SILVER CREEK WATERSHED

Ecosystem Analysis at the Watershed Scale

Fremont National Forest
Silver Lake Ranger District

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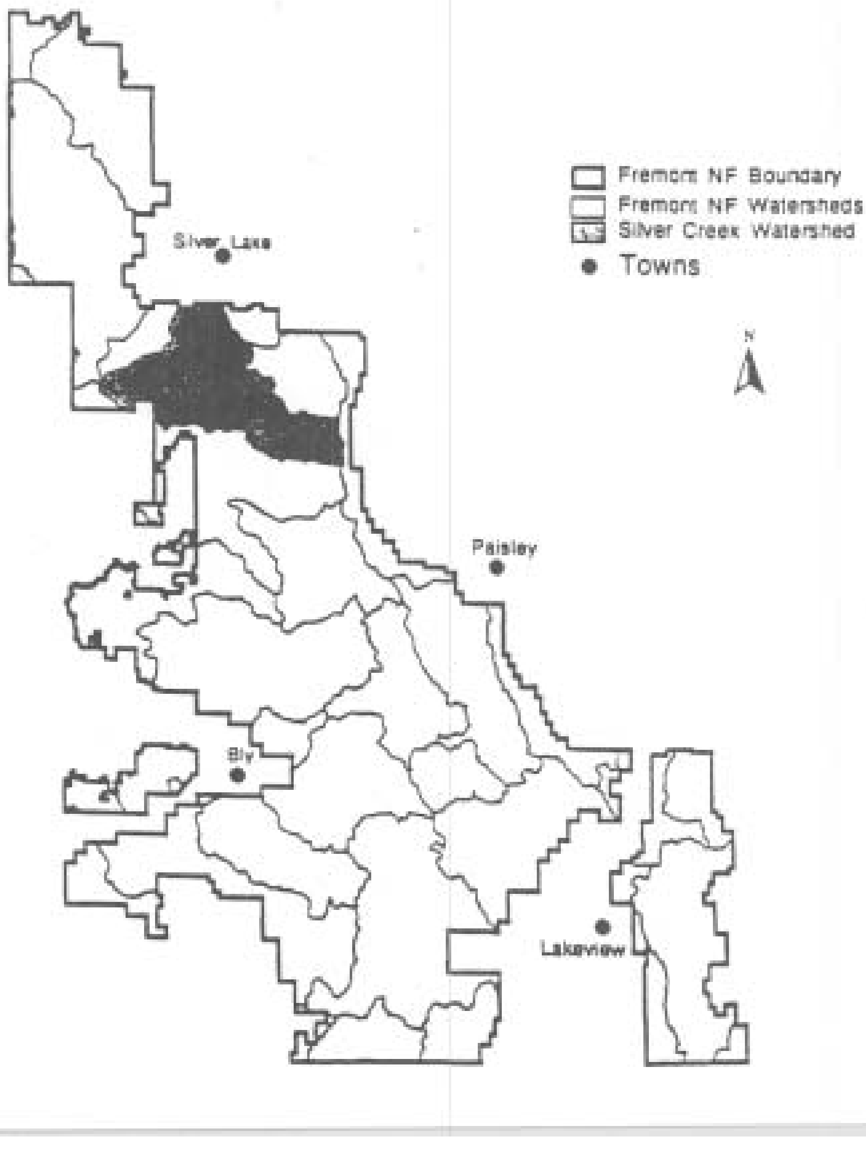

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ECOSYSTEM ANALYSIS at the WATERSHED SCALE

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INTRODUCTION AND DESCRIPTION OF THE WATERSHED

INTRODUCTION

There are seven subsheds within the Silver Creek Watershed on the Silver Lake Ranger District of the Fremont National Forest. This document reports the findings of the Interdisciplinary Team (ID Team) and summarizes that information for this report. This is not a decision document, nor does it make changes in land allocation or select specific projects to be implemented. However, this analysis will be useful for future analysis that will lead to site-specific project implementation. It is an interim step between the Fremont National Forest Land and Resource Management Plan (Forest Plan-1989) and the project level.

The analysis began in 1994 by District ID Team members who studied the present conditions of the Silver Creek Watershed. This document presents a current understanding of the processes and interactions of concern occurring within the Silver Creek Watershed by the Headquarters Core ID Team. It is the goal of the Forest to have healthy forest ecosystems which provide sustainable and beneficial uses to the public. Watershed analysis looks at the ecosystem as a whole and not just the individual parts. This analysis provides a logical way to learn more about how ecological systems function within the watershed by incorporating knowledge specific to the watershed into the planning process. It is intended to help the Forest gain a better understanding of how past land-use activities interact with the physical and biological environments in the watershed. This information is essential to protect and sustain the beneficial uses and to protect the natural systems occurring within the watershed.

This analysis was conducted by a five member core-team from the Supervisors Office consisting of a soil scientist, hydrologist, wildlife biologist, silviculturist, archaeologist, with assessment data provided by Ranger District specialists. The team followed the six step process as outlined in the "Ecosystem Analysis at the Watershed Scale-Federal Guide for Watershed Analysis". This six step process includes: Characterization of the Watershed, Identification of Issues and Key Questions, Description of Current Conditions, Description of Reference Conditions, Synthesis and Interpretation of Information, and Management Recommendations. Each of these steps are further evaluated in relationship to seven core topics which include: Erosion Processes, Hydrology, Vegetation, Stream Channel, Water Quality, Terrestrial and Aquatic-Species and Habitats, and Human Uses.

The Silver Lake Ranger District will use this analysis to select specific projects that will move the watershed toward the desired condition described in the Forest Plan. These projects will then be addressed through separate analysis conducted on a project-by-project basis by a Silver Lake Ranger District ID Team. The project analysis process will include involvement by the general public and result in a site specific decision as required by NEPA.

DESCRIPTION OF THE WATERSHED AREA

General Watershed Area

This watershed is within the Basin and Range Physiographic Province which is characterized by fault-block mountains enclosing basins with internal drainages. Silver Creek flows into Paulina Marsh, one of the most northwestward playas of the Basin and Range Province, about four miles north of the watershed boundary.

The seven subsheds in the Silver Creek Watershed include: West Fork Silver Creek, Guyer Creek, Indian Creek, Squaw Creek, Benny Creek, Silver Creek, and Thompson Reservoir (Reference to "Z" includes those local unnamed drainages which flow into Thompson Reservoir). The watershed encompasses approximately 108,278 acres and is located four miles south of the Town of Silver Lake. The Silver Creek Watershed includes all the area drained by Silver Creek and its tributaries, up to and including the confluence with the West Fork Silver Creek. Elevations range from 4,200 feet on the extreme north end to 7,500 feet near Yamsay Mountain.

The western portion of the watershed flows generally east from a 7,500 feet un-named ridge ("one ridge east" of Yamsay Mountain/Buck Ridge), while the eastern portion flows generally west from the gentle sloping basalt uplands of Winter Rim which rises to 7,200 feet. Thompson Reservoir is located within the south central portion of the watershed where streamflow is generally north.

Approximately 83,898 acres (77%) of the watershed is managed by the Forest Service, approximately 3,500 acres (3%) is managed by the BLM, and about 20,880 or (20%) are owned by private interests; primarily U.S. Timberlands, Roseburg Lumber, and the Silver Lake Irrigation District. The watershed is within Lake County and a small portion is within the Lakeview Federal Sustained Yield Unit.

The seven subsheds are made up of the following square miles:

	Total Area Square Miles	National Forest Square Miles	Private or Other Jurisdiction Square Miles
West Fork Silver Creek	23.9	20.9	3.0
Guyer Creek	13.8	9.7	4.1
Indian Creek	41.2	27.6	13.6
Squaw Creek	19.1	14.0	5.1
Benny Creek	10.6	9.6	1.0
Silver Creek	31.3	30.9	.4
Thompson Reservoir	17.5	16.0	1.5
	157.4	128.7	28.7

The watershed consists of eight Management Areas (MA's). The following table shows acreages and management area emphasis (see Management Area Map this section for ownership. MA 15 is not shown on the map because of map scale and the small areas involved:

FOREST SERVICE LANDS

MA	ACRES	EMPHASIS
1	2,767	Mule Deer Forage and Cover on Winter Range
3&14	9,945	Old-growth Habitat for Dependent Species Above the Management Requirement Level
5	53,505	Timber and Range Production
6A&B	7,592	Visual Corridors
8C	262	Research Natural Area
9B	539	Semiprimitive Recreation
15	9,288	Fish and Wildlife Habitat and Water Quality
	83,898	

CLIMATE

The area is located in the semiarid rain shadow east of the Cascade Mountains. The heaviest precipitation comes during November, December, and January (10% to 12% of the annual total for each of the 3 months), and is snow-dominated. The other 9 months exhibit a fairly even distribution of precipitation, ranging from 9% of the annual total for each of the spring months to 6% for each of the summer months. Spring precipitation is usually associated with frontal systems while intense localized thunderstorms typify summer precipitation. Average annual precipitation varies by elevation and ranges from about 13 inches near the confluence of West Fork Silver Creek and Silver Creek, at the low point of the watershed, to over 35 inches on the 7,500 foot un-named ridge. The 24 hour 25 year precipitation intensity, according to the National Oceanographic and Atmospheric Agency (NOAA), Atlas 2, ranges between 2.40 and 2.80 inches.

Precipitation records taken in Silver Lake, Oregon, indicate that the average from 1969 through 1993 is just over 9 inches. The precipitation ranges from 5.7 to 14.2 inches.

Temperatures also vary widely, both seasonally and by elevation. Summer highs are near 100°F in the lower elevations and winter lows are well below 0°F at any elevation. Freezing temperatures can occur any time of the year, especially in cold air basins and at high elevations. Higher elevation areas have a progressively shorter growing season, especially above 6,500 feet, where ponderosa pine becomes less common.

GEOLOGY

A rocks mineral composition, resistance to weathering, and age dictate the amount and type of soil that develops. The most common bedrock in the Silver Creek Watershed is basalt which contains high calcic plagioclase feldspars and pyroxene. It may or may not contain olivine. This hard rock slowly weathers mechanically into rubble, boulders, cobbles, pebbles, sand, silt, and clay. Basalt, the hardest rock present in the Silver Creek Watershed, decomposes the slowest, followed by andesite, diorite, rhyolite, and tuff. All but Guyer Creek and Indian Creek subsheds have basltic rock as the most commonly occurring bedrock. Indian Creek is most commonly (47%) underlain by Tertiary vent and near vent silicic bedrock. Such rock weathers at a faster rate than the basalt which underlies West Fork Silver Creek, Squaw Creek, Benny Creek, "Z", and Lower Silver Creek subsheds. Guyer Creek is most commonly (48%) underlain by Tertiary ash flow tuff. Such rock weathers at a faster rate than the near vent silicic rock which occurs widely in the neighboring Indian Creek subshed.

Underlying bedrock is often the parent material for the soils present at a given site. A major exception to that condition is in areas where Mazama ash has been deposited over the bedrock and the residual soils which had developed from the underlying bedrock. Such areas occur widely in the West Fork Silver Creek, Guyer Creek, and Indian Creek Subsheds.

The following table shows bedrock geology for the Silver Creek Watershed, by subshed. A map showing bedrock geology of the watershed is on file at the Ranger District Office:

BEDROCK GEOLOGY OF THE SILVER CREEK WATERSHED

Subshed---> Acres--->	W.Fk. 24000	Guyer 11557	Indian 8835	Squaw 12408	Benny 26390	Z 8814	Silv. 16274	TOTAL 108278
	Ac %	Ac %	Ac %	Ac %	Ac %	Ac %	Ac %	Ac %
QUATERNARY								
Qs Sedimentary		1093 9%	1811 21%	138 1%		1786 20%	137 1%	4965 5%
Qf Flows & breccia			532 6%			1608 18%		2140 2%
QUATERNARY-TERTIARY								
QTp Pyroclastics of basalt cinder cones				306 3%	166 1%			472 tr.
QTs Sedimentary							472 3%	472 tr.
TERTIARY								
Tb Olivine basalt	1484 6%	677 6%	1370 16%	3568 29%	14393 54%	2104 24%	4630 28%	28226 26%
Tob Older basalt	12545 52%	1912 17%	276 3%	4824 39%	11428 43%	401 5%	6233 38%	37619 35%
Tvm Basalt/andesite of strato volcanoes or lava cones				2728 22%	147 1%	292 3%	572 4%	3739 3%
Tvs Vent & near-vent silicic rocks		2048 18%	4190 47%			128 1%	2892 18%	9258 9%
Tat Ash flow tuff	7034 29%	5523 48%	550 6%			51 1%	546 3%	13704 13%
Tp Pyroclastics of basalt cinder cones	106 1%	246 2%	106 1%	179 1%		79 1%	751 5%	1467 1%
Ts Sedimentary				664 5%	250 1%	567 6%		1481 1%
Trh Ryolite/dacite flows & ash flow tuffs	2828 12%							2828 3%
Tps Subaqueous deposits of palogonitized basaltic ejecta						73 1%	41 tr.	114 tr.
Tc Clastic rocks & flows						47 1%		47 tr.

The youngest rocks listed above are the Quaternary alluvial deposits of the Thompson Valley/Lower Indian Creek area (Qs). The oldest bedrock are the Tertiary basalts of the early (Lower) Pliocene Epoch. These are prominent in the Squaw and Benny Creek subsheds. The youngest rock (though not bedrock) in the watershed is the pumice layer from the eruption of Mt. Mazama 6,500 years ago. As shown in following sections of this document, this pumice is the parent material for the "Group 5" soils and landtypes which occur widely in the West Fork Silver Creek, Guyer Creek, and Indian Creek subsheds.

An Abbreviated Geologic Time Scale:

Cenozoic Era	Quatenary	Holocene Epoch (recent)	
		Pleistocene Epoch	
			1,000,000 B.P.
	Tertiary	Pliocene Epoch	
			13,000,000 B.P
		Miocene Epoch	
			25,000,000 B.P.
		Oligocene Epoch	

(Scale dates back billions of years to the Precambrian Period)

The dominant parent materials in the watershed are interbedded basalt, andesite, and tuff (45%). However, within the three western subsheds (West Fork Silver Creek, Guyer Creek, and Indian Creek) the dominant parent material is pumice (69%), while within the four eastern subsheds (Benny Creek, Squaw Creek, Lower Silver, and "Z" - Thompson) the dominant parent materials are interbedded basalt, andesite, and tuff (66%).

SOILS

One of the factors which determines the kind of soil which occurs in an area is parent material. Parent material is the unconsolidated mass from which the soil profile develops. It may or may not relate to the underlying bedrock.

Five groups of parent material occur within the Silver Creek Watershed. Their occurrence is displayed in the table below.

PARENT MATERIAL OF SOILS IN THE SILVER CREEK WATERSHED

Subshed --> Acres -->	W. Fk 24000	Guyer 11557	Indian 8835	Squaw 12408	Benny 26390	Z 8814	Silver 16274	Total 108278
	Ac %	Ac %	Ac %	Ac %	Ac %	Ac %	Ac %	Ac %
Not Grouped (variable or water or null)	1564 7%	1202 10%	1280 15%	1037 8%	1198 5%	2443 28%	1975 12%	10699 10%
GROUP 1 (13-24) Derived from a wide variety of transported materials (i.e. Thompson Valley lowlands)	245 1%	559 5%	1600 18%	364 3%	287 1%	2320 26%	246 1%	5621 5%
GROUP 2 (25-39) Derived from interbedded basalt, andesite, and tuff. In areas of shallow soils this group is associated with "scabrock flats"	6527 27%	317 3%	301 3%	6749 54%	23878 90%	3128 36%	8418 52%	49318 45%
GROUP 3 (40-49) Derived from rhyolite (i.e Hagar Mountain is a rhyolitic eruptive center)	0 0%	110 1%	123 1%	0 0%	145 1%	17 0%	2384 15%	2779 3%
GROUP 4 (50-76) Derived from pyroclastic and sedimentary rocks	6212 26%	261 2%	780 9%	670 5%	217 1%	437 5%	3055 19%	11632 11%
GROUP 5a (77-80) Shallow/mod. derived from Mazama ash and pumice, overlying residual soil from rhyolite	0 0%	1563 14%	3491 40%	0 0%	0 0%	296 3%	0 0%	5350 5%
GROUP 5b (81-92) Shallow/mod. derived from Mazama ash and pumice, overlying residual soil from basalt	9218 38%	7544 65%	1258 14%	3592 29%	660 2%	173 2%	199 1%	22644 21%
GROUP 5c (93-99) Deep soil derived from Mazama ash and pumice, overlying residual soil from basalt	245 1%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	245 0%

Soil Texture & Effects on Turbidity of Major Landtypes in the Silver Creek Watershed are as follows:

	% of Subshed							% of Water-shed	Texture of "A" Horizon	Sediment Yield Potential from sand, silt, clay with disturbance (H,M,L impact on stream turbidity)
	A	B	C	D	E	Z	F			
2							6	4	variable	High
22			10			15		2	sandy loam	Moderate
23			7			11		2	loam	Low
28				11		5		5	stony cly lm	High
29					9			3	loam	High
30A	6				8		8	6	clay loam	High
35				24	10			10	loam	Low
36							11	2	loam	Low
37A					16			5	sandy loam	Low
38					11	22	13	8	sandy loam	Low
39					12			3	loam	Low
42							5	1	sandy loam	Low
53	10							3	loam	Moderate
64	12		9			5	14	7	loam	Low
77A		6	16					2	loamy sand	Low
77B		8	19					3	loamy sand	Low
85		9		10				2	loamy sand	Low
88A	13	22						6	loamy sand	Low
88B	10							3	loamy sand	Low
89A		16						3	loamy sand	Low

The above list does not include all landtypes but does account for over 80% of the area within the watershed.

VEGETATION

Vegetation is highly variable for several reasons including high variation in elevation (4,200 to 7,500 feet), annual precipitation (13 to 35+ inches), length of growing season, soil texture and depth, and aspect. Other factors contributing to variability are historic management levels (fire suppression, cattle grazing, and timber harvest) and natural event occurrences (insect infestations and wildland fires). About 20% of the area is scabrock flats or other non-forested types. These non-forested types generally support grasses, sagebrush and juniper. Less than 2% of the area is composed of riparian meadows/zones which support a variety of forbs, grasses, sedges, willow, alder, aspen and cottonwood.

The vegetation types of commercial forest land varies between pure ponderosa pine, pure lodgepole pine, and mixed conifer stands that include ponderosa pine, lodgepole pine, sugar pine, western white pine, white fir and shasta red fir. Most of these lands have been altered by timber harvest, suppression of wildfires for decades, drought-related mortality, and intense wildfires.

TOPOGRAPHY

The Silver Creek Watershed is characterized by gentle topography. Approximately 92,650 acres (86%) have slopes between 0 and 15% slope, 14,200 acres (13%) have slopes ranging between 16 and 35%, while 1,550 acres (1%) have slopes greater than 35%. Portions of the West Fork Silver Creek and Silver Creek flow through canyonlands, up to 450 feet deep, with localized sideslopes of up to 60%. The table below does not include a length or width value for the "Z" subshed. This subshed is characterized solely of intermittent drainages which flow into Thompson Reservoir from a number of different directions. The table below gives a brief description of the topographic characteristics of the area:

TOPOGRAPHIC CHARACTERISTICS.

Subshed	Area Ac.	Area (Sq. mi)	Length(Mi)	Width(Mi)	Relief(Ft)	Order
A (West Fk.)	24,000	37.5	16.1	2.3	3,065	4
B (Guyer)	11,557	18.1	10.0	1.8	2,440	4
C (Indian)	8,835	13.8	8.7	1.6	1,170	3
D (Squaw)	12,408	19.4	13.8	1.4	2,100	3
E (Benny)	26,390	41.2	12.9	3.2	2,180	3
F (Silver)	16,274	25.4	8.1	3.1	520	3
Z (Thompson)	8,814	13.8	---	---	1,300	4

FLUVIAL SYSTEM

Subshed A includes the West Fork Silver Creek and its major tributary the North Fork Silver Creek. West Fork Silver Creek flows into a small reservoir which is backed up behind a dam at the confluence of West Fork Silver Creek and Silver Creek in T29S, R14E, Sec.5. West Fork Silver Creek is perennial for its entire length. It originates at year-around springs, and even in extreme drought years exhibits flow through August, September, and October. North Fork Silver Creek is perennial from an area of springs (NE1/4, NE1/4, Sec.24) downstream. Above that point North Fork is intermittent. This was field verified in the late summer of '94.

Subshed B includes Guyer Creek and its major tributary Strawberry Creek in addition to several unnamed tributaries. Guyer Creek flows into Thompson Reservoir in T30S, R13E, Sec. 19. Guyer Creek originates at year-around springs and is perennial for its entire length. Strawberry Creek has no perennial reaches.

Subshed C includes Indian Creek and Silver Creek (above Thompson Reservoir). These two streams reach a confluence about 2-1/2 miles above the reservoir, and from that point downstream are named "Silver Creek". Indian Creek drains a larger area than Silver Creek, above their confluence, and flows for a longer period each year. There are no perennial reaches in this subshed, however, historically Indian Creek may have been perennial. The GIS streamlayer currently shows 2.8 miles of perennial stream in this subshed. The majority of Indian Creeks headwaters (on U.S. Timberlands property) have been clearcut in the past two decades.

Subshed D includes Squaw Creek and minor tributaries. It is intermittent with its primary source of water comming from the gentle sloping basalt uplands of the Winter Ridge block fault. In addition, it is fed by a number of springs

(Aspen, Peck, and Puddle) at various points along its route. It flows into Thompson Reservoir in T31S, R14E, Sec. 5.

Subshed E includes Benny Creek and its tributaries Graham Creek, Welker Creek, and Hawk Creek. All of these tributaries are intermittent (despite 10.4 miles of "perennial" stream listed in GIS). The primary source of water for Benny Creek is the gentle sloping basalt uplands of the Winter Ridge block fault. Its tributaries begin at lower elevations, well below the uplands of Winter Ridge. Benny Creek flows into Thompson Reservoir in T30S, R14E, Sec. 33.

Subshed F includes Silver Creek below Thomspon Reservoir. Its tributaries include Auger Creek which is intermittent and several other un-named tributaries. The level of flow of Silver Creek is controlled by the dam at the north end of Thompson Reservoir. During very low snowpack years, Thompson Reservoir essentially dries up by late summer and consequently Silver Creek also dries up. However, the main stem of Silver Creek is listed below the reservoir as perennial. Silver Creek flows into a small reservoir at the confluence of West Fork and the main Silver Creek in T29S, R14E, Sec. 5.

Subshed Z includes those intermittent and ephemeral drainages which flow directly into Thompson Reservoir form the northeast, southwest, and south.

The following table shows fluvial system characteristics:

FLUVIAL SYSTEM CHARACTERISTICS

Subshed	Area (ac.)	Stream (a) Length	Stream (a) Density	Order	Channel Slope	Drainage (b) Length	Drainage (b) Density
A (West Fk.)	24,000	23 mi.	0.6 mi/sq mi.	4	3.0%	65 mi.	1.7 mi/sq mi.
B (Guyer)	11,557	11	0.6 mi/sq mi.	4	3.5	34	2.0 mi/sq mi.
C (Indian)	8,835	2.8	0.2 mi/sq mi.	3	2.3	25	1.8 mi/sq mi.
D (Squaw)	12,407	0	0.0 mi/sq mi.	3	2.2	30	1.6 mi/sq mi.
E (Benny)	26,389	0*	0.0 mi/sq mi.	3	2.2	62	1.5 mi/sq mi.
F (Silver)	16,273	6**	0.2 mi/sq mi.	3	0.9	42	1.7 mi/sq mi.
Z (Thompson)	8,813	0	0.0 mi/sq mi.	4	N/A	11.3	0.8 mi/sq mi.

* Although listed in GIS as perennial, none occur.

** In 1994 Lower Silver Creek was dry due to drought conditions, however, it is included here as a perennial.

(a) Miles of perennial streams.

(b) Miles of perennial, intermittent and ephemeral stream channels.

STEP 1

CHARACTERIZATION OF THE WATERSHED

STEP 1. CHARACTERIZATION OF THE WATERSHED

The purpose of the characterization phase is to identify the dominant physical, biological, and human processes and features of the watershed that affect ecosystem functions and conditions. Relationships between these ecosystem functions or conditions and those taking place in the watershed were evaluated. The ID Team also considered the status of land allocations, plan objectives, and regulatory constraints that influence resource management for this watershed. This section identifies the primary ecosystem elements needing more detailed analysis in subsequent sections.

Erosion Processes

The Silver Creek Watershed is composed entirely of igneous(volcanic) rocks, most of which are extrusive. The geomorphology of the watershed is the result of uplifting on the eastern portion due to a major block fault (Winter Rim), and a large basaltic/andesitic eruptive center (Yamsay Mountain) on the western portion. Hager Mountain is the largest rhyolitic eruptive center within the watershed. Other eruptive centers include Partin Butte, also ryholite, and Foster Butte and Sycan Butte which are basaltic.

Because of the geologic faulting and eruptive centers, streams to the west generally drain east/northeast while streams to the east drain west/northwest. Four of the subbasins flow into Thompson Valley Reservoir. Below the reservoir streams flow generally north towards Silver Lake. Sediments from the uplands are deposited within the reservoir which is located on a large alluvial deposit. This deposit extends to the southern portion of the watershed boundary.

The dominant rock types, which make up about 66 percent of the watershed, are interbedded basalt, andesite, and tuff. Soils derived from this kind of bedrock are moderately deep to bedrock, typically have textures which are stony or very stony loams or clay loams, and are brown or reddish-brown in color. Deeper soils typically support conifers, while shallow, scabrock flats only favor low sagebrush, bunch grasses, and juniper. These shallow soils primarily occur on broad upland flats or uniform sideslopes.

The forested basalt and tuff derived soils have low to moderate surface erosion rates and a low risk to mass movement. These soils are resistant to erosion and weather into clays which holds the soil together. However, the soil is highly susceptible to compaction from management activities which reduces infiltration and increases overland flow and erosion. Shallower soils have high erosion risks due to restricted infiltration and percolation rates. Overland flow is common on these soil types. These rocks are stable and have a strong resistance to mass movement.

Much of the West Fork Silver Creek, Guyer Creek, and Indian Creek subbasins have an ash or pumice mantle over the buried basalt derived soils. These are shallow to moderately deep Mazama deposits which are poorly developed and have loamy sand or sand textures. Sheet erosion risks are low but gully erosion and displacement risks are moderate to severe depending on slopes. Rhyolite comprises about 8 percent of the watershed. These soils generally are light colored, very gravelly or cobbly, and deep to vertically fractured underlying bedrock. Ponderosa pine and pine associated conifers are the dominant vegetative species. They occur on dome-shaped rhyolitic eruptive centers, such as Hager Mountain, which have steep sideslopes and a radial drainage pattern.

Rhyolitic soils have a moderate to high risk of rill and gully erosion because of their loose, coarse texture and the steep landforms on which they occur. The risk to compaction is low. The risk to mass movement(debris avalanche) is low, but it does occur especially on the steeper slopes. Rotational slumps do not occur on these soil/bedrock materials.

Pyroclastic and sedimentary bedrock comprises about 11 percent of the area. These soils are moderately deep to deep, brown and yellowish brown residual soils with medium or coarse textures. They occur on gently sloping tablelands at the lower elevations between the forest boundary and Thompson Reservoir.

Lacustrine deposits occupy about 5 percent of the watershed primarily south and west of Thompson Reservoir. These soils have developed in alluvial bottomland and terrace deposits. They often have a hard silica cemented duripan in the subsoil which restricts effective rooting depth and moisture storage. Generally low sagebrush occurs on these sites. Big sagebrush occurs on the terrace soils where the duripan is either deeper or hasn't developed. Textures range from gravely sandy loam to gravelly clay loam. Slopes are generally less than 5 percent.

Pyroclastic and lacustrine soils also have a low to moderate risk of surface erosion and compaction. These soils occur on gently sloping landforms where the risk of overland flow is minimal.

The remaining 10 percent of the watershed consists of miscellaneous soil types which includes alluvial and colluvial stringers along streams, anaerobic soils in wetlands, ponds and depressions, rock outcrops and talus slopes, and also the surface water within the reservoir. These soils have a wide range of characteristics and risk ratings.

Hydrology

A. Climate

The watershed is located in the semiarid rain shadow region east of the Cascade Mountains. This area has both maritime and continental climate patterns, with most of the weather patterns moving inland on cyclonic low pressure fronts off the Pacific coast. Maritime air masses are significantly blocked by the Cascade Mountain Range, causing precipitation over much of the area.

Average annual precipitation varies with increasing elevation, ranging from a low of 13 inches in the valleys, 20-30 inches in the eastern and western portions of the watershed, and up to 35 inches at the highest elevations. Much of this precipitation occurs from October through March, with snow as the dominate precipitation type. Convective thunderstorms provide rain in spring and summer, although the summer months are relatively dry.

The 25 year (24 hour) precipitation intensity, according to the National Oceanographic and Atmospheric Agency (NOAA), Atlas 2, ranges between 2.40 and 2.80 inches. A review of the precipitation records taken in Silver Lake, Oregon, indicates that the average from 1969 through 1993 is just over 9 inches. Although Silver Lake is about 11 miles north of the center of the Silver Creek Watershed, the annual precipitation pattern is analogous. The precipitation ranges from 5.7 to 14.2 inches.

Temperatures also vary widely, both seasonally and by elevation. Summer highs are near 100^{o}F in the lower elevations and winter lows well below 0^{o}F at any elevation. Freezing temperatures can occur any time of the year, especially in cold air basins and high elevations. Higher elevation areas have a progressively shorter growing season especially above 6,500 feet, where the ponderosa pine becomes less common.

Precipitation, combined with factors which influence snowmelt, are the climate variables with the greatest affect upon the hydrology of the Subsheds.

B. Water Quantity

Guyer Creek, West Fork Silver Creek, and North Fork Silver Creek are spring fed streams and these streams, in addition to lower Silver Creek, are the only perennial streams within the Silver Creek watershed. All other streams are intermittent or ephemeral. The exception to this are small reaches of intermittent streams that are spring fed and have short sections with perennial flow that quickly subsurface. Portions of Indian Creek, Squaw Creek, and Benny Creek are examples. The largest intermittent streams are Benny Creek, Squaw Creek, Indian Creek, and Auger Creek.

Runoff from streams are highly influenced by the soils and geology of the area. The subsheds on the east half of the Silver Creek watershed (non-pumice zone) have higher runoff rates, but of shorter duration, than the subsheds on the west half of this watershed (pumice zone).

Thompson Reservoir is located in the center of the watershed and collects water from Guyer, Indian, Squaw and Benny Creeks. Lower Silver Creek starts at the outlet of the Thompson Reservoir dam with Auger Creek being the only major contributor to flow below the reservoir. The perennial portion of lower Silver Creek flows northward until it reaches the confluence with West Fork Silver Creek at an elevation of 4,435 feet. There are several diversions, and stream flows below Thompson Reservoir are controlled by the Irrigation District. Beaver dams are present in the lower reaches of lower Silver Creek, Guyer Creek, North Fork Silver Creek and West Fork Silver Creek.

Stream flow records from the watershed are sparse. Silver Creek has a flow station below the watershed with continuous flow records from 1922 to present, with no other continuous flow records taken in the watershed. Storage and release of water from Thompson reservoir affects timing and volumes of flow from the watershed. Thompson reservoir collects flow from 52% of the watershed land base. The reservoir stores water during the high flow periods and releases water during the low flow periods. The capacity of the reservoir is 18,470 acre feet and is often not filled on a yearly basis. As of 1991, the historic average retention in the reservoir was 15,500 acre feet which is almost 3,000 ac/ft below the maximum capacity.

Mean monthly flows appear to have shifted with the peak of the hydrograph being earlier in the season. This may have implications to fish spawning and water storage. (This is discussed under the synthesis portion of the document). Flows vary greatly depending on the location in the watershed. Generally, flows on the eastern streams are intermittent and "flashy" in nature and flow as a direct result of snow melt.

Peak flows have likely increased in magnitude as a result of roads and compaction from timber harvest activities. Road densities can add to the overall drainage system of the watershed. Road densities were obtained from GIS and do not show small private roads, temporary roads or skid roads. Overall, the road system is composed of open and closed roads with an average total road density of 3.6 mi/mi^2. The total open road density is 3.1 mi/mi^2. Road surfaces range from bituminous to native materials. Presently 62.5 miles of the roads are designated for passenger cars and 548 miles are designated for high clearance vehicles. Of these, 96.5 miles are closed to all vehicular travel. Information on surface type or closure status is not available on 63.9 miles of these roads.

The following table shows a comparison of road densities by subshed.

OVERALL DRAINAGE DENSITY
(Drainage Density on Combined National Forest System Land and Private)

Subshed	Stream Drainage Density (Mi/Sq Mi)	Road Density (Mi/Sq Mi)	Increase in Drainage Network
West Fork Silver Creek	1.7	3.4	220%
Guyer Creek	2.0	4.7	240%
Indian Creek	1.8	4.7	260%
Squaw Creek	1.6	4.2	260%
Benny Creek	1.5	3.3	230%
Silver Creek	1.7	3.6	230%
Thompson Res	0.8	2.3	350%

Vegetation

A. Upland Forest and Range

The forested portion of Fremont National Forest lands is comprised of 61,600 acres and can be divided into three broad ecoclass groups: 1) Lodgepole Pine associated communities, 2) Ponderosa Pine communities, and 3) Pine associated communities. There are approximately 7,200 acres of the Lodgepole pine type, 11,000 acres of the Pine associated types, and approximately 43,400 acres of the Ponderosa pine type.

Forest production capability within the watershed averages 42 cu.ft. per acre per year with a range of 24-75 cu.ft. per acre per year. Range production potential within the watershed averages 398 pounds of air dried forage produced per acre per year with a range of 172 to 1730.

The major disturbance factors that have been important to the upland forest/range vegetation are fire, insects and disease, timber harvest, and grazing. With the advent of fire suppression around 1910, historical fire frequencies were altered. The most significant alteration has been in the lower elevation ponderosa pine ecoclass areas where fire suppression has resulted in increased densities of understory in ponderosa pine (Pinus ponderosae and western juniper (Juniperous occidentalis). A similar pattern of increased density is occurring in the the mid-elevational pine associated types. In this case the increased density has mainly involved an increase in the white fir (Abies concolor) component. In many cases these low and mid-elevational sites have potentially missed 1 to 4 fire occurrences during the period from 1910 to present. This has resulted in an increase in the density of the seedling, sapling and small pole sized timber. In the higher elevation true fir zone, while there has been an increase in density, the overall effect of fire suppression is probably minimal as fire suppression has not occurred for less than one cycle in most cases.

Fire suppression has also changed structures over the landscape. Historically, in the lower elevations, ponderosa pine ecoclass stands were typically open and parklike or late successional single canopy with only a few late successional multistrata stands. With fire suppression this open condition was minimized with much more structure in the understory being created.

Insect and disease populations have also been affected by the decrease in the frequency of fire. The three most significant insects in the watershed are the Western Pine Beetle (Dendroctonus brevicomis), Mountain Pine Beetle (Dendroctonus ponderosae Hopkins), and the Fir Engraver (Scolytus ventralis). Increased density and drought have increased stress on these trees, thus increasing mortality over the watershed. This is due to density related mortality and insects.

The most important diseases in the watershed are dwarf mistletoe and Armillaria root disease. Three species of mistletoe occur within the watershed: Arceuthobium americanum on lodgepole pine (Pinus contorta), Arceuthobium campylopodum on ponderosa pine, and Arceuthobium abietinum on white fir. Its effect is greatest in single species stands with a multilayered canopy (Eglitis et al, 1993).

Armillaria root disease (Armillaria ostoya) effects both ponderosa pine and white fir (Abies concolor). White fir is the most susceptible. Within the watershed Armillaria has been a serious problem in some areas (see map 1 in Appendix-maps and data section). The virulence of Armillaria has been correlated with stresses related to increased densities, compaction, and creation of large stumps for buildup of innoculum Eglitis et al., (1993A).

Significant harvest activity in the watershed did not begin until 1947. Since then harvest treatments have varied from evenaged systems such as clearcuts, overstory removals, and unevenaged management systems.

The disturbance regimes within the watershed have resulted in an array of vegetation patterns across the landscape, ranging from early seral stage (consisting of seedlings, saplings and poles) to late/old structural (LOS) (consisting of large old trees in a single canopy to others that are multistrata).

The upland forest/range vegetation is composed of a variety of grass, shrub and brush species. Fire and grazing are the main disturbance vectors that have had significant effects on these systems. Fire suppression in effect has allowed for the encroachment of ponderosa pine and western juniper upon historically fire maintained open grass and shrub systems. In addition, most of the watershed has been subjected to varying intensities of grazing since the 1880's by both cattle and sheep. These have potentially contributed to the success of conifers along meadow fringes by keeping down herbaceous competition and removing allelopathic material in seedbeds (Wooley, 1994).

Noxious weeds have been identified in several areas of the watershed. Sensitive plants such as Castilleja chlorotica, Penstemon glaucinus, and Melica stricta are known to occur in the watershed.

B. Riparian

Riparian vegetation buffers the fluvial system from potential impacts of disturbances caused by direct management. Included within the Silver Creek watershed are a variety of sedges (Carex spp.), shrubs such as Alnus incana and Salix spp., and deciduous tree species such as aspen (Populus tremuloides). Conifer species such as ponderosa pine, white fir and lodgepole pine also occur along the edges of riparian zones and within formerly active flood plains. The above ground biomass adds to the coarseness of the surface, dissipates floodwater energy, and acts as a filter to catch and hold the sediment before it can reach the stream. It also provides microsites for the germination and establishment of new plants within the riparian zone.

The major factors influencing the riparian condition within the watershed are grazing, timber harvest and fire suppression.

Grazing within riparian areas has been important in modifying species composition through cattle browsing, and trampling of trees, shrubs, and herbs, reduction of soil productivity through compaction, and the lowering of the water table through downcutting.

Timber harvest along riparian zones has had the effect of reducing shade along streams thus increasing stream temperatures, and reducing the number and type of down woody material to streams through stem removal. Also, increased amounts of sediment delivered to the stream has resulted from adjacent timber harvest activities.

Fire suppression has effected riparian systems in this watershed by allowing for encroachment of conifers into shade intolerant plant communities such as aspen communities, thus reducing their ability to regenerate or compete for site resources in the low light conditions created by conifer encroachment.

Stream Channel

A. General Description

Streams fall into three classifications, perennial, intermittent and ephemeral. There are 46 miles of perennial, 235 miles of intermittent, and 161 miles of ephemeral streams identified in the watershed.

The perennial steams are Silver Creek, Westfork Silver Creek, Northfork Silver Creek and Guyer Creek. There are several large intermittent streams within the watershed including Benny, Squaw, Indian, Auger, Graham, and Hawk Creeks. In addition, portions of Benny, Squaw and Indian Creeks have perennial flow for short distances before flow goes subsurface and streams become intermittent again. Generally, streams on the western portion of the watershed originate from springs and tend to be perennial.

Streams on the eastern portion of the watershed flow from the uplifted landscape that occurred when Winter Ridge faulted and the rim formed. These streams tend to have a less defined drainage with much of the water sheeting across the surface. The majority of flow occurs as a direct result of runoff from snowmelt. Intermittent flow that occurs later in the season is from saturated soil resulting from snow melt. The streams on the eastern portion tend to be much flashier, with most of the flow occurring between March and July. As a result of the shorter period of flow, these steams have riparian vegetation that is associated with drier soil conditions. Perennial streams on the western portion have much more vigorous and diverse riparian vegetation.

Ephemeral streams in the western portion of the watershed (pumice zone) do not have well defined channels. However, formation of draws in the landscape indicate that erosion does occur and these channels flow in extreme events. Ephemeral channels on the eastern portion of the watershed are better defined and usually have evidence of channel scour with a defined bed and bank.

B. Fluvial System

West Fork Silver Creek flows into a small reservoir which impounds water behind a dam at the confluence of West Fork Silver and lower Silver Creeks in T29S, R14E, Sec. 5. West Fork Silver Creek is perennial for its entire length. It originates at a year round unnamed spring source, and even in extreme drought years exhibits flow through August, September, and October. North Fork Silver

Creek is perennial from an area of unnamed spring source (NE1/4, NE1/4, Sec. 24) downstream. Above that point, North Fork Silver Creek is intermittent.

Guyer Creek flows into Thompson Reservoir in T30S, R13E, Sec. 19. Guyer Creek is perennial for its entire length. It originates at a year round unnamed spring source. Strawberry Creek has no perennial reaches.

Indian Creek and Silver Creek (above Thompson Reservoir) reach a confluence about 2-1/2 miles above the reservoir, and from that point downstream are named "Silver Creek". However, Indian Creek drains a larger area than Silver Creek. There are no perennial reaches in this subshed, however, historically Indian Creek may have been perennial. GIS currently shows 2.8 miles of perennial stream in this subshed. The majority of Indian Creeks headwaters (on US Timberlands lands) have been clearcut in the past two decades.

Squaw Creek and its tributaries are intermittent, with the primary source of water being the gentle sloping basalt uplands of the Winter Ridge block fault . In addition, it is fed by a number of spring sources (Aspen, Peck, and Puddle Springs) at various points along its route. It flows into Thompson Reservoir in T31S, R14E, Sec. 5.

Benny Creek and its tributaries Graham Creek, Walker Creek, and Hawk Creek are intermittent (10.4 miles of "perennial" stream listed in GIS). The primary source of water for Benny Creek is the gentle sloping basalt uplands of the Winter Ridge block fault. Its tributaries begin at lower elevations, well below the uplands of Winter Ridge. Benny Creek flows into Thompson Reservoir in T30S, R14E, Sec. 33.

Lower Silver Creek (below Thompson Reservoir) and its tributaries include Auger Creek (intermittent) and several other un-named tributaries. The level of flow of Silver Creek is controlled by the dam at the north end of Thompson Reservoir. During very low snowpack years, Thompson Reservoir essentially dries up by late summer. In this event, Silver Creek also dries up. However, the main stem of Silver Creek is listed as perennial. Silver Creek flows into a small reservoir which is backed up behind a dam at the confluence of West Fork Silver Creek and Silver Creek in T29S, R14E, Sec. 5.

The Thompson Reservoir subshed includes Thompson Reservoir and the intermittent and ephemeral drainages which flow directly into Thompson Reservoir. Most of these drainages flow from the southwest and northeast.

Water Quality

A. Beneficial Uses of Water

Water generated within the watershed supports many beneficial uses, including irrigation, livestock and wildlife watering, and road watering for dust abatement. Thompson Reservoir is an important feature within the watershed that provides beneficial uses including water recreation activities such as fishing, boating, and camping. Other beneficial uses include providing an important habitat for redband trout, a federal candidate species for the Endangered

Species List and a Region 6 sensitive species. Also, the watershed provides habitat for non-game fish including dace and tui chub species.

Streams and riparian areas provide habitat for resident fish, aquatic life, wildlife, recreation, and aesthetic purposes. Guyer Creek, West Fork Silver Creek and North Fork Silver Creek are the perennial streams that provide the major fishery opportunities. Intermittent streams within the watershed may provide some spawning opportunities for trout that live in the reservoir. Riparian habitat along intermittent streams including Benny, Squaw and Indian Creeks are important for a variety of wildlife species. Maintaining beneficial uses is also important for meeting the Clean Water Act and the Antidegradation Policy of the water quality standards regulation, 40 CFR 131.12 (40 FR 51400, 1983).

Demand for these beneficial uses are expected to increase in the future. Presently, there are no uses of water in the watershed for industrial supply, hydropower or commercial navigation.

Perennial streams within the watershed have been monitored for large wood, temperature, pools and sediment. These water quality parameters are discussed further in Current Conditions. Temperature and sediment are limiting factors that are affecting water quality in perennial streams within the watershed. Both West Fork Silver Creek and Silver Creek are on the Environmental Protection Agency 303 (d) List.

Vertical stability of stream channels has been affected with streams being downcut in many cases and contributing large amounts of sediment to Thompson Reservoir. Downstream of Thompson Reservoir, stream temperatures are elevated and sediment in stream substrates are high.

B. Water Rights

The Forest holds state water rights on 19 sites within the watershed. Three of the sites are for road watering and the remaining 16 are for stock water ponds.

Existing private water claims in the watershed includes only water rights within Thompson Reservoir. Irrigation season for surface water starts April 1. Water from the reservoir is generally withdrawn between April 1 and October 1. There is no ground water use within the watershed.

Species and Habitats

A. Terrestrial

1. Threatened, Endangered and Sensitive Species

a) Northern Bald Eagle

Three bald eagle use areas (an active nest site, a winter roost area, and a potential nest/roost area) occur at Thompson Reservoir and along Silver Creek. Total acres within these areas are 17,500. About 2,900 acres of forest stands in the areas are presently suitable nesting/roosting habitat.

Another 1,400 acres of forest stands could be treated to maintain/improve habitat suitability. Thompson Reservoir is a key foraging area. Numbers of eagles using the roost and the location of the roost stand is unknown.

b) American Peregrine Falcon

Potential nesting habitat has been identified at 21 cliff sites, primarily along Silver Creek. It is not known if any of the sites are occupied. The best foraging habitat would be Thompson Reservoir and the spillway area where the West Fork flows into Silver Creek.

c) Western Sage Grouse

A lek site occurs along the West Fork Silver Creek at the Forest boundary. The site covers about 80 acres. No birds have been observed at the site since at least 1981.

2. Keystone Species

a) Big Game

The watershed is located within the Silver Lake Management Unit for deer and elk, and the South Central Elk Management Zone. Three herd ranges, the Winter Ridge and Yamsay elk herds, and the Silver Lake deer herd, occur here. The elk population is estimated at 800 to 1,300 animals and the deer population at 10,300 wintering animals. The entire watershed is suitable habitat for deer and elk.

Generally, all seasonal habitats are in a state of advanced plant succession, and thus have a reduced carrying capacity to support big game. Deer and elk occur throughout the watershed year round, but their seasonal distribution and density is regulated by weather conditions. There are 2,767 acres of deer winter range in Management Area 1. This range was documented as being in poor condition as early as 1948. Elk winter range occurs around Foster and Sycan Buttes and Hager Mountain. An elk calving area occurs in the upper Squaw and Benny Creek subsheds. The deer population trend is presently stable, but erratic, and the elk herds are on an upward trend. Both cover and habitat effectiveness for deer summer range meet or exceed Forest Plan standards for all subsheds east of Silver Creek, but HE(habitat effectiveness) on deer transition range in Silver Creek is below Forest Plan standards. Two large wildfires (Toolbox and Coyote) created transient large forage areas which are gradually losing their effectiveness as pine plantations mature. The Alder Ridge fire of 1996 will provide about 3500 acres of early seral foraging habitat for the next 20 to 30 years. Road density exceeds the desired condition for habitat security in some parts of the watershed. An increase in the distribution and density of juniper has reduced the productivity of herbaceous and woody forages, but increased cover at lower elevations in the watershed. Riparian habitat conditions for fawning, calving and rearing, especially along intermittent streams have been degraded by heavy livestock and deer grazing.

b) Beaver

Currently, there are only 2 active colonies, one at Silver Creek marsh and the other in upper Guyer Creek. The present distribution of beaver and the number of colonies is far less than what it was 30 to 50 years ago. More potential habitat exists than is presently occupied. The present condition of this habitat is less than desirable because of riparian habitat degradation and a lower water table, especially on intermittent streams.

3. Management Indicator Species Associated with Late and Old (LOS) Forest Cover

a) General

Dedicated old-growth forest stands (Management Area 3 and 14) occur on 4,100 acres in the watershed. Another 16,900 acres of LOS forest cover has been identified, but are not dedicated stands. LOS forest cover has declined significantly since 1950, and species composition has changed from a mostly pure ponderosa pine to a more mixed conifer forest. In general, habitat for species associated with open, parklike LOS single canopy ponderosa stands has declined while multi-storied mixed conifer LOS habitat has increased.

b) Goshawk

Two active nest sites and one alternate nest site have been identified in the Benny and Thompson Reservoir subsheds. Overall, habitat suitability and availability for nesting have declined in all subsheds since 1950.

c) Pileated Woodpecker

Three active foraging areas have been identified: one each in upper Guyer Creek, upper West Fork, and at Hager Mountain. Overall, suitability and total acres of foraging habitat has increased since 1950.

d) American Marten

Hager Mountain, Winter Ridge and the Antler-Buck semi-primitive area are the 3 general areas that provide potential marten habitat. The only confirmed marten sign is in the Antler-Buck area. Both habitat availability and continuity have declined in all subsheds since 1950, but suitability may have increased in some patches of LOS forest habitat.

e) Black-backed Three-toed woodpecker

Only about 2,000 acres of LOS lodgepole pine are available as the most suitable habitat for black-backed woodpeckers. Habitat availability and suitability across all subsheds have declined since 1950 with the loss of LOS pine forests. Foraging sign has recently increased across the watershed in association with increased bark beetle activity in the late and old ponderosa and lodgepole pine stands. Local movements and small concentrations of birds occur in response to local temporary sites of high beetle activity. The increase noted in foraging sign may reflect more of a change in distribution than a large increase in bird numbers.

4. Dead Wood Habitat Management Indicator Species

a) Primary Excavators

All subsheds probably have experienced a decline in populations of primary excavating species since 1950. Populations are surmised to be marginally viable at present. Number of acres of potential habitat has declined and distribution has become more restricted as snags and down log habitat have been reduced. The quality of remaining suitable habitat has improved in recent years due to the increased mortality of large diameter trees in late and old forest cover.

b) Red-naped sapsucker

The preferred habitat of sapsuckers is LOS aspen stands which have very limited distribution throughout the watershed. Aspen is restricted almost exclusively to moist/wet sites around riparian areas and higher elevations on Winter Ridge and upper Guyer and West Fork Creeks. There are only about 200 acres of aspen. Many LOS stands are decadent, mixed with conifer species and have little if any regeneration. The distribution and total acres of aspen are undoubtedly less than what occurred prior to 1950.

B. Aquatic-Sensitive Fish

An evaluation of sensitive fish species was conducted for the Yamsay Allotment Environmental Assessment (Yamsay EA). The results of the EA are included in this watershed analysis for purposes of assessing current habitat conditions for sensitive fish species, riparian environments, and soil and water resources. The evaluation identified Guyer Creek, Lower Silver Creek and West Fork Silver Creek as having resident populations of redband trout (Onchorhynchus mykiss spp.), and a Region 6 sensitive species. The inland redband (rainbow) trout are defined as all inland, non-anadromous Onchorhynchus mykiss populations occurring in central and eastern Oregon desert streams. According to Behnke (1981), several basins west of the Alvord basin and north of the Lahontan basin have the interior redband trout as their native trout species. This watershed is in the Fort Rock basin and meets this criteria. The redband trout is a spring (March through June) spawner with eggs usually hatching in 4 to 7 weeks and alevins taking an additional 3 to 7 days to absorb the yolk before becoming free swimmers (Sigler and Sigler 1991). The average age at first spawning is typically 2 to 3 years. Redband trout, up to 12 inches in length, require access to spawning gravels of up to 2.5 cm diameter with less than 30 percent fine sediment. Generally, water temperatures in excess of 21°C (70°F) are unfavorable and may cause stress to all age classes (Sigler and Sigler 1991). Both sediment and temperature are limiting factors in this watershed. Sediment exceeds 30 percent in the majority of the perennial streams. Reaches of West Fork Silver and Silver Creek have temperatures in excess of those tolerable.

The watershed provides important habitat for a variety of fish within the Summer Lake Basin. Both perennial streams and Thompson Reservoir support populations of several species of game fish including redband trout, rainbow trout, eastern brook trout, cutthroat trout, and large mouth bass. The Oregon Department of Fish and Wildlife also stocks fingerling and catchable size rainbow trout in Thompson Reservoir. Cutthroat trout are stocked every other year. Non-game fish species found in the Summer Lake basin, and thought to occur in the watershed, include unknown tui chub species, unknown dace species, and speckled dace.

Non-native fish introductions to the Silver Creek Watershed include Eastern brook trout, rainbow trout and large mouth bass (large mouth bass are illegal introductions). White bass/striped bass hybrids were recently introduced in Thompson Reservoir by the ODF&W.

Level II stream surveys were done in Guyer Creek (1990), West Fork Silver Creek (1992), and North Fork Silver Creek (1992). These surveys inventoried the presence of fish species and habitat. Redband trout occurrence was documented in Guyer and West Fork Silver Creeks within the Yamsay Allotment during the 1990 and 1992 habitat surveys. No redband trout were noted during the 1992 survey of North Fork Silver Creek.

Human Uses

The Silver Creek Watershed provides a multi-faceted natural environment that is both attractive and utilized by human beings for all manner of activities. These activities range from utilitarian functions to spiritual pursuits and mental renewal. All natural features contained within the watershed support a full array of human needs.

Occupation of the watershed first occurred in the open areas contiguous and away from the forests. American Indians took advantage of the dominant natural features, i.e. rock outcrops, wet and dry meadows, pooled water and running water for their resource needs and religious practices.

A small portion of the former Klamath Tribes reservation occupies the extreme southwest area of the watershed most of which is within the Indian Creek Subshed. Tribal members retain hunting, fishing and gathering rights in this area.

Euro-American exploration and settlement focused on the open and watered areas. Trappers and mountain men moved in and through the Silver Creek area. Early settlers found abundant grasses for their stock and settled adjacent to the watershed while using the Silver Creek basin for seasonal grazing.

Timber harvesting and supportive infrastructure (i.e. roads and railroads) construction proceeded slowly in the Silver Creek watershed and accelerated after 1945.

Built in 1922, Thompson Reservoir dominates the landscape of the watershed. This water impoundment feature, which was built in partnership with a local irrigation district, has subsequently become a major recreational site. Large numbers of people use the area for seasonal activities, while the reservoir continues to serve irrigation needs for the Silver Lake basin area.

STEP 2

IDENTIFICATION OF ISSUES AND KEY QUESTIONS

STEP 2. <u>IDENTIFICATION OF ISSUES AND KEY QUESTIONS</u>

Step 2 identifies the key issues and questions developed by the analysis team. This identification of issues helps focus the analysis on the key elements of the ecosystem that are most relevant to the management questions and objectives, human values or resource conditions within the watershed. The knowledge obtained from the watershed assessment completed by the District and information from the core team specialists helped refine the issues. Each issue is addressed specifically by answering the key questions and the parameters listed below each issue.

<u>Issue #1</u>: Past management practices such as logging, grazing, road building, and irrigation reservoirs have altered water quality within the watershed.

Key questions:

1. Does Silver Creek and its associated tributaries meet State of Oregon and Forest Plan water quality standards?

   Parameters: Temperature and particulate matter.

2. Where and which management activities and natural processes have resulted in degraded water quality within the Silver Creek Watershed?

   Parameters: Bank stability, percent stream shading, sediment delivery, macroinvertebrates, and erosion.

3. Is Thompson Reservoir affecting the Silver Creek Subshed and can adjustments be made in the management of the reservoir in order to meet water quality standards?

   Parameters: Temperature and sediment.

<u>Issue #2</u>: Functions and physical characteristics of the riparian ecosystem within the Silver Creek Watershed have been altered from their assumed historic condition.

Key questions:

1. How do land management activities and alteration of natural disturbance processes affect riparian ecosystems? Are these activities preventing recovery where these ecosystems are currently not functioning properly?

   Parameters: Bank stability, channel morphology, soil condition, soil drainage/lowering of the water table, large woody debris and vegetative community.

2. How have changes in riparian ecosystems affected other resources such as riparian vegetation, fish and wildlife habitat, forage productivity, and downstream irrigation?

   Parameters: Pools, temperature, base flows, and water quality (temperature and turbidity).

Issue #3: Past management practices such as reservoir construction, road construction, grazing, timber harvest, etc., have altered base flow, peak flow, and timing of peak flow.

Key questions:

1. Has the natural flow regime in the watershed been altered by grazing, timber management, road building, and diversion activities?

   Parameters: Timing and frequency of mean flows and base flow, cumulative effects, soil moisture storage, soil drainage, and current disturbances.

2. How have management activities and alteration of disturbance processes affected the watersheds ability to withstand catastrophic events?

   Parameters: Stream channel morphology and volume of runoff.

3. How has Thompson Reservoir affected the flow regime of the Silver Creek Subshed?

   Parameters: Timing and frequency of mean flows and peak flows and stream channel morphology.

Issue #4: Management activities have modified fish and wildlife habitat conditions and have caused changes in species distribution and populations.

Key questions:

1. How have fish and wildlife abundance, distribution, diversity, habitat conditions, and aquatic system processes and flows been altered?

   Parameters: Past and present habitat conditions and connectivity; fish and wildlