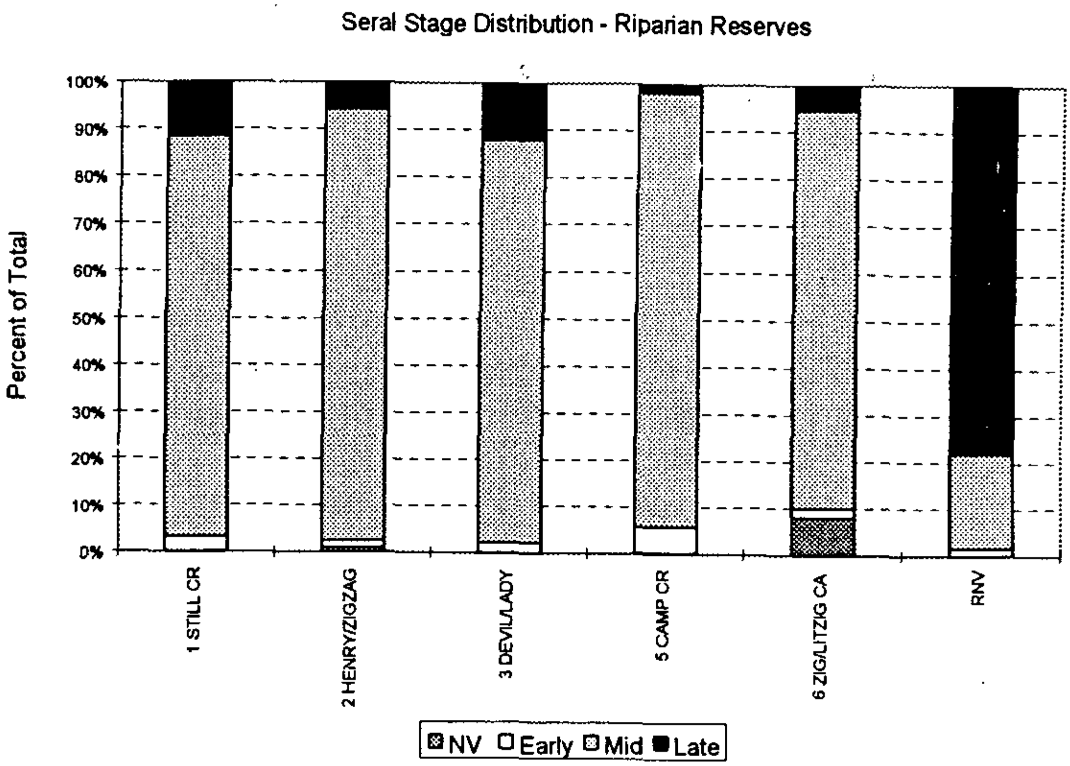
With the exception of Camp Creek, less than 12% of the baseflows of any subwatershed are allocated. The Camp Creek subwatershed has 10-20% of the baseflows allocated, based on recurrence interval low flow. Because some wetlands in the upper subwatershed and anadromous fish habitat in the lower subwatershed are maintained by low flows, this is a concern.

ACS Objective #8: Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration; and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

ACS Objective #9: Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

Both ACS Objectives #8 and #9 were assessed by evaluating stand structure and composition within the Riparian Reserves.

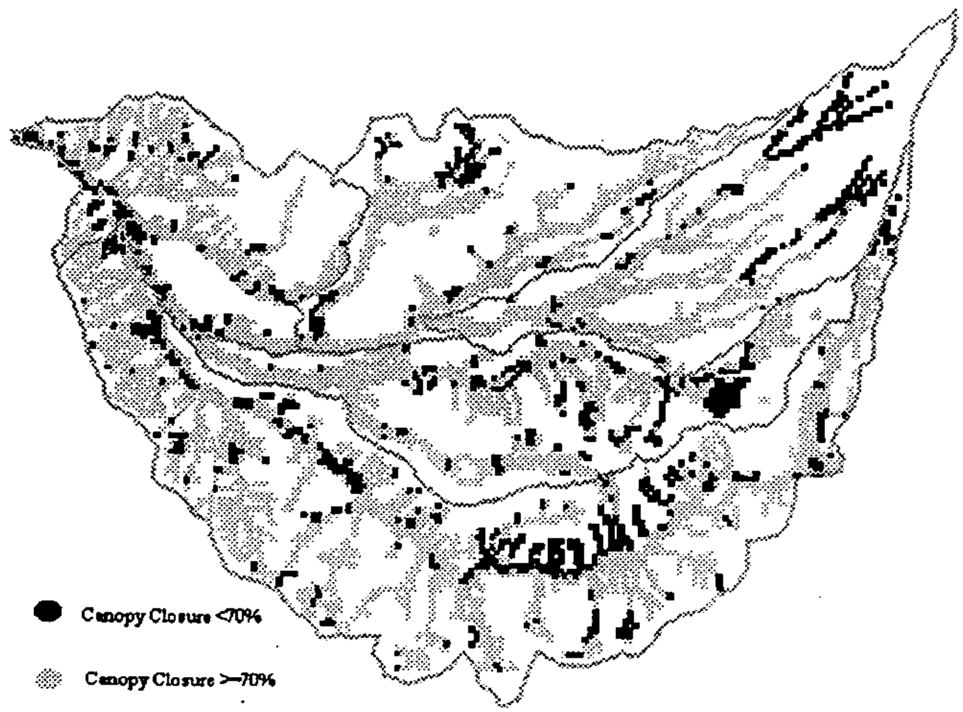
Figure 6-16 -- Riparian Reserve Stand Structure



The entire watershed is far outside the historic conditions for late seral stand structure within the Riparian Reserves. This is attributed to the fires between the turn of the century and 1952. Subwatersheds vary from 2-20% late seral structure in the Riparian Reserves, compared to the historic condition of 76%. Camp Creek subwatershed has the lowest percent in late seral stand structure (2%). This is attributed to the recent fire history in this area (89% of this subwatershed has burned at least once since the turn of the century).

Thermal Regulation

Figure 6-17 -- Riparian Reserve Canopy Closure



Canopy closure is the primary variable controlling thermal regulation. This is due to the large influence of solar radiation on thermal regulation. Direct solar radiation intercepting the stream surface is the principle factor in raising stream temperature in forested watersheds (Brown, 1969). Across all subwatersheds, more than 80% of the area within Riparian Reserves contains 70% or greater canopy closure. Even though the area within the Riparian Reserves is largely in mid seral stands, the resulting canopy closure will result in thermal regulation (both summer and winter) that is within the range of natural variation. This is due to the combination of mid and late seral stands being within the same range for the current and historic conditions.

Nutrient Filtering

Riparian vegetation regulates the exchange of nutrients and material from upland forests to streams (Swanson et al. 1982; Gregory et al. 1991), an important function of the Riparian Reserves. Nitrogen will be the nutrient of concern, due to its importance to biological communities, and the potential for water quality concerns if its concentration becomes too great.

Most of the nitrogen lost from forests to streams are relatively small for most undisturbed forest ecosystems (Cole 1979, Triska et al. 1984). Nitrogen inputs from forest management activities are usually associated with: logging, fire, and forest fertilization. Recent research indicates that riparian zones are important sites for denitrification (Green and Kauffman 1989).

The riparian areas within the Zigzag Watershed are outside the range of natural variation for stand structure. However, there is very little early stand structure within the Riparian Reserves (2-6% based on subwatershed), and early stand structure is within the same range as the historic condition (2%). Canopy closure data indicate that even though the stands within the riparian area are not in late seral conditions, they are very well vegetated. In fact, more than 80% of the riparian area has canopy closure of 70% or greater. Because the riparian areas are well vegetated, they should provide nutrient filtering between the uplands and the stream system. This is particularly true, considering the limited nitrogen inputs associated with management activities.

Within the aquatic system, organisms involved in nutrient cycling in streams (particularly bacteria, fungi, and algae) reside on surfaces such as wood and rock. These organisms are capable of transforming nitrogen, phosphorus, and other nutrients between inorganic and organic forms. Woody debris levels (both large and small) within the Zigzag Watershed are within the range of natural variation -- with the exception of the Zigzag and Little Zigzag rivers. Both of which are very low in combined levels of woody debris (1.5 and 4.8 pieces per mile). Levels of woody debris within the watershed indicate adequate sites for organisms involved in nutrient cycling.

Sediments, inorganic nutrients, and organic toxicants are removed by water that flows across wetlands (FEMAT Appendix V-E). Wetlands play a critical role in the nutrient filtering based on their ability to remove excess nutrients from the system. Wetlands throughout the watershed should approximate the range of natural conditions, based on the large amount of area in wilderness and roadless areas. However, there have been some impacts to wetlands in the Government Camp area, and within sections of the Zigzag River where the it was straightened.

Surface Erosion

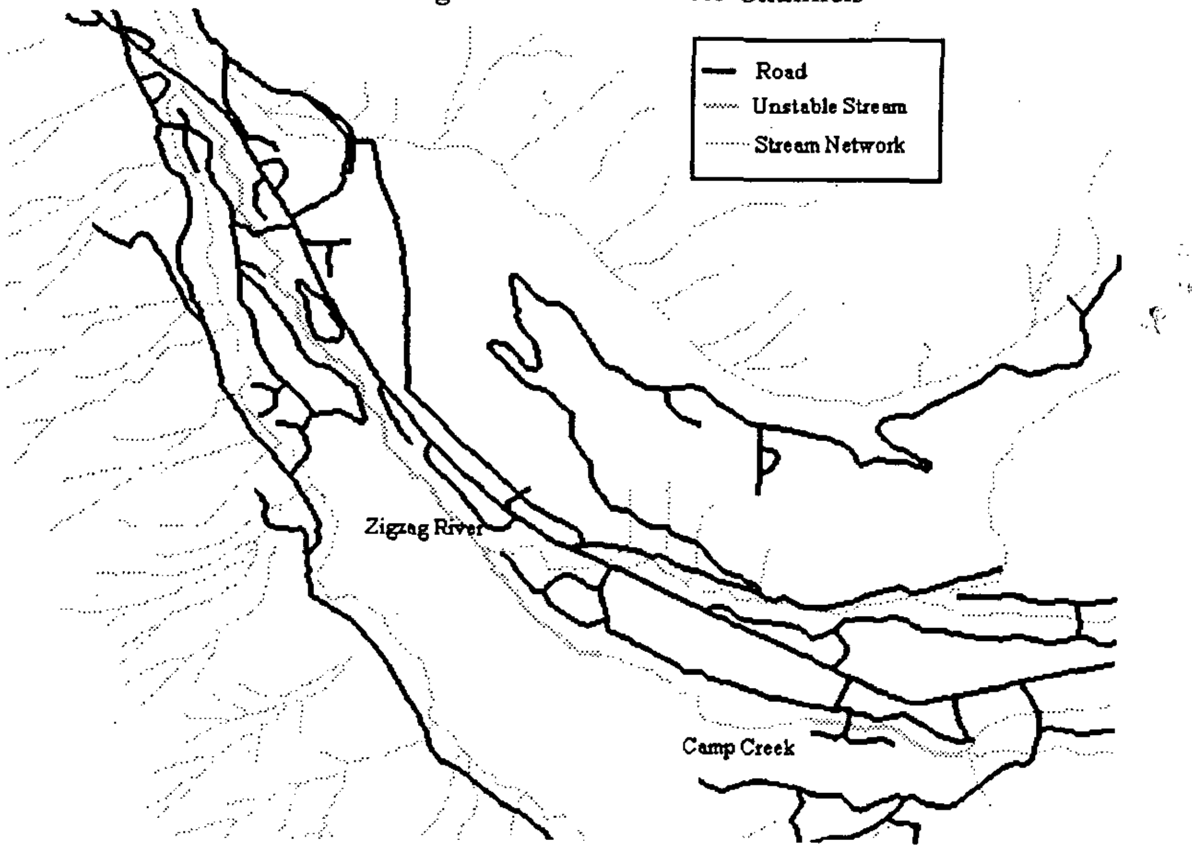
Species composition and structural diversity required to maintain appropriate rates of surface erosion is a function of effective ground cover within the delivery zone to streams. At the watershed scale, roads are the largest single impact to effective ground cover within this zone (assumed to be 300 feet for this analysis). Roads are within the delivery zone for over 13% of the stream miles in the Still Creek, Henry/Zigzag, and Camp Creek subwatersheds. Maintenance and restoration of these conditions could result from effective road surfacing and revegetation of cut and fill slopes.

Highway 26 and Still Creek Road (Forest Service Road #2612) are the roads with the highest potential for sediment delivery within the entire watershed. Field measurements were taken along these roads to determine effective ground cover and road cut and fill acreage. Estimates of road cut and fill slopes were used for all other roads. Vegetation along Still Creek Road includes dense shrub cover along some cut and fillslopes and within the ditchline. While the brush in the ditchline is effective at reducing sediment supply and transport, it is also effective at diverting waterflow along the road surface -- contributing to road surface erosion.

Bank Erosion and Channel Migration

Many unstable stream reaches in the lower Camp Creek and lower Zigzag River are high risk areas for bank erosion and channel migration. Many of the sensitive stream reaches in Zigzag River and Camp Creek are associated with mudflow deposits. These channels were cleaned of woody debris and straightened after the 1964 Flood, and are now confined to protect roads and developments (Recreation Residences and private developments) located within the Riparian Reserves (Figure 6-18). Limited channel migration is outside the natural condition for these types of channels, so continual maintenance will be required.

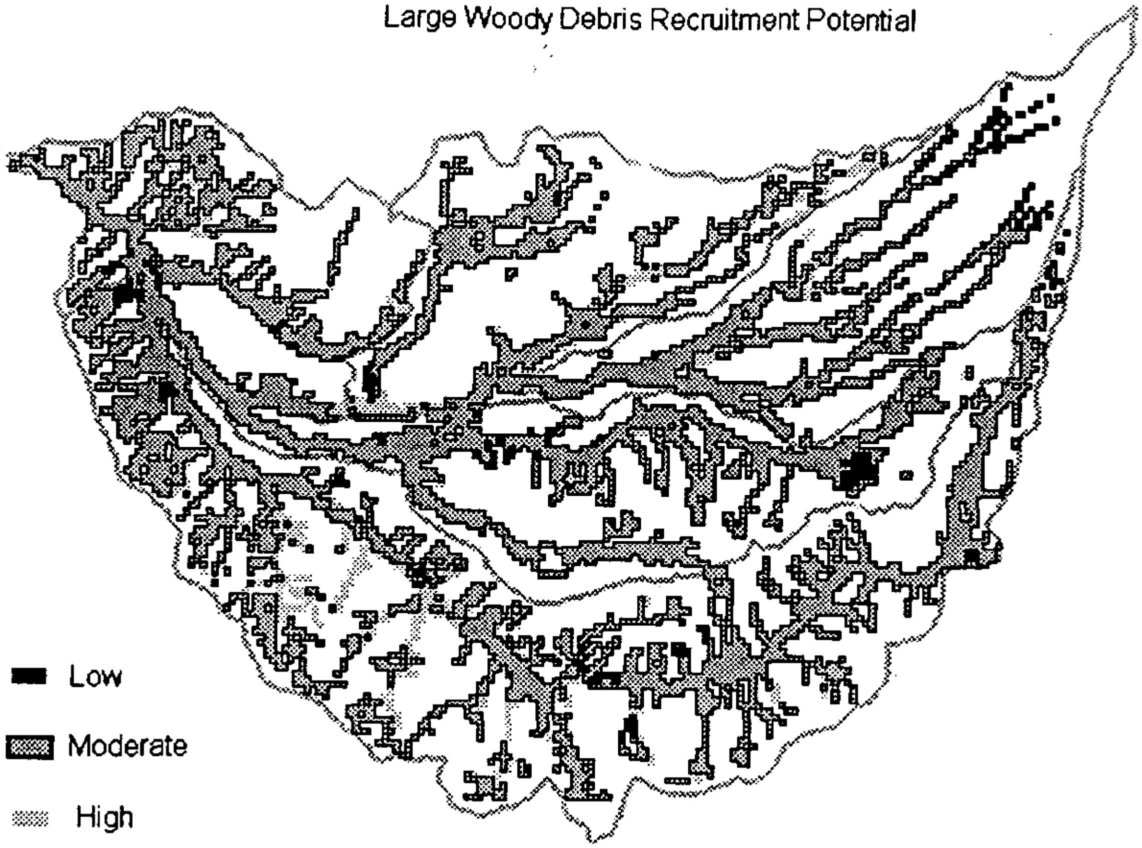
Figure 6-18 -- Unstable Channels



Large Woody Debris Inputs

All the subwatersheds within the Zigzag Watershed have a high concentration (80-100%) within the moderate large woody debris recruitment potential class. (With the exception of the Devil/Lady subwatershed within the Recreational Residence tracts area, which has a higher large woody debris recruitment potential.) This condition reflects the stand structure of the watershed's upland areas. This indicates that the fires which burned through the watershed between 1901 and 1952 impacted both the uplands and the riparian areas. Approximately 86% of the watershed has been burned at least once since the turn of the century. This is reflected in the relatively even distribution of the moderate large woody debris recruitment potential class across the its subwatersheds.

Figure 6-19 -- Large Woody Debris Recruitment Potential



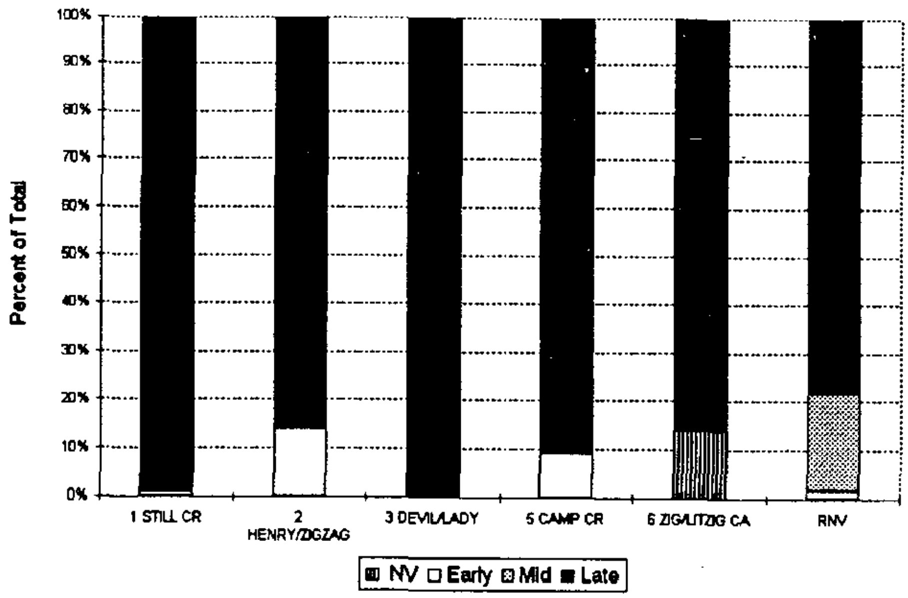
This condition would appear to be outside the range of natural variation. due to the large amount of area in a mid seral and moderate large woody debris recruitment potential class condition.

The entire Zigzag Watershed is well outside the range of historic condition (from PULSE) for late seral stand structure within the Riparian Reserves. This is attributed to the fires that occurred between the turn of the century and 1952. Subwatersheds vary from 2-20% late seral structure in the Riparian Reserves, compared to the historic condition (from PULSE) of 76%. The Camp Creek subwatershed has the lowest percent in late seral stand structure (2%) -- attributed to the 1952 Zigzag Fire.

This fire legacy has resulted in stand conditions that favor life history guilds that prefer small trees (mid seral) with large patches, rather than guilds that prefer late seral conditions with large patches.

The LAD process was used to depict how the watershed's landscapes should appear from 50-200+ years in the future. The Riparian Reserve stand structure was estimated based on design cells from this LAD process.

Figure 6-20 -- Riparian Reserve Stand Structure Under the Northwest Forest Plan



The conceptual landscape approximates the historic condition based on stand structure. The main difference is the conceptual landscape design is limited in mid seral stand. This, most likely, will not be a problem because: even though the desired condition for Riparian Reserves is late seral stand structure, natural disturbance mechanisms (fire, insects and disease) exist that will likely create early and mid seral stand conditions.

This stand structure should provide habitat conditions to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.

Key Question #3: How do conditions of the watershed affect opportunities for development within the ski areas, Recreational Residences, Organization Camps and private lands?

The current high-level of recreational use in the Zigzag Watershed is expected to increase in the future. The State Comprehensive Outdoor Recreation Plan (SCORP), projects a 57% increase in recreational use between 1987 and 2000 in the Portland metropolitan region, which includes the Zigzag Watershed. This will cause an increased demand for additional recreational facilities both on public and private lands in the watershed. This increased demand will also likely cause additional resource impacts at existing and planned facilities. The potential for conflicts between the various recreational uses and resource management objectives will also exist.

Conditions of the watershed which affect opportunities within ski areas, recreational residences and organization camps are tied to standards and guidelines from the Northwest Forest Plan. The forest plan lists additional standards for all federal lands (ROD p. C-1 through C-5) and riparian reserves (ROD p.C-30 through C-38) and matrix lands (ROD p. C-39 through C-61). In particular, standards for management of recreation sites within riparian reserves can be found on ROD p. C-34.

Ski Areas

Between 1987-2000, SCORP data projects a 37% increase in downhill skiers and a 51% increase in snowplay/snowboarding, an annual increase of 2.8% and 3.9% respectively. Actual ticket sales at Mt. Hood's ski areas increased 21% between the 1989/90 and 1994/95 seasons, or an increase of approximately 3.5% annually. Based on actual sales figures, the projections from the SCORP data appear to be reasonably accurate. Actual usage between years will vary, depending on snow conditions, but overall, use is increasing at the ski areas.

To meet this increased demand, all three of ski areas in the watershed, Timberline Lodge, Multorpor Ski Bowl, Summit, are considering expanding existing ski runs and improving ski lifts to address safety concerns, providing additional capacity, and improving the recreational experience. In addition, the Multorpor Ski Bowl and Summit ski areas are considering new support facilities such as additional parking, improving existing or developing new lodge buildings, and adding additional ski runs into undeveloped areas.

Most new expansion proposals would be located at least partially within the Riparian Reserves. Any openings or facilities must meet standards and guidelines for the allocation, including those for the Riparian Reserves. They must also meet Aquatic Conservation Strategy (ACS) objectives. Limitations on creation of additional openings not meeting standards may limit future expansion at these areas.

Many existing facilities of the ski areas are also within Riparian Reserves. There should be little change to current operations unless those operations are preventing attainment of ACS objectives (see S&G RM-1, p C-34 of ROD). The Record of Decision states, "We presume that currently existing and permitted ski areas will be allowed to continue under current permit terms" (ROD p. 15).

The ski areas are also looking at expanding year-round use of their permit areas. Restrictions on ski area operations are likely to be less during winter months when a covering of snow provides additional protection to sensitive sites not present during the summer season. Activities which can result in ground disturbance are more likely to occur during summer months following loss of the snowpack. Summer use of these areas will likely require additional limitations to protect resource values and meet current standards and guidelines, especially within riparian areas.

Applications of salt (sodium chloride) are made to the Palmer snowfield to improve snow conditions for summer skiing. While most of the snowfield is within the Salmon River watershed, a portion of the snowfield drains into Still Creek as well. Monitoring results have shown that chloride and conductivity levels in Still Creek are higher than other streams within the watershed. These conductivity levels are also higher than Fir Creek, an unmanaged subwatershed in the Bull Run watershed which is used for comparison purposes. The results are below water quality criteria thresholds established for salt sensitive aquatic species. However, the levels are above base or background levels and may be outside the range that species, populations and communities are uniquely adapted. Additional monitoring is needed to identify effects of snowfield salting on upper Still Creek.

In contrast to higher elevation or alpine ski areas such as Timberline, Multorpor Ski Bowl and Summit ski areas are located within the transient snow zone where snow conditions have a wide-range of variability during the ski season. Because of this, both areas are considering mechanized snowmaking to extend their ski seasons during low snow years. Multorpor Ski Bowl has been already making snow to a limited degree in past years. The ability to make snow at these two areas, however, is limited by the lack of the necessary cold snow-making temperatures.

In addition, there are several wet areas and seeps located on the ski slopes, particularly within the Multorpor Ski Bowl and Summit ski areas. These wet areas affect the ski area's ability to retain snow on their ski runs. In order to improve snow retention, original stream drainage patterns within these ski runs have been modified with french drains (subsurface drainage channeling structures) and culverts. The wet areas and seeps are part of the Riparian Reserves and activities in these areas must meet Riparian Reserve standards. If they are unable to meet current direction, additional facility development may be limited and modifications to existing areas may be necessary.

A small population of white bark pine exists within the Timberline Lodge permit area. The nuts of this tree species have historically provided American Indians with an important food source within the watershed. Therefore, protection of white bark pine for cultural and ecological values could limit potential ski area development around these trees. Because of their limited presence in the watershed, these effects are expected to be minimal.

In addition, ski areas must adhere to visual quality standards that, depending on the area's visual sensitivity and any potential for visual impacts, can also affect development plans.

The Region Six sensitive plant, ground cedar, *Diaphasiastrum complanatum*, is located within the Multorpor Ski Bowl permit area. Routine slope brushing is maintaining the vegetation in an early seral stage. Since ground cedar is affected by competition, slope brushing may be enhancing its habitat. At this time, it appears ski area operations will not be affected by its presence. Even so, potential ski area activity impacts to this plant should continue to be monitored.

Peregrine falcons that have been released at a hacking site on cliffs above Multorpor Ski Bowl have yet to become established in this location. Should they become established here, human access to areas near the nesting site may be limited during the nesting season to reduce the disturbance potential to these birds.

Historic sites also exist within the ski areas that could affect operations. The Multorpor Ski Bowl ski area's permit area includes the Barlow Road Historic District and a Forest Service-owned warming hut. Protection standards for these features may affect expansion of the ski area's parking lot and warming hut use. Other historic features include the Camp Blossom area in the Timberline permit area, and West Leg Road in the Summit Ski area. Both of these features are eligible for the National Register of Historic Places. Management standards require that these and any other historic features located within ski areas be identified, analyzed, and adequately preserved prior to implementation of any projects that could affect their historic character.

Recreation Residences

There are 557 Recreation Residences located within the watershed. These are privately owned cabins located on National Forest land and are authorized by a special use permit. The residences are for recreational use and not full-time occupancy. The special use permits outline for the cabin owner requirements for maintenance and care of the residences and the lands they residences are on.

Approximately 87% of the Recreation Residence tracts are located within the Riparian Reserves of Still Creek, Camp Creek, and the Zigzag River. In addition to Riparian Reserve standards and guidelines, activities in these areas must also meet ACS objectives. The ACS objectives most likely to be affected by the presence of these residences are those related to water quality, flow regime, physical integrity of the aquatic ecosystem and stand structure and composition.

It is estimated that 71% of the watershed's Recreation Residences have some type of septic system. Approximately 16% have outhouses or cesspools. The type of system being used for 13% of the Recreation Residences is unknown. Septic systems directly adjacent to surface waters or high ground water tables may have the ability to introduce fecal contaminants to water resources. Preliminary water quality monitoring has not shown effects to water quality associated with the recreation residence tracts. Additional monitoring is recommended to determine if there are effects to water quality.

Some residences are located within the 100 year floodplain of the watershed's streams. In the past, requests have been made to modify stream channels to protect cabins from potential damage during flood events. Following 1964 flooding, wide-spread stream clean-out efforts were implemented to provide additional protection to streamside residences. To reduce effects on channel structure, restrictions may be placed on increasing the sizes of existing residences, or the building of new or rebuilding of existing damaged structures within the 100 year floodplain.

Preliminary mapping has shown that 65% of the Recreation Residences are potentially located in areas that have laminated root disease. Infected trees adjacent to many of the residences pose a significant safety hazard since the disease decays the roots close to the root collar, making them highly susceptible to windthrow. Removing individual hazard trees has lessened the safety risk to some of the residences but does not address reducing the spread of the disease. Since the residences are within areas of the preferred host type of tree, the rate of spread will increase.

While some of the infected trees may be cut down and left on site for downed woody debris, or felled into streams to provide additional habitat for fish, many trees are completely removed from the area. Tree removal could conflict with objectives to provide for short term snag habitat and large woody debris recruitment, especially within the Riparian Reserves. As mentioned above, this reduces the forest's downed wood component, affecting stand structure and composition. In order to address conflicts in land management direction of safety verses allowing a natural process to operate within the watershed, a comprehensive management strategy should be developed. The strategy should address protection of the Recreation Residences, determining the extent of the infection, controlling the spread of the disease, including the regeneration of disease resistant species, and protection of stand structure and composition as required by the ACS objectives.

Management direction for the Recreation Residences calls for maximizing protection of existing vegetation adjacent to the residences and minimizing the number and size of roads, especially within Riparian Reserves. This direction, however, conflicts with a fire protection strategy calling for the clearing of flammable vegetation up to 30 feet from buildings. Insuring roads are wide enough to accommodate current fire-fighting equipment is another fire prevention strategy. Current management direction will offer a lower level of fire protection for some residences.

Some Recreation Residences are also located within the Barlow Road Historic District. Activities at these residences must protect the district's historic features, possibly limiting some improvements associated with the residences.

Some Recreation Residences built in the early part of this century may be historically significant, and therefore eligible for the National Register of Historic Places. No comprehensive historic survey of the residences has been conducted. Currently, buildings are evaluated individually when construction modification proposals are made. The Forest Service has limited authority to preserve the historic character of privately owned buildings, but can limit modifications to the cabin exterior's in an effort to protect the building's historic character. A comprehensive historic survey of all residence tracts would facilitate future management decisions regarding acceptable modifications to protect significant historical features.

At the watershed scale, fish habitat and water quality do not appear to be degraded within the Recreational Residence tracts, though there are individual residences where resource problems are present and should be addressed. This is in keeping the ROD, p. 15, which states, "we expect that current permit terms will be sufficient to meet the overall goals" of the ROD.

Organization Camps

Of the six Organization Camps within the watershed, four of these have more than 50% of their permit areas within the Riparian Reserve. Two of these, the Portland Post Office Club and Trails Club of Oregon, are almost totally within Riparian Reserves. Because their current permits are expiring, re-issuance of special use permits for five of the six camps is currently underway. During these evaluations, the areas will be reviewed for consistency with management direction, including meeting ACS objectives. Modifications to the existing permits may be recommended based on the results of these consistency reviews.

Kiwanis Camp and Paradise Trail Christian Camp are located within the Barlow Road Historic District. Activities at these sites must also protect the historic features of the district.

Private Lands

Overall conditions within the watershed have varied effects on its private lands. The Mt. Hood Forest Land and Resource Management Plan (LRMP) and Northwest Forest Plan (NW Forest Plan) standards do not apply on these private lands. State and local land use regulations do apply. Any effects on private lands from federal land management direction would be indirect.

Rhododendron and Government Camp are the watershed's two communities that are totally surrounded by National Forest lands. This geographic reality limits future expansion of these communities. Most of Rhododendron's private lands have been developed. Any potential for future growth in this community is therefore limited.

Government Camp, however, does have undeveloped private lands that allow for future expansion. Even so, the capacity of this community's existing sewer plant is limiting its growth. Currently operating at maximum capacity, the sewer plant is located on National Forest lands. The community is evaluating alternatives for meeting an increased demand. The alternatives include expansion of the existing plant, construction of a new plant at one of two sites, or piping the sewage to Rhododendron for treatment at the Hoodland treatment plant. All alternatives are located on National Forest land and would affect Riparian Reserves to varying degrees. All alternatives must meet LRMP and NW Forest Plan standards for those parts of the proposals on the National Forest.

Some alternatives under consideration also involve construction within the Barlow Road Historic District. Construction at these sites must meet the management direction for protection of the historic district's features.

With some exceptions, fecal coliform concentrations in the sewage treatment outfall meet appropriate water quality standards and are within the range of an undisturbed area. However, there have been a number of short duration, yet high concentration, of fecal coliform bacteria discharges into Camp Creek. These discharges may violate the National Pollutant Discharge Elimination System Water Discharge (NPDES) permit and Oregon state water quality standards.

Current water withdrawal allocations in Camp Creek are at 10% of the average annual baseflows, or 20% of the average 100-year duration baseflows. These withdrawals may be inconsistent with ACS objective #6, maintaining adequate in-stream flows to sustain riparian, aquatic and wetland habitats, as well as ACS objective #7, maintaining the timing, variability and duration of floodplain inundation. Federal agencies such as the Forest Service do not have authority to control water withdrawals, which is the responsibility of the State of Oregon.

Key Question #4: How do conditions of the watershed affect the availability of forest products such as timber and other wood products, plant materials, huckleberries, and minerals?

The primary factors affecting the availability of commodities within the watershed include the land allocations and the existing vegetative condition. (A summary of Northwest Forest Plan standards and guidelines for special forest product collection and harvest is contained in the Zigzag Watershed Analysis Appendices.) On privately owned lands, state laws and local zoning requirements serve as the controlling regulations affecting commodity availability.

The approach for answering this question was to summarize the availability for commodity production by land allocation and acreage . Table 6-3 summarizes the availability of commodities within the watershed based on the limitations prescribed by management direction, state laws, and land allocation.

For commodities described under Key Question 4, the following considerations apply:

- **Timber** -- refers to commercial saw-timber.
- ***Special forest products*** -- describes a broad range of forest materials such as firewood, posts and poles, beargrass, mushrooms, and Christmas trees. ("Special Forest Products" is abbreviated "SFP" in Table 6-3.)
- **Mineral** -- resources in this analysis include locatable minerals and rock quarries.

Definitions for Table 6-3:

- **Excluded**: Activities not permitted within the land allocation/zoning.
- **Very limited**: Activities limited only to those that benefit the management objectives of the land allocation/zoning.
- **Somewhat limited**: Management direction and/or regulations restrict the availability to a moderate degree. Commodity outputs are generally consistent with the management objectives of the allocation/zoning. Additional resource considerations will apply.
- **Few limits**: the activity is compatible with the land allocation/zoning. Additional resource considerations will apply.

Table 6-3 -- Commodity availability based on land allocation/ownership within the Zigzag Watershed

LAND ALLOCATION	ACRES IN WATERSHED	PERCENT OF WATERSHED	AVAILABILITY OF COMMODITIES
A2 Wilderness	11,216	30	Excludes all commodities listed.
Riparian Reserve	7,082	18	Timber: very limited SFP: very limited Minerals: new developments limited
Late Successional Reserve	5,375	14	Timber: very limited SFP: very limited Minerals: very limited
A11 Winter Recreation	3,165	8	Timber: very limited SFP: somewhat limited Minerals: new developments very limited
A5 Unroaded Recreation	2,901	8	Timber: very limited SFP: somewhat limited Minerals: new developments very limited
B2 Scenic Viewshed	2,612	7	Timber: somewhat limited SFP: few limits Minerals: somewhat limited
B6 Special Emphasis Watershed	2,491	7	Timber: somewhat limited SFP: few limits Minerals: somewhat limited
A4 Special Interest Area (Barlow Road Historic District)	951	3	Timber: very limited SFP: somewhat limited. Minerals: new developments very limited
B3 Roaded Recreation	588	2	Timber: somewhat limited SFP: somewhat limited Minerals: new developments somewhat limited
A10 Developed Recreation	205	less than 1	Timber: very limited SFP: very limited Minerals: very limited
B12 Backcountry Lakes	156	less than 1	Timber: somewhat limited SFP: somewhat limited Minerals: new developments somewhat limited
Private Ownership	988	3	

Timber

- Timber production is excluded within Mt. Hood Wilderness, comprising approximately 30% of the watershed (11,216 acres).

- Timber production is very limited on land allocations comprising more than 51% of the watershed: Riparian and Late Successional Reserves; and A lands Winter, Unroaded and Developed Recreation and Special Interest Area.

- Timber production is somewhat limited on 5,847 acres or 16% of the watershed, all in "B" land allocations of Scenic Viewshed, Special Emphasis Watershed, Roaded Recreation, and Backcountry Lakes. In general, timber production and maintenance of a healthy forest conditions are secondary objectives of these land allocations.

- No Timber Emphasis (C1) lands are located within the watershed.

- No estimates were made for timber production on the 988 acres of private lands within the watershed. There are some private timber lands in the Enola Hill and Eureka Peak areas.

- The Conceptual Landscape Pattern identifies long-term vegetation objectives for the land allocations in the watershed. The Conceptual Landscape Pattern cells with potential for timber harvest are: Mature Forest/Occasional Openings, Mature Forest/Small Openings, Mature Forest/Variable Openings, and Mature Forest/Ridgetop Openings.

- The greatest potential for timber production within the watershed is within the B6 Special Emphasis Watershed allocation. This allocation comprises 2,491 acres, or 7%, of the watershed and is represented by the Mature Forest/Variable Opening design cell. At any given point in time, up to 1/3 of the lands (830 acres) within this design cell may be in created openings that vary from 5-60 acres in size.

- Within the B6 Special Emphasis Watershed allocation, there are several areas where forest stands are displaying reduced health and vigor. In the B6 land allocation, 168 acres of stands are affected by laminated root disease. There are 926 acres of level 3 defoliation from spruce budworm and 195 acres planted with off-site trees. Harvest or salvage of these stands could produce some timber volume and regenerate forest health conditions.

- The watershed contains a total of 850 acres of off-site plantations on B2 Scenic Viewshed and B6 Special Emphasis Watershed. Timber harvest and replanting would restore the local genetic composition of these stands. However, in many cases these stands are low in volume and stocking and timber yield would be limited.

- Approximately 15% of B land allocations are lands designated as unsuitable for timber production (suitability screens 1, 3, or 4). Suitability mapping and field validation will be necessary during timber sale planning on lands with regulated timber harvest.

- The Mature Forest/Occasional Openings design cell comprises 5,676 acres, or 15% of the watershed, and is found solely within A land allocations.

- The Mature Forest/Small Opening design cell comprises 3,010 acres, or 8% of the watershed and is found on B land allocations (Backcountry Lakes, Roaded Recreation and Scenic Viewsheds).

- Late seral forest for the Zigzag Watershed overall is currently at 7%. In watersheds with less than 15% late seral forest, all late seral patches should be retained, regardless of land allocations (ROD C-44). Protection of these stands could be modified when reserved areas have reached late successional conditions. Since the Zigzag Watershed is below the 15% standard, all late seral forest must be retained until the reserves mature. Retention of late seral forest within the watershed would include 563 acres of late seral stands in B allocations. The remaining acreage is in reserved allocations.

- The Mature Forest/Ridgetop Opening design cell comprises 346 acres, less than 1% of the entire watershed.

- On lands managed for huckleberry production, retention of openings for huckleberry production would delay re-establishment of timber stands, therefore, a short-term impact to timber production would occur.

- Completion of an interim LAD would help identify current opportunities for timber harvest within the watershed. Additional site analysis will aid in identifying timber harvest locations.

- Timber volume may be limited on sites where historic fires consumed soil organic matter and led to severe post fire erosion. The resulting stands show reduced health, vigor and growth. (See Composite Fire History Map in Chapter 4.)

- Few opportunities exist to manage stands less than 80-years-old within the LSR. There are 66 acres of managed stands within the LSR (Cool Creek #4, #5, and #8). These plantations are less than 10 years-old. There are no natural stands less than 80 years of age within the LSR.

- The Scheduling and Network Analysis Program (SNAP) can be used as a tool to model and schedule future timber harvest based on stand growth rates and land allocation constraints.

Special Forest Products

- The availability of special forest products is very limited on approximately 34% of the watershed. Riparian and Late Successional Reserves and Developed Recreation allocations are very limited in their potential to supply special forest products. (Because special forest products is a broad category, consult the appropriate references for each land allocation and product.)

- Commercial gathering of special forest products is prohibited on Wilderness lands.

- Additional site specific analysis is needed to evaluate the opportunities for gathering special forest products in Riparian and Late Successional Reserves.

- Additional species-specific information is needed to address the affect of special forest product harvesting on species of concern.

- Firewood and post and pole products are secondary products of timber harvest. Their supply would be indirectly limited by timber harvest levels.

- There is a small potential to produce huckleberries within the watershed's 346 acres of Mature Forest/Ridgetop Openings design cell.

Minerals

- There are currently no active locatable mining claims or geothermal lease permits within the watershed. Rock quarries within the watershed are not expected to produce materials in the near future.

Probable Sale Quantity (PSQ) Analysis

Probable Sale Quantity (PSQ) is the estimated timber sale quantity under the Northwest Forest Plan's Standards and Guidelines. Based on the opportunities and constraints associated with the land allocations under the Northwest Forest Plan, an attempt was made to dissaggregate the Northwest Forest Plan's PSQ to the Zigzag Watershed.

Because PSQ applies Forest-wide, it is therefore difficult to disaggregate it into a single watershed. PSQ was calculated for the 13 major drainages on the Mt. Hood NF. Thus, forest constraints and stand conditions were developed at this level. When harvest levels are reduced to the watershed level, each watershed gets its piece of the harvest "pie" in a blind disaggregation -- without any consideration for conditions within each specific watershed. Harvest levels for each watershed change from decade to decade to reflect the distribution and composition of stands across all watersheds.

For the Zigzag Watershed, the disaggregated first decade harvest level (not disaggregated PSQ) is 527 mbf/year. The disaggregated harvest for the first five decades is shown below:

Decade	mbf/year
1	527
2	67
3	247
4	812
5	758

Much variability exists between decades. These harvest levels are based on 1,813-acres available for timber management under various B land allocations. Using these acres, and an estimate of their volume-per-acre contribution under a regulated forest condition, a PSQ estimate for the Zigzag Watershed would be 664 mbf/year. This is higher than the average harvest level for the first 50 years (482 mbf/year). It is either an indication of the need to constrain harvest while the area recovers from past management, or reflects that more desirable stands are available elsewhere on the Forest.

Further examination of the Northwest Forest Plan's modeling assumptions show that 81% of the B allocation acreage is being managed at a minimum level with no timber harvest. (It is important to note that, when the Northwest Forest Plan's modeling assumptions were made, Late Succession Reserves and Riparian Reserves had not been removed from the B allocations.)

Acres were shifted for many reasons, including:

1. Acres that were unsuitable for timber harvest (non-forest, roads, unstable areas, regeneration difficulties).

2. Acres in Late Successional Reserves (LSR) were removed and placed under a no harvest prescription. (This was done because LSRs were only one of a number of reserve strategies that were evaluated.)

3. Riparian Reserves (estimated for the Northwest Forest Plan analysis, since not all streams were mapped at that time) averaged approximately 45% of the land base.

4. Visual protection along trails and from viewpoints, such as Timberline Lodge.

5. Sensitive visual areas that allow harvest but where harvest will actually most likely never occur.

6. A 4% removal of the land base outside Tier 1 key watersheds for unstable lands (Northwest Forest Plan direction).

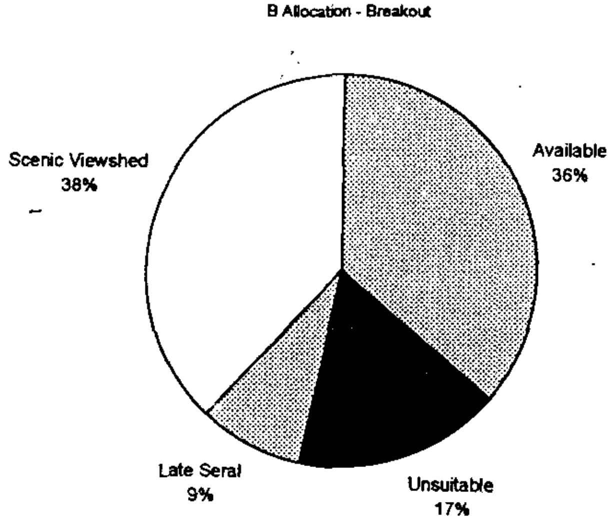
For the Zigzag Watershed, only 1,813 acres remain available for timber harvest out of the 9,599 acres of B allocations on the Forest Plan control map.

In the Northwest Forest Plan's analysis process, an initial estimate of harvest volume was calculated for the Forest using a FORPLAN model. The acres available for timber management were identified and FORPLAN scheduled harvest against these acres to generate a volume estimate. Later, some adjustments were applied to the initial volume estimates. The Mt. Hood NF's estimated harvest volume was reduced by 27%, to account for green tree retention, operational difficulties, and a Forest inventory adjustment.

Probable Sale Quantity Scaledown

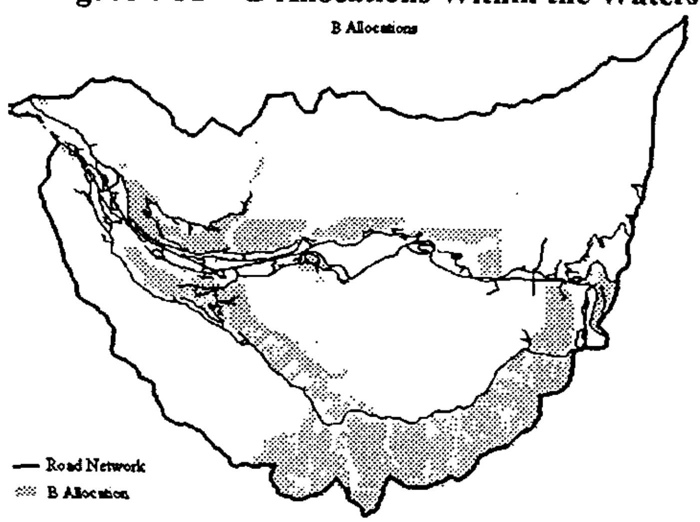
Using the same assumptions that were used for Northwest Forest Plan modeling to assess currently available acres, only 36% of the B lands would be available for regulated harvest (after Late Successional Reserves and Riparian Reserves were delineated and removed from B allocations).

Figure 6-21 -- B Allocation Distribution



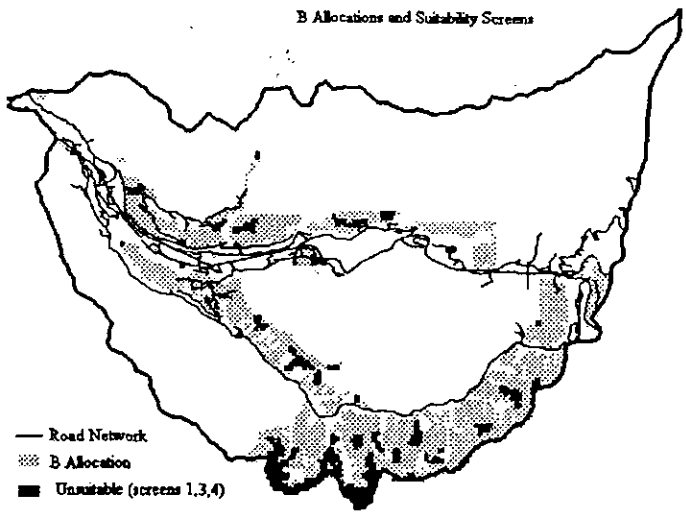
Following the same process that was used for the Northwest Forest Plan modeling, 5,847 acres of B allocation lands within the Zigzag Watershed may be available for harvest.

Figure 6-22 -- B Allocations Within the Watershed



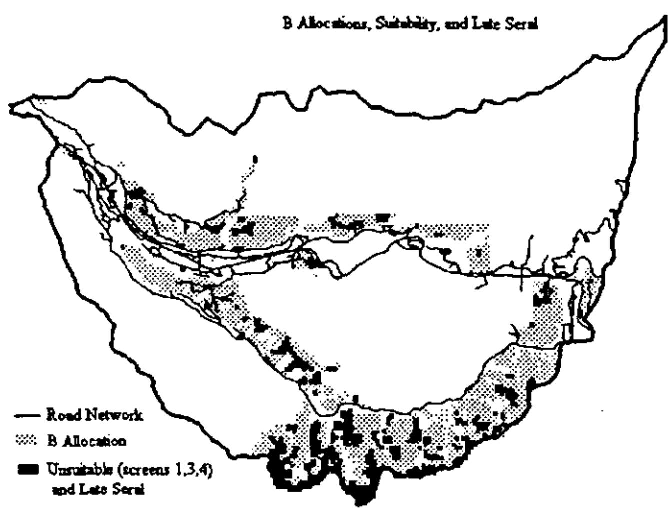
Removal of unsuitable areas (unvegetated, unstable, or regeneration difficulties) would result in 4,854 acres being available for harvest.

Figure 6-23 -- Unsuitable Areas Within B Allocations



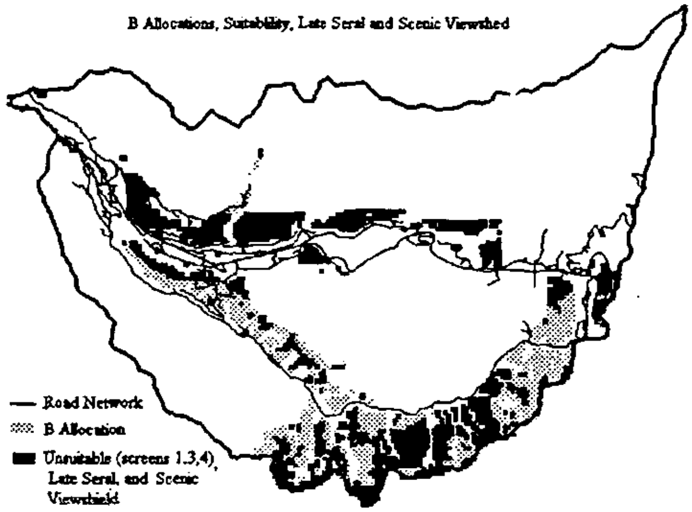
Late seral stands are now removed from availability due to the limited area in late seral stands within this watershed. The Northwest Forest Plan requires all remaining late successional stands to be protected (ROD C-44) if less than 15% late-successional forest exists within a fifth field watershed. This leaves 4,358 acres.

Figure 6-24 -- Unsuitable Areas and Late Seral Stands



If scenic viewshed is now removed, the available acreage is 2,172 acres. All the scenic viewshed was removed for this watershed analysis due to the large amount of sensitive visual areas associated with Highway 26 and Timberline Lodge. In general, timber production and maintenance of a healthy forest conditions are secondary objective of this land allocation. The standards and guidelines for this allocation state that regulated harvest should occur and that all vegetation management activities shall be directed toward creating or maintaining the desire landscape character through time and space. However, to remain consistent with the assumptions used for modeling the Northwest Forest Plan, these areas were removed from the Zigzag Watershed landbase available for harvest.

Figure 6-25 -- Unsuitable Acres, Late Seral and Scenic Viewshed



If the 4% removal of lands outside Tier 1 key watersheds is removed from the available represents 2,085 acres (compared to 1,813 from the original estimate) -- this would generate an estimated PSQ of 763 mbf per year.

The major difference between the original estimate and the current estimate of acres available for harvest appears to be within Riparian Reserves. The original estimate assumed 45% of the land base would be in Riparian Reserves. The Riparian Reserves allocated during the watershed analysis account for 34% of the land base.

Recommendation

Recognize Northwest Forest Plan estimates (both first decade harvest and PSQ). After all, until adequate time and resources become available to model harvest for the Zigzag Watershed, only a 15% difference currently exists between the two estimates. This future modeling effort would need to identify any additional acreage withdrawals based on site-specific information, and also verify yield reductions based on management prescriptions that would be implemented for this watershed.

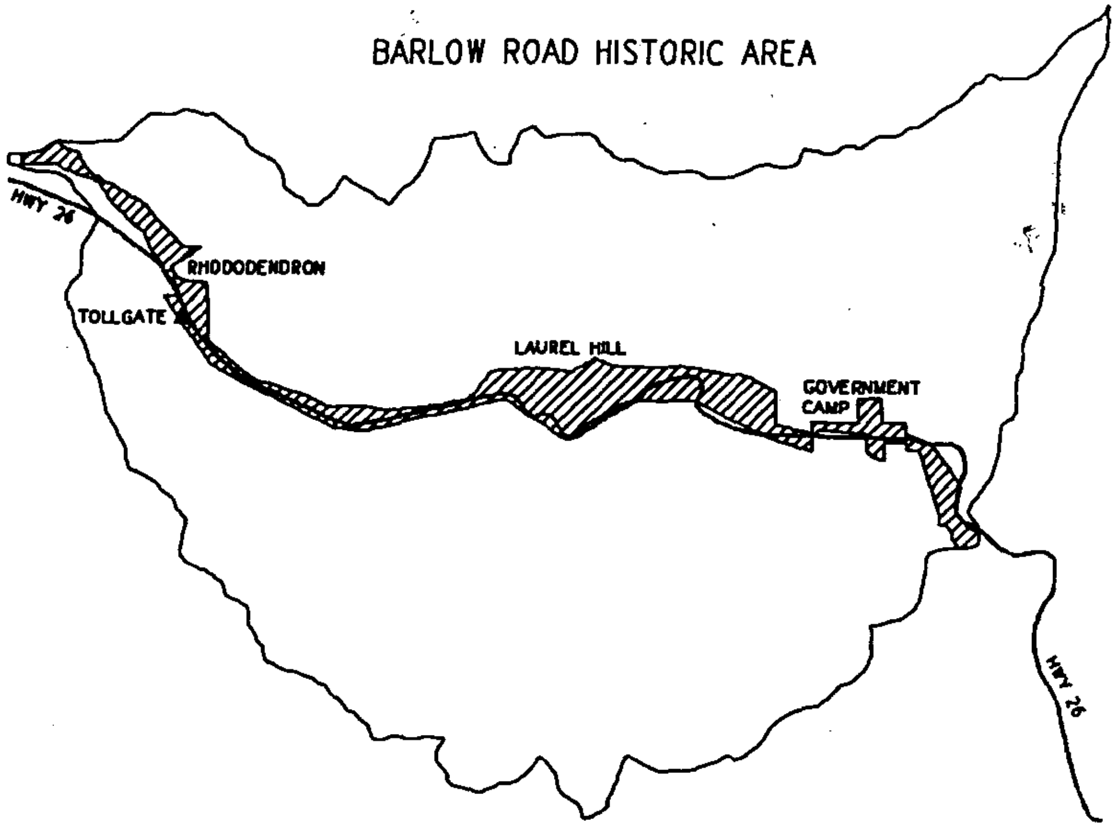
Question #5: How do conditions of the watershed affect the maintenance and development of U.S. Highway 26?

The conditions that most affect U.S. Highway 26 (US 26), are the LRMP and Northwest Forest Plan allocation standards and guidelines, as well as the biological, physical, and social conditions along the highway within the watershed. The highway passes through, or adjacent to, a variety of land allocations whose standards have the potential to affect the highway's operation.

Barlow Road Historic District

The Barlow Road Historic District has protection standards which will likely affect future development proposals for the highway. Many of this district's important historic features are located immediately adjacent to the existing highway, where expansion is most likely to take place. Most of the highway parallels or has actually been constructed on portions of the historic Barlow Road and is, therefore, currently contained within the historic district. Figure 6-26 illustrates US 26 and its relationship to the Special Interest Area containing the historic district. Historic district protection standards may affect US 26 by limiting expansion of the highway's width in some locations, or requiring other mitigation measures to preserve historic features.

Figure 6-26- Highway 26 and Barlow Road Historic District



Riparian Reserves/Aquatic Conservation Strategy

Over 4.5 miles of the highway is located within Riparian Reserves and must therefore meet standards and guidelines for these reserves, as well as Aquatic Conservation Strategy (ACS) objectives in its operation and design.

The highway has affected hydrologic connectivity from cuts and fills that have intercepted or otherwise affected subsurface water flows. This is very apparent where the highway passes through the wetland complex adjacent to Multorpor Fen or in road cuts to the west of the Snowbunny sno-park area. In both of these locations, subsurface flows are being affected. Efforts to reduce and/or mitigate these effects may affect future highway design,

The physical integrity of streams in the watershed, especially Camp Creek between Multorpor Ski Bowl and Mirror Lake Trail head, has been affected by the channelization of the creek by the location of the highway. There is a greater potential for unstable stream banks within this section. This can mean higher levels of maintenance for that portion of highway and possibly design modifications for future highway operations to keep from further degrading the steam's integrity and minimize maintenance needs.

Water quality is being affected in various ways by the highway's operations. Sediment from road cuts and fills and sand from highway sanding activities are entering streams in the watershed affecting water quality in Camp Creek and Zigzag River. Actions affecting highway operations may be necessary to reduce the levels of sediment into the affected streams.

There is also a concern that water quality is being affected by oils and other chemicals from vehicles that have accumulated on the highway over the dry summer season and are being washed off into streams and wetlands, especially during the first flush period. However, the extent of and effects from this are unknown at this time.

In addition to affecting water quality, sediment from the highway operations is also affecting the sediment regime of Camp Creek and Zigzag River from higher than natural levels of sediment entering those streams. As mentioned above, actions may be necessary to reduce the levels of sediment into the affected streams.

There is a low large woody debris recruitment potential along sections of the highway from the removal of trees hazardous to highway operations. This is especially true along Camp Creek between Multorpor Ski Bowl and Mirror Lake trailhead and to a lesser degree, at other stream crossing areas within the watershed. This affects the structural diversity of the Riparian Reserve in those areas. Possible mitigation for this could be to bring in woody debris from other sources to replace this lost potential.

Other Conditions Potentially Affecting Highway Operations

Habitat for terrestrial wildlife species is being bisected by the US 26 corridor. This affects the connectivity and effectiveness of the habitat within the watershed. Any widening of the highway will only intensify these effects by:

- further fragmenting wildlife habitat by increasing the space between blocks of habitat on each side of the highway,
- larger cuts and fills will be additional barriers to wildlife,
- increasing the risk to wildlife by creating a wider highway corridor that animals must cross, and
- if any median barriers are part of the highway, they will be an additional barrier to wildlife attempting to cross the highway.

Efforts to minimize these effects may affect future highway design.

The highway's scenic viewshed standards have the potential to affect the design of activities that can be seen from the highway. These standards may also affect activities on one section of the highway that can be viewed from other highway locations. These standards have the potential to affect highway design in future expansion proposals to minimize effects to visual quality.

The presence of laminated root disease in the watershed will likely increase the number of hazard trees along the highway.

The increasing demand for recreation opportunities within the watershed will increase the number of visitors using the highway and areas adjacent to it. This will increase the need for side road access to the highway and the potential for safety problems developing along the highway at intersections will increase.

The highway has provided a mechanism for the introduction and dispersal of knapweed and other noxious weeds and non-native invasive plants. Actions may be necessary to reduce the spread and dispersal of these plants.

The close proximity of some Recreational Residences and of Tollgate Campground to the highway may affect expansion proposals in an effort to protect these residences or a portion of the campground.

Key Question #6: How do conditions of the watershed affect the inventoried roadless areas?

The watershed's three inventoried roadless areas (see Figure 6-27) were first identified and evaluated during the 1970s' RARE II process and then as part of the Mt. Hood Land and Resource Management Plan (LRMP), completed in 1990. In 1984, the Oregon Wilderness Bill released these and other inventoried roadless areas throughout the state to non-wilderness uses. Final land allocation decisions for these areas were made as part of the forest land management planning process as identified in the National Forest Management Act. The LRMP identified non-wilderness land use allocations for these areas. Recently the Northwest Forest Plan has further amended these allocations to include Late Successional Reserves and Riparian Reserves. Current land allocations by inventoried roadless area within the watershed is summarized in Table 6-4.

Figure 6-27 - Roadless Areas Within The Watershed

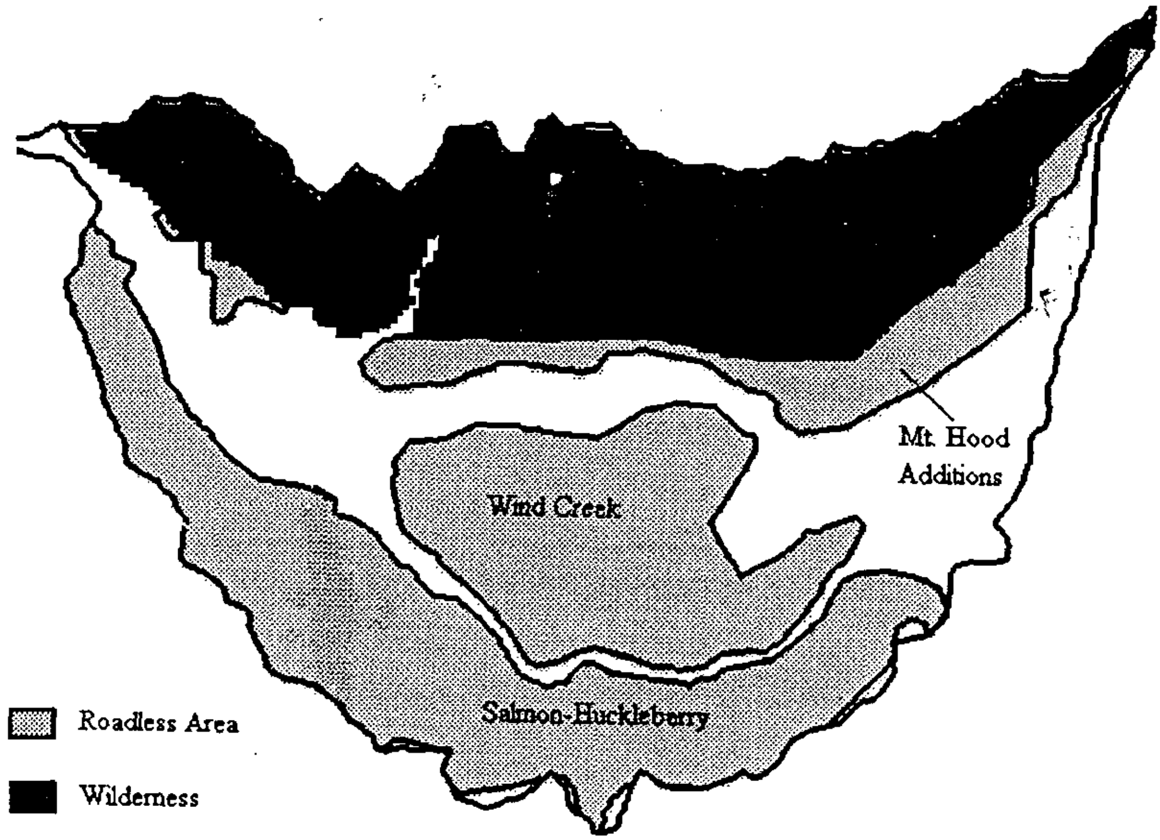


Table 6-4 -- Acres By Land Allocation Within Inventoried Roadless Areas within the Watershed

Land Allocation	Roadless area acres by land allocation			Total Acres
	Mt. Hood Additions	Wind Creek	Salmon-Huckleberry	
A-4 Special Interest Area	67			67
A-5 Unroaded Recreation		2,813	173	2,986
A-9 Key Site Riparian		47		47
A-11 Winter Recreation	1,079	131		1,210
B-2 Scenic Viewshed	853		847	1,700
B-3 Roaded Recreation			406	406
B-6 Special Emphasis Watershed		412	1,356	1,768
B-12 Back Country Lake			149	149
Late Successional Reserve			4,394	4,394
Riparian Reserve	811	2,031	961	3,803
Total	2,810	5,434	8,286	16,530

Roadless areas can be characterized not only by their physical lack of roads, but also by characteristics of their natural integrity, apparent naturalness as viewed by visitors to the area, remoteness, and opportunities for solitude and primitive recreation. Existing land allocations and their corresponding management goals and objectives are the conditions that have the greatest potential to affect characteristics within the inventoried roadless areas. Standards and guidelines for an allocation may allow a variety of management activities, including timber harvest, road building and recreational facility development to take place within an area. Depending upon the type and level of intensity of the management activity, it may have the potential to significantly affect roadless area characteristics.

The "A" allocations, Riparian Reserves and the Late Successional Reserve (LSR), are areas where no programmed timber harvest is scheduled. While timber harvest is not a planned output, it may occur within these allocations as a tool to accomplish the allocation's primary goals. While salvage harvest may be allowed, with the exception of Winter Recreation (A-11), no road construction for this harvest is permitted within the other "A" allocations.

Within the "B" allocations, the land is primarily managed for goals other than timber production. Timber production is still recognized as a secondary goal. In these allocations, programmed timber harvest is a planned output and may occur in the future.

Even with timber harvest in an area, roadless characteristics may still be retained to some degree, depending on silvicultural prescriptions, harvest intensity, and the type of logging system used. For example, use of selective harvest prescriptions, especially a light-intensity harvest, would have less impact to the roadless area characteristics than a heavier intensity regeneration harvest. Utilizing an aerial yarding system such as helicopters or long-span skyline for timber harvest could eliminate the need to construct access roads.

The landscape analysis and design (Chapter 5) describes the future vegetation pattern likely to result from the implementation of current land management direction. Design cells which maximize the amount of continuous late-seral forest have the greatest potential for retaining roadless characteristics. Those design cells in which larger openings are planned are areas where roadless characteristics would most likely be affected. Table 6-5 summarizes acres by design cell for each of the inventoried roadless areas.

Table 6-5 – Roadless Area Acres By Landscape Analysis Design Cell

Design Cell	Roadless area acres by design cell			Total Acres
	Mt. Hood Additions	Wind Creek	Salmon-Huckleberry	
Alpine	245			245
Continuous Mature Forest	778	2,071	5,528	8,377
Mature Forest - Occasional Openings	897	2,906		3,803
Mature Forest - Small Openings	848	15	1,154	2,017
Mature Forest - Variable Openings		410	1,359	1,769
Mature Forest - Ridgetop Openings			245	245
Developed	42	32		74
Total	2,810	5,434	8,286	16,530

The Continuous Mature Forest design cell will have the greatest potential for long-term retention of all roadless characteristics. The land allocations that are encompassed by this design cell are the LSR and Riparian Reserve allocations. This design cell makes comprises more than 50% of the inventoried roadless areas, with the greatest portion occurring in the Wind Creek and Salmon Huckleberry roadless areas.

Most roadless characteristics will also be retained within the Mature Forest/Occasional Openings design cell. Any effects on roadless characteristics will depend on size and location of the openings being made. The land allocations encompassed by this design cell are the A-5 Unroaded Recreation and the portion of A-11 Winter Recreation land allocations located outside developed ski area boundaries. The bulk of this design cell is the A-5 Unroaded Recreation land allocation within the Wind Creek Roadless Area. Road construction is not permitted in this allocation. Tree removal would be primarily limited to small openings for features such as trails for hiking, mountain bike and Nordic skiing, as well as for small openings to create vista points along these trails. Road construction is permitted within the design cell's A-11 Winter Recreation land allocation areas.

Some roadless characteristics may be retained in the Mature Forest/Small Openings design cell. Land allocations for the design cell include B-2 Scenic Viewshed, B-9 Backcountry Lakes, and part of the B-3 Roaded Recreation lands. Management direction for land allocations in these cells allows for creation of larger openings, as well as a greater potential for road construction than allowed in the previously described design cells. A greater potential exists for existing roadless characteristics to be affected within this cell than within the Mature Forest/Occasional Openings cell. The long-term landscape pattern in this design cell may include smaller openings covering up to 20% of the area.

The Mature Forest/Variable Opening and Mature Forest/Ridgetop Opening design cells include the B-6 Special Emphasis Watershed and part of the B-5 Roaded Recreation land allocations. These two cells have the greatest potential to affect roadless characteristics to the watershed's roadless areas. Management of these lands permits a greater number of openings than in previously designed cells. Road construction is permitted within these lands. The long-term landscape pattern in the Mature Forest/Ridgetop Opening cell may include human created openings up to 20 acres in size for over 50 % of the area. Long-term landscape pattern in the Mature Forest/Variable Opening design cell may include openings up to 60 acres in size for over 33% of the area. The presence of these openings would significantly affect the roadless character's remoteness and its appearance of a natural, undisturbed landscape. In addition, any associated road development would further affect the roadless character of these areas.

Slightly more than 2,500 acres of the eastern half of the Salmon Huckleberry Roadless Area currently shows a high level of spruce budworm defoliation in which many bare tree tops are visible (see Figure 6-28). Of this, 1,962 acres are within design cells in which land management allocation direction allows timber harvest (Mature Forest/Small Openings, Mature Forest/Variable Openings, and Mature Forest/Ridgetop Openings). Table 6-6 illustrates, by design cell, where high levels of spruce budworm defoliation have occurred. If salvage harvest is implemented to remove trees killed by the budworm infestation, roadless characteristics will be affected. The level of these effects to roadless characteristics will depend on harvest method, harvest intensity, and amount of roading necessary for salvage operations.

Figure 6-28 Roadless Area With Heavy Levels Of Spruce Budworm Infestation

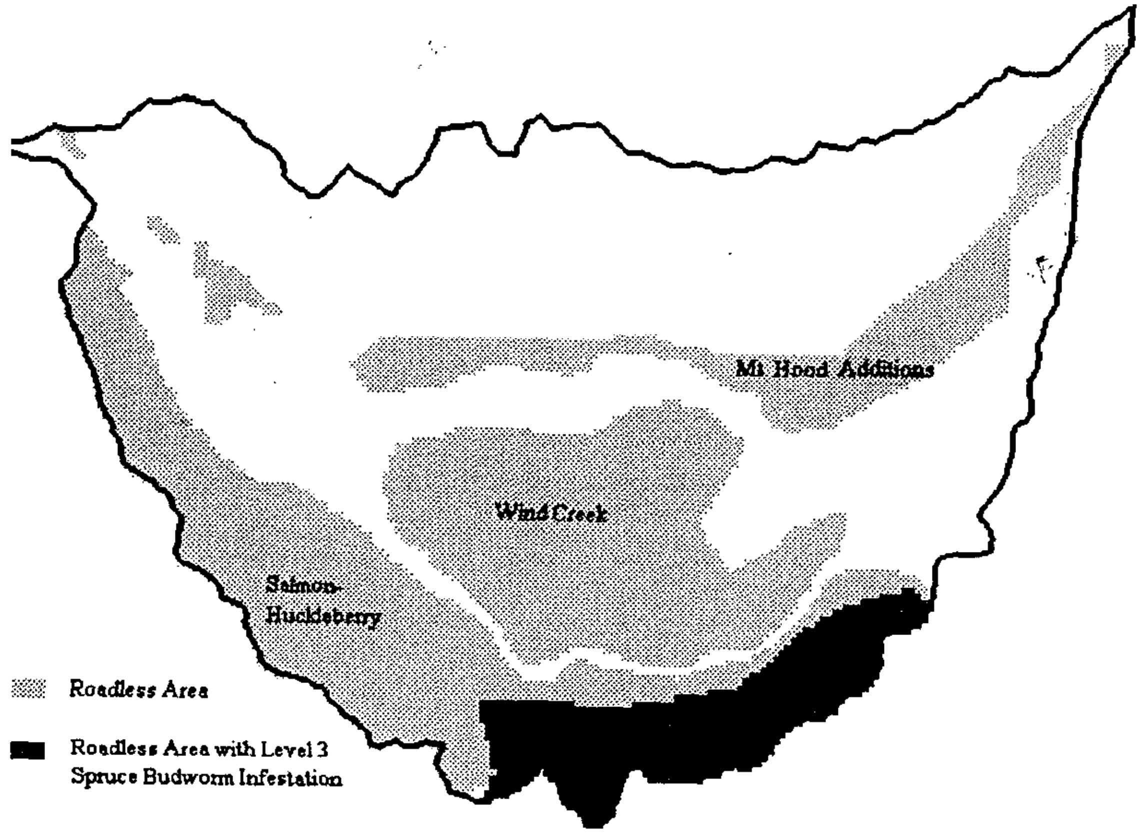


Table 6-6 -- Acres of Heavy Spruce Budworm Defoliation By Design Cell

Design Cell	Acres by design cell with heavy spruce budworm defoliation			Total Acres
	Mt. Hood Additions	Wind Creek	Salmon-Huckleberry	
Continuous Mature Forest			566	566
Mature Forest - Small Openings			966	966
Mature Forest - Ridgetop Openings			131	131
Mature Forest - Variable Openings			865	865
Total			2,528	2,528

Laminated root disease has also infected trees within roadless areas. A favored treatment strategy for reducing the spread of this disease requires harvesting trees within an infected area and replanting with disease resistant trees. The land allocations where this type of harvest would likely take place are represented by the Mature Forest/Small Openings and Mature Forest/Variable Openings design cells. Based on the information in Table 6-7, any harvest likely to affect roadless characteristics would be in the Mt. Hood Additions area within the Mature Forest/Small Openings design cell, or in a small area near the Wind Creek

Roadless Area. Similarly to the effects to roadless areas from the spruce budworm, effects to the roadless characteristics will depend on harvest method and number of trees to be removed.

Table 6-7 - Acres By Design Cell of Roadless Areas Infected With Laminated Rood Disease

Design Cell	Acres by design cell of laminated root disease			Total Acres
	Mt. Hood Additions	Wind Creek	Salmon-Huckleberry	
Continuous Mature Forest	175	170	343	688
Mature Forest - Occasional Openings	35	52		87
Mature Forest - Small Openings	460			460
Mature Forest - Variable Openings		25		25
Total	670	247	343	1,260

Chapter 7 - Recommendations

Chapter 7 - Recommendations

Introduction

This chapter will focus on guidance and recommendations for project-level planning and overall land management planning, based on the findings presented and discussed in previous chapters.

This chapter will present recommendations for:

- *Setting and refining Riparian Reserve boundaries*
- Late Successional Reserves
- Retention of B-5 Pileated and Pine Marten Areas
- Upper Still Creek Potential Restoration
- Restoration Strategy
- Monitoring Strategy
- Additional Management Considerations

Recommended Riparian Reserves

Riparian Reserves, a key element of the Aquatic Conservation Strategy (ACS), provide areas along streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis. Riparian Reserves are also important to the terrestrial ecosystem, serving as dispersal habitat for certain terrestrial species and connectivity corridors among ıate successional habitats.

To provide effective habitat connectivity within the watershed, as well as to address a variety of landscape level concerns, it is recommended that Riparian Reserve widths be consistent throughout the major vegetation zones. Delineating Riparian Reserves in this manner will eliminate small-scale variations, while ensuring larger-scale connectivity and function. Additionally, this method will facilitate administration and analysis.

The Zigzag Watershed Analysis recommends the following reserve widths by vegetation zone (Table 7-1). Assumptions for establishing the site potential tree height and the supporting documentation from the watershed analysis is also presented in this table. Final Riparian Reserve boundaries are prescribed during site specific analysis and through the National Environmental Protection Act (NEPA) decision-making process (ROD B-13).

Table 7-1 -- Recommended Riparian Reserve Widths

STREAM/RIPARIAN ZONE TYPE	WESTERN HEMLOCK ZONE	PACIFIC SILVER FIR ZONE	MOUNTAIN HEMLOCK ZONE
Fish bearing streams (2 site-potential tree heights)	420'/side 840' total	340'/side 680' total	300'/side 600' total
Non-fish bearing, permanently flowing streams (1 site-potential tree height)	210'/side 420' total	170'/side 340' total	150'/side 300' total
Seasonally flowing or intermittent streams (1 site potential tree height)	210'/side 420' total	170'/side 340' total	100'/side 200' total
Lakes and natural ponds (2 site potential tree heights)	420' surrounding	340' surrounding	300' surrounding
Wetlands (1 site-potential tree height)	210' surrounding	170' surrounding	150' surrounding
Unstable and potentially unstable areas (see note below) (1 site-potential tree height)	210' surrounding	170' surrounding	100' surrounding
Key Site Riparian	See comment below		

Key Site Riparian

Key Site Riparian designations of the LRMP are incorporated into the Riparian Reserve network. Seventy-two acres of Key Site Riparian, however, extend beyond the widths in Table 7-1. In such instances, these Riparian Reserve widths would be increased to include these additional acres.

Unstable and Potentially Unstable Lands

It is recommended that when unstable and potentially unstable lands are encountered, a geologist or soil scientist field verify the extent of instability. The Riparian Reserve width will begin at the edge of the instability. The analysis file includes tools to identify unstable conditions within the watershed that will trigger additional field investigation.

Supporting Documentation for Riparian Reserve Recommendations

Determination of Riparian Reserve Widths

Direction for designating Riparian Reserve widths is stated in the ROD (Standards and Guidelines, pages C-30 and C-31). Riparian Reserve widths are discussed in terms of site potential tree height, or a given slope distance -- whichever is greater. For the Zigzag Watershed, *measured* site-potential tree heights were used to delineate the recommended width as the measured heights reflect the greatest distance.

A site potential tree is defined as the average maximum height of the tallest dominant trees (200 years or older) for a given site class. Nancy Diaz, Mt. Hood NF Area Ecologist, compared two approaches to determine average maximum tree heights. The first approach averaged site indices and then determined the maximum height for the average site index. The second approach averaged actual heights of older site index quality trees measured on plots (with Douglas-fir used as the predominant species).

It was found that averaging site indices provided a significantly lower tree height than actually measured on the plots. This may be due to the productivity of the riparian zone. (Reference: Riparian Tree Height Information from Ecology Plots, Nancy Diaz, Mt. Hood National Forest.) The measured tree heights method yields a more applicable estimate of buffer width and will be used for both the Western Hemlock Zone and the Pacific Silver Fir Zone.

For the Mountain Hemlock Zone, the recommendation is to use slope distances from the ROD since there were too few plots measured in this zone to accurately ascertain average maximum tree height. It is also thought the smaller tree heights of higher elevation species would be best approximated by the ROD distances.

Based on this process, the site potential tree heights are listed in Table 7-2 below.

Table 7-2 -- Site Potential Tree Heights

WESTERN HEMLOCK ZONE	Douglas fir measured tree ht. 210'
PACIFIC SILVER FIR ZONE	Douglas fir measured tree ht. 170'
MOUNTAIN HEMLOCK ZONE	Limited measured data Use recommended widths (table 7-1)

Analysis of conditions and trends within the Zigzag Watershed reveals the processes and existing effects important to riparian habitat within the watershed. The discussion of Key Question #2 details watershed conditions with respect to the ACS objectives. Additional key questions identify terrestrial processes and functions supported by Riparian Reserves. Key points from these analyses that support the recommendation of consistent Riparian Reserve widths are summarized below. (For an extensive discussion of the analysis, consult the appropriate sections of this document.)

Structure and Function

Riparian areas within the watershed provide potential habitat for a number of plant species of concern, including vascular plants, bryophytes, lichens and fungi.

Riparian areas provide habitat for a number of wildlife species of concern, including harlequin duck and red-legged frog.

Riparian reserves are instrumental in maintaining appropriate water temperatures for species such as Cope's giant salamander.

Riparian Reserves are critical in the maintenance and recovery of habitat for aquatic species including coho salmon, spring chinook salmon, steelhead, cutthroat trout and rainbow trout.

At present, the amount of riparian forest in a late seral stage ranges from 2-20% by subwatershed. This is considerably below the historic condition which is thought to be near 80% of riparian forest in a late seral.

Large woody debris and pool levels across the watershed are below the Mt. Hood National Forest Land and Resource Management Plan (LRMP) and Columbia River Policy Implementation Guide/Salmon Summit (PIG) standards. Furthermore, large woody debris and pool levels across the watershed are also below, or are at the low end of the range of natural variation.

Pool volumes across the watershed are well below the natural condition, with the exception of Still and Camp creeks, where extensive rehabilitation activities have taken place.

The lower Zigzag river flows through unstable material in volcanic mudflow deposits.

A 1988 Oregon Department of Environmental Quality (DEQ) assessment indicates moderate problems with turbidity, sediment and stream structure for all streams surveyed in the watershed.

Repeated fires across much of the watershed have led to loss of snags, downed wood, and depleted soil nutrition. Increased demand may be placed upon the Riparian Reserves to offset these losses at the landscape scale.

Connectivity

The Zigzag Watershed is currently below the range of natural variation for late seral forest. This may place increased pressure on riparian habitats to serve as connectors of late seral patches, as well as emphasize the landscape level importance of any late seral forests currently existing within riparian areas.

Private lands are not subject to the ACS objectives. As a result, riparian areas on private lands may be afforded lesser protection than those on national forest lands. Concentrations of private lands, specifically within the communities of Rhododendron and Government Camp, may contribute to reduced connectivity of Riparian Reserves.

While road densities within the Zigzag Watershed are low, 44% of the road miles in the watershed are within 300 feet of stream channels. These roads run parallel to or cross major streams. Included in these calculations are 4.6 miles of Highway 26 and 10.8 miles of Still Creek Road (Forest Road #2612). Roads within riparian reserves effectively reduces connectivity for some terrestrial and aquatic species.

The wildlife habitat assessment for this watershed analysis assumed that Riparian Reserves provide -- and will continue to provide -- terrestrial connectivity throughout the watershed. This was assumed knowing that in some places, current Riparian Reserves have decreased canopy closure. With implementation of Riparian Reserve standards and guidelines, these conditions are expected to improve over time.

Current Conditions

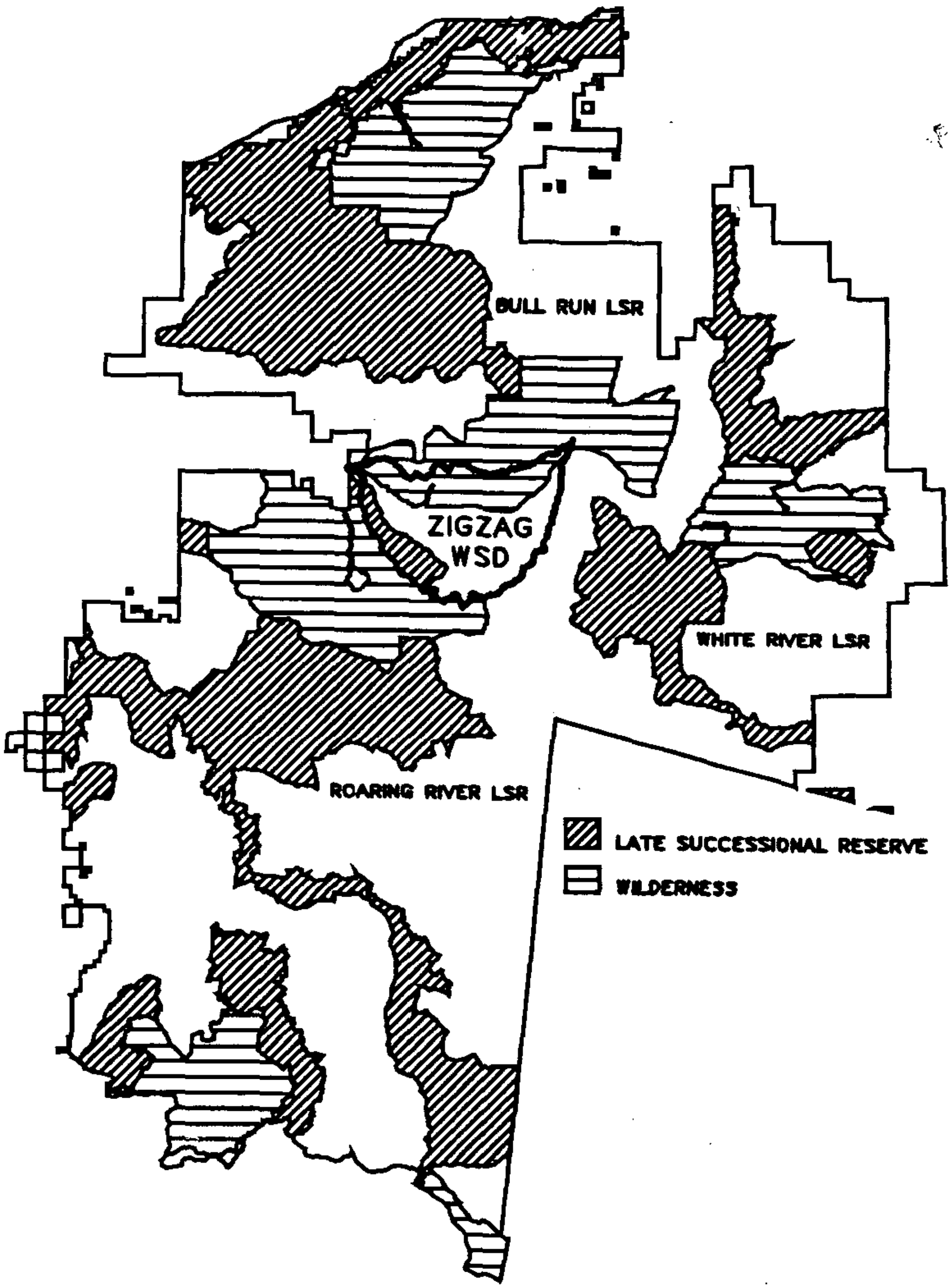
The standards and guidelines for Riparian Reserves are described in the ROD (pages C-31 through C38). In general, when current conditions within Riparian Reserves retard or prevent attainment of the Aquatic Conservation Strategy Objectives (see Key Question #8), efforts should be taken to modify or mitigate the detrimental conditions.

LSR Summary and Recommendations

The ROD states that "a management assessment should be prepared for each LSR (or group of smaller LSRs) before habitat manipulation activities are designed and implemented" (ROD C-11). A management assessment for the Still Creek LSR #R0205 will be scheduled in the future. The information derived from the Zigzag Watershed Analysis, and summarized in this chapter, is recommended to be carried forward in support of the overall LSR assessment.

Figure 7-1 on the following page shows the locations of all the mapped LSRs and wilderness areas within the Mt. Hood National Forest, including the location of the Still Creek LSR.

Figure 7-1 -- LSRs and Wilderness Areas on the Mt. Hood NF



Historic and Current Conditions/Trends

The Zigzag Watershed contains the Still Creek LSR (5,375 acres). The Still Creek LSR is adjacent to the Salmon-Huckleberry Wilderness with the Mt. Hood Wilderness to the north. The following table describes historic and current vegetative conditions within the Still Creek LSR.

Habitat	Historic (1944)	Current
Late-seral	25%	18%
Mid-seral	53%	78%
Early-seral	20%	3%
Non-vegetated	2%	1%

The table's historic reference is from the 1944 county survey database. Although still fairly recent, this database portrays the LSR prior to most management activities. Late seral habitat has decreased slightly, from 25% to 18%, due to a small amount of harvest of stands with laminated root disease in the Cool Creek area, as well as differences in data and methodology.

Mid seral stands have increased, from 53% to 78%, and early seral stands have respectively decreased, from 20% to 3%. This shift is mainly due to maturation of the early seral stands.

One owl pair is currently located within the LSR.

Effectiveness of Habitat

The FSEIS (USDA 1994) referenced the Interagency Scientific Committee (ISC) report model which showed that owl "clusters" of 15-30 owls (numbers varied depending on the assumptions for juvenile dispersal) could be expected to be "self-sustaining" or unlikely to disappear due to random demographic and environmental events. This finding led to the original impetus to draw Habitat Conservation Areas (HCAs), and later LSRs, in such a way that they encompass potential territories for 15 to 30 pairs of owls.

The above description is one measure to evaluate a fully functioning LSR. It is also appropriate to evaluate the biological status of other late seral associates inhabiting the LSR. The information available to evaluate the biological status of all late seral associates is however, extremely limited.

The Still Creek LSR currently supports one pair of spotted owls that have been located annually since 1981. This LSR would not likely support any more than one pair until more late seral habitat develops. Therefore the LSR is not meeting the criteria described above for a fully functioning LSR. However, the LSR itself is adjacent to the Salmon-Huckleberry Wilderness to the south, and near to the Mt. Hood Wilderness to the north. These wilderness areas can contribute to late seral habitat and increase the overall effectiveness of the LSR.

Another measure of effectiveness of LSRs is the percentage of late seral habitat. Intuitively, a fully functioning LSR should be largely late seral. As mentioned previously in this summary, the Still Creek LSR currently has only 18% late seral habitat, located mainly in the Cool Creek area. Most of the remaining stands are in even aged, mid seral stages. It is estimated it will take an additional 100 to 200 years to develop old growth habitat characteristics within these stands.

Silvicultural treatments for managed plantations and natural stands less than 80 years old may be applied to hasten the development of late seral structure. However, there are no natural stands within the LSR less than 80 years of age. There are three plantations, totaling 66 acres, all less than 10-years-old. Therefore, there are minimal opportunities to hasten stand development.

Furthermore, 18% of the LSR includes stands with laminated root disease. Laminated root disease is a disturbance agent that generally increases ecosystem diversity. It selectively kills susceptible conifers and thus provides growing space for less susceptible conifers as well as immune hardwoods and shrubs. The disease causes openings in stands, develops areas of unique stand structure, and contributes greatly to the presence of snags and downed woody debris. However, snags are inevitably windthrown. While these attributes are important for some wildlife species, laminated root disease will reduce the amount of late successional Douglas-fir and western hemlock habitat.

Connectivity

At the landscape level, the Zigzag Watershed has a low level of fragmentation and most of the watershed remains forested. There is a small amount of fragmentation within some land allocations. Overall, forested stands within the watershed provide good connectivity for terrestrial species.

Riparian Reserves are providing and will continue to provide terrestrial connectivity throughout the watershed. In some places, Riparian Reserves may have decreased canopy closure, yet these conditions should improve in the future. LSRs, the Mt. Hood Wilderness, Riparian Reserves, and other design cells that move the landscape towards late seral habitat will greatly enhance connectivity over time.

Connectivity is reduced by Highway 26 which essentially bisects the watershed. This affects wildlife in several ways. Habitat is fragmented and wildlife movement is affected by the risk of crossing the highway. Cut and fill slopes and cement median strips can also be impair animal movements.

Retention of Existing Late Seral Forest

Late seral forest for the Zigzag Watershed overall is currently at 7%. In watersheds with less than 15% late seral forest, all late seral patches should be retained, regardless of land allocations (ROD C-44). Protection of these stands could be modified when reserved areas have reached late successional conditions. Since the Zigzag Watershed is below the 15% standard, all late seral forest should be retained until the reserves mature. This standard affects 563 acres of late seral stands in B allocations, which allow some level of timber harvest. The remaining acreage is in reserved allocations.

Pileated Woodpecker And Pine Marten Area Recommendations

No retention is recommended for all of the B-5 areas within Matrix lands in the Zigzag Watershed.

Page C-3 of the ROD states: "Administratively Withdrawn Areas that are specified in current Forest Plans to benefit American martens, pileated woodpeckers, and other late-successional species are returned to the Matrix unless local knowledge indicates that other allocations and these standard and guidelines will not meet the objectives for these species."

A Forest-wide analysis was drafted (7/17/95) that assessed the relative importance of individual B-5 areas, based on their contribution to late-seral forest conditions at the watershed level. The analysis procedure first "screened out" any B5 area that was in reserved land allocations. The remaining areas were reviewed for their relative location to Northwest Forest Plan land allocations. B5 areas that were immediately adjacent to late successional reserves, Congressionally reserved areas, and administratively withdrawn areas, were screened out.

B5 areas that entered the next screen were assessed for their proximity to Riparian Reserves, specifically stream orders "3" and "4." This screen also focused on connectivity of the B5 areas to each other, and to other land allocations. The last screen captured existing knowledge at the field level.

At the watershed level, an analysis was completed that calculated the acreage of B5 areas outside of land allocations that allowed for late-seral habitat development. 207 acres of B5 areas are outside of reserved areas in the Zigzag Watershed. Those 207 acres were then reviewed for: the amount and distribution of late-seral habitat in the watershed; quality of late-seral habitat within the watershed; and proximity to Riparian Reserves.

The Forest-wide analysis recommended that all B5 areas within Matrix in the Zigzag Watershed be returned to the Matrix. District biologists have concurred with that recommendation.

Upper Still Creek Potential Restoration

In Key Question #4, disturbance processes in the upper portion of the Still Creek subwatershed were addressed in relation to land allocations and commodity withdrawals. The larger scale issue of forest health restoration within the Still Creek subwatershed was not fully addressed or synthesized. In contrast to commodity withdrawal, forest health restoration could address secondary goals of many of the land allocations where maintenance of a healthy forest condition is a secondary goal. A useful formula for evaluating forest health at the landscape scale is given by Kolb et al in the article "Concepts of Forest Health" (Kolb et al, 1994). (The analysis file contains a summary of standards and guidelines for timber management opportunities by land allocation within the watershed).

The following watershed specific factors would be considered in addressing restoration of forest health at the landscape scale:

- soil suitability
- insect infestation of western spruce budworm and Douglas-fir beetle
- offsite plantations
- site productivity
- risk of current fire
- past fire history
- hydrologic regime

A path to fully answer this Key Question is described below:

1. Determine the natural range of variation for the applicable disturbance processes.

2. Evaluate these disturbance processes, either individually or combined, at the landscape scale in relation to the range of natural variation. These processes are evaluated independently of land allocations.

3. If the disturbances are outside the range of natural variation, determine how to return to within the range. Again, this step is performed independently of land allocation.

4. Determine what is the natural rate of recovery for these processes.

5. Next, compare the land allocation designations with how to return to the range of natural variability (step 3).

6. Finally, compare active management of the ecosystem (how to return to within the range of variability) with passive management or letting the system recover on its own.

Restoration Opportunities

Introduction

Guidance for assembling this section came from: the Aquatic Conservation and Late Successional Reserve strategies in the ROD; the Interagency Watershed Restoration Strategy (Regional Ecosystem Office, October, 1994); and analysis of the current watershed condition and trends. The current vegetative condition and the conceptual landscape design assisted in the development of restoration objectives designed to hasten the attainment of desired vegetative structure.

Restoration projects are based on objectives resulting from altered landscape processes. To assist with project prioritization, primary restoration needs were selected from those projects that were tied to standards and guidelines for Riparian and Late Successional Reserves, and those that would benefit species of concern identified in the watershed analysis.

Secondary restoration needs were selected to move the watershed towards the objectives described by the conceptual landscape design. **(Restoration projects that are expected to have the greatest immediate resource benefit are noted with an asterisk (*) in the right hand columns of Table 7-3 and Table 7-4 on the following pages.)**

Table 7-3 -- Zigzag Watershed Primary Restoration Opportunities

Altered Process	Restoration Objective	Restoration Projects	Emphasis Areas	*
Increased peakflows from increase in stream drainage network	Restore peakflows to range of natural variation, or minimize increases in peak streamflows due to management activities	Reduce the number of road crossings over streams so the increase in the stream drainage network is less than 10% over undisturbed conditions. Replace culverts to accommodate 100 year flood (RR S&G RF-4, ROD p. C-33)	Still Creek and Henry/Zigzag subwatersheds	*
Reduced vegetative and hydrologic connectivity between streams and wetlands	Restore the timing, variability, and duration of floodplain inundation and water table elevation in floodplains and wetlands	Reconnect and restore side channel habitats Rehabilitate disturbed areas Enhance connectivity between disjunct wetlands and streams Riparian plantings and silviculture	Side channels of Zigzag River, Camp Creek, Still Creek and in Summit Meadows and Multorpor Fen	*
Pool volume is outside RNV	Increase pool volume towards the RNV	Increase pool levels through large woody debris placement to move within the RNV	Zigzag River	*
Reduction in side channel habitat effectiveness	Improve side channel function	Reconnect and restore side channels Increase side channel quality by incorporating large woody debris	Zigzag River subwatershed Enhance in Zigzag River, Camp Creek and Still Creek subwatersheds.	*
Reduction in historical range of anadromous and resident fish	Restore fish migration to historical range	Replace barrier culverts with non-barrier culverts	Little Zigzag River, Still Creek, Henry Creek, and Lady Creek	*
Woody debris levels outside RNV	Increase woody debris levels	Move woody debris within the RNV by importing woody debris	Zigzag and Little Zigzag Rivers	*

Altered Process	Restoration Objective	Restoration Projects	Emphasis Areas	*
Existing stand structure is outside the RNV in Riparian Reserves.	Restore structural complexity of riparian vegetation.	Riparian plantings Activities to promote natural regeneration Riparian silviculture	Anadromous reaches of Still Creek, Camp Creek and Zigzag River	
Altered stand structure	Increase diversity of stand structure to promote late seral habitat and snags	Consider prescribed fire or prescribed natural fire in development of wilderness fire plan	Mt. Hood Wilderness	
Late seral forest habitat below RNV	Restore late seral habitat to promote viability of late seral species	Silvicultural treatments in natural and managed stands to advance late successional structure (multi-storied canopy, snags, and LWD)	Mature Forest/ Occasional Openings, Mature Forest/ Ridgetop Openings and Mature Forest/ Variable Openings design cells	
Altered genetic composition from non-local seed sources	Remove non-local seed sources	Gradual replacement of non-local stands/stocks Prioritize sites for harvest	Still Creek, Zigzag Burn area. See offsite stand map, page 4-28	
Reduced biodiversity through introduction of noxious weeds and invasive, non-native plants	Secure viability and distribution of native plants; reduce noxious weed and invasive non-native plant populations	Remove noxious weeds and invasive non-native plant populations. Prevent conditions that would encourage establishment of new populations Collect and propagate native plant materials	Recreation residences, along US 26, Laurel Hill Quarry, ski runs, and adjacent to developed communities.	*
Altered vegetation structure and composition adjacent to high mountain lakes	Restore vegetation and habitat characteristics of shorelines	Exclude users from sensitive areas Plantings Site decompaction	Mirror Lake Veda Lake Enid Lake	*

Altered Process	Restoration Objective	Restoration Projects	Emphasis Areas	*
Altered sediment regime	Reduce sediment production and delivery to stream channels from roads, highway sanding and other ground disturbing activities.	Install barriers to trap and contain highway sand.	Highway 26.	*
		Road obliteration and re-vegetation	Henry/Zigzag, Camp creek and Still Creek subwatersheds.	*
		Re-vegetation of road cuts and fills	Highway 26	*
		Replace culverts to accommodate 100 year flood (RR S&G RF-4, ROD p. C-33)	Road 2612	*

Table 7-4 – Zigzag Watershed Secondary Restoration Opportunities

Altered Process	Restoration Objective	Restoration Projects	Emphasis Areas	*
Reduced biodiversity of fish stocks	Reduce competition and interaction between native and non-native fish species	Work in cooperation with ODFW to enhance native coho, chinook and cutthroat stocks	Portion of the watershed where non-native fish are stocked. Includes Hidden, Mirror, Devils, Veda, and Collins Lake and Camp Creek.	
Reduced fisheries habitat effectiveness (migration, human disturbance, species movement(	Increase habitat effectiveness	Decrease fishing pressures in key habitat through angler education on conservation needs and goals Limit access points to river	Anadromous reaches	

Altered Process	Restoration Objective	Restoration Projects	Emphasis Areas	*
Altered stand structure has increased the risk of catastrophic fire	Reduce stand susceptibility to fire or effects from fire. Restore vigorous stand health by reducing stand densities and off site trees - promote species and age class diversity	Salvage standing dead trees or severely defoliated trees, (while leaving some of appropriate size for snags) Gradual replacement of off-site plantings with other species Stand density reduction	Upper Still Creek	
Altered forest structure and composition has resulted in loss of snag habitat	Increase in snag levels of appropriate size	Creation of snags by girdling, topping, prescribed fire or other means. Nesting boxes around lakes and other critical areas	Previously burned areas and adjacent to managed stands with low snag levels. In created openings to provide habitat for mountain bluebird. Adjacent to lake sites where necessary	*
Terrestrial down woody debris levels are below RNV	Increase down woody debris, to increase substrate for clubmoss and amphibians	Enhance late seral habitat Incorporate down woody debris	Still Creek	
Reduced wildlife habitat effectiveness (migration, human disturbance, species movement)	Reduce influence of human presence on wildlife sensitive to human disturbance (deer and elk).	Decrease road density to within Mt. Hood LRMP standards.	Camp Creek and Henry/Zigzag subwatersheds.	*
Reduction in traditional areas available for huckleberry production	Increase acreage of huckleberry production in traditional use areas	Create additional openings and manage for huckleberry production	Mature Forest, Ridgetop Openings design cells	
Degradation of historically significant cultural sites	Protect and preserve historically significant sites	Recreation site management around important areas to reduce impacts, i.e. barriers, closures	Summit Meadows area Barlow Road Historic District	*

Altered Process	Restoration Objective	Restoration Projects	Emphasis Areas	*
Disturbance of vegetation and soils in alpine plant community	Reduce erosion, encourage native plant re-establishment	Native plantings	Timberline ski area and campsites and trails within the wilderness.	
Decrease in organic matter and altered site productivity	Restore and maintain organics and nutrients, duff and litter layer	Conservation of on-site organic matter (woody debris, litter and duff). Underplant alders	Still Creek and other areas with repeated burns. See composite fire map, page 4-15.	
Altered zooplankton populations at Devils Lake	Restore natural species diversity and population levels	Reduce non-native fish stocks	Devils Lake	
Altered sediment regime	Reduce sediment production and delivery to stream channels from campsites, quarries and other sites..	Discourage recreational use at erosive sites; concentrate use at less erosive sites; harden surfaces at areas of concentration Provide effective drainage protection and erosion control at quarry sites and waste area storage sites	Camp creek and Still creek developed and dispersed campsites. Laurel Hill and Tupper quarries; road 2612 waste sites.	

Monitoring

The purpose of this section is to identify monitoring opportunities associated with key processes and functions within the watershed. The processes and functions identified are critical to maintaining or restoring the key attributes. Monitoring within this section falls into two broad categories: 1) baseline monitoring to assesses the current condition prior to implementation of the NW Forest Plan, and 2) implementation and effectiveness monitoring associated with implementation of the NW Forest Plan (which includes restoration projects identified in this document).

Table 7-5 - Monitoring Recommendations

PROCESS OR FUNCTION	MONITORING QUESTION	MONITORING OPPORTUNITY	EMPHASIS AREAS
Native plants and wildlife habitat	Are noxious weeds and invasive non-native species invading disturbed sites within the watershed	Monitor for noxious weeds and invasive non-native plants	Recreation Residence tracts and Hwy 26
Plant and wildlife species of concern	What is the status of C-3 and other species of concern in the watershed?	Survey and manage as per protocol (See also botany recommendations in the analysis file)	Potential habitats of individual species
Riparian reserves	Are riparian reserve widths being implemented according to recommendations in this analysis and site specific circumstances?	Monitor implementation of riparian reserves.	Project areas where disturbance to the riparian reserve may occur.
Sediment transport and deposition	What is the impact of road related sediment delivery on aquatic habitat conditions?	Particle size distribution above and below road and hwy. crossings, depositional stream reaches	Depositional reaches in Camp Creek, Still Creek, and lower Zigzag river.
In-channel fine sediment	Do levels of fine sediment in pool tail crests meet Forest Plan Standards?	Pebble counts in pool tail crests to establish fine sediment levels	Still Creek and Camp Creek
Peak Streamflows	Is there a trend in peak streamflows in the Zigzag River ?	Trend analysis on data from the Zigzag River streamflow gauge	Zigzag River

PROCESS OR FUNCTION	MONITORING QUESTION	MONITORING OPPORTUNITY	EMPHASIS AREAS
Peak Streamflows	Is there a change in magnitude of peak streamflows in the Still Creek Watershed associated with stream drainage network expansion?	Establish a crest stage gauge near the mouth of Still Creek	Still Creek
Baseflows	What is the effect of water withdrawals on baseflows in the Camp Creek subwatershed	Establish a stream gauge in the Camp Creek subwatershed	Camp Creek
Water quality: fecal contamination	Are periodic high concentration/low duration fecal coliform discharges from the Government Camp sewage treatment plant having an effect on aquatic habitat in Camp creek?	Macroinvertebrate monitoring	Camp creek
Water quality: fecal contamination	Are septic systems associated with the Recreational Residences effective at preventing fecal contamination of nearby streams?	Stratified sampling program for enterococcus bacteria	Still creek, Camp creek, and Zigzag river.
Water quality: sodium and chloride	Are there effects to water quality from Palmer snowfield salting?	Continuous conductivity and flow measurements	Upper Still Creek
Fish viability species of concern	What is the distribution of sea-run cutthroat trout in the watershed?	Survey for presence and distribution of sea-run cutthroat trout in the watershed	
Fish viability species of concern	Are native summer steelhead stocks present in the Zigzag watershed?	Survey for native summer run steelhead	Still Creek
Fish viability species of concern	Is bull trout present in the watershed?	Survey for presence and distribution of bull trout	Bull trout habitat areas
Fish Viability Species of Concern	Are there areas of genetically isolated populations of cutthroat or rainbow trout?	Survey for presence and distribution of cutthroat and rainbow trout in areas that have not been stocked with rainbow trout	
Fish Viability Introduced Stocks	What areas have been affected by brook trout?	Survey for the presence and distribution of brook trout	

PROCESS OR FUNCTION	MONITORING QUESTION	MONITORING OPPORTUNITY	EMPHASIS AREAS
Fish population species of concern	What is the status of smolt populations in Still Creek	Operate smolt trap to quantify native populations of coho salmon and steelhead	Still Creek
Recreation supply and demand	What is the demand for semi-primitive recreation within the watershed? Is the watershed meeting the demand for semi-primitive recreation?	Evaluate suppiy/demand opportunities and limitations	
Water quality and quantity	What is the affect of water quality/quantity on populations of Bog Clubmoss?		Camp creek, Multorpor Fen

Data and Analysis Gaps

Data and analysis gaps were noted in the analysis when a key process could not be addressed adequately to fully answer the key question. Data gaps were identified as missing or incomplete information needed to assess a process or concern. Analysis gaps were analyses that were not completed due to time; money, resource or data constraints. In the process of implementing ecosystem management it would be appropriate for the districts or forest to address these data and information gaps.

Table 7-6 - Data and Analysis Gaps

PROCESS	DATA GAP	ANALYSIS GAP
C-3 plant and animal population viability	Documented C-3 locations were due from REO in June 1995 may include some new locations.	
Late seral habitat distribution		Field verify late seral habitat from vegetation data layer
Wildlife habitat effectiveness		Calculate road densities within inventoried winter range
Ecology of ground cedar	Determine the role of ground disturbance (including fire) in the maintenance of ground cedar populations.	
Wetland hydrology		Evaluate the role of Collins pond in the maintenance of water quality and quantity in Multorpor fen.
Fire processes		Use of fire in Wilderness to promote late seral forest and also to restore natural processes before fire suppression.
Fire processes		Further refinement and field verification of fire regimes
Erosional processes	Establish range of natural variability for geologic rates of surface erosion and mass wasting	
Soil productivity	Soil limitations and capabilities in areas proposed for management.	
Slope stability	Location and extent of unstable and potentially unstable riparian reserves	
Sediment production	Field validation of erosion potential on disturbed sites	
Commodity production		Acres and volume available for timber harvest by decade

PROCESS	DATA GAP	ANALYSIS GAP
Special forest products gathering		Effects to C-3 species and species of concern
Fish Viability Species of Concern		Quantitative population viability modeling for: native stock winter steelhead, wild spawning stock chinook salmon, and wild spawning stock coho salmon
Fish Viability Species of Concern		Effects of wild spawning introduced steelhead on native stocks Effects of introduced stocks of rainbow trout on native rainbow and cutthroat trout
Wildlife population viability	Evaluate biological status of late seral associates other than northern spotted owl	
Presence and population viability of redband and bull trout	Presence, numbers and distribution of redband and bull trout	Quantitative viability modeling for redband and bull trout
Presence of exotic fish species (brook trout)	Presence, numbers and distribution of brook trout	
Presence of unique stock of cutthroat trout	Assess genetics of cutthroat trout	
Lake ecology		Effects of introduced brook trout on lake ecosystem
Stream channel stability	Areas of unstable Rosgen stream types in mudflow deposits that have been channelized	
Fish habitat: pool levels and large woody debris		Establish range of natural variation for pools and large woody debris for the Sandy subbasin (based on unmanaged watersheds and historical data)
Peak streamflows	Peakflow information for Still and Camp creeks	
Baseflows	Baseflow information for Camp Creek	
Aquatic species habitat: in-channel fine sediment	Particle size distribution for depositional reaches, storm and "first flush": data for turbidity and/or suspended solids	Sediment fluctuations associated with management activities
Fish Habitat Water Quality		Determine importance of nutrients associated with salmon carcasses with the Zigzag Watershed
Aquatic Ecosystem Water Quality	Literature search for the most current data on the effects of sodium and/or chloride concentrations on aquatic organisms	

PROCESS	DATA GAP	ANALYSIS GAP
Landscape Structure		Interim Landscape Analysis and Design steps
Public use and demand	Actual level of public use in the watershed for fishing and other recreational uses.	
Historic human use		Detailed analysis of prehistoric and historic human use in the watershed, especially within Recreation Residence tracts.

Additional Management Recommendations

Develop a comprehensive management strategy and vegetation plan for treatment of laminated root disease within the watershed. Strategy should address meeting Northwest Forest Plan standards, safety concerns, and reducing the spread of laminated root disease. Principle areas of concern within the watershed include the recreation residence tracts, organization camps and areas adjacent to highway 26.

Complete a review of Recreation Residences prior to permit renewal or reissuance. The review should include and evaluation of consistency with ROD standards and guidelines.

Complete a thematic heritage resource evaluation of the Recreation Residence tracts to determine historic significance of the tracts and their individual buildings.

Survey and monitor use of laminated root disease snags for wildlife occupancy and duration.

Develop additional guidance for the management of vegetation in the Recreation Residences tract. The guidance should address Northwest Forest Plan objectives (e.g. aquatic conservation strategy objectives) hazard tree removal and fire protection.

Develop guidance for road maintenance standards within recreation residence tracts.

Complete interim Landscape Analysis and Design (LAD) steps, defining opportunities and constraints, describing the recommended landscape pattern and infrastructure and developing an access and travel management plan. Evaluate different management strategies utilizing a modeling system such as the Scheduling and Network Analysis Program (SNAP) system.

Chapter 8 - References

Chapter 8 - References

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Chapter 9 - Preparers And Persons Consulted

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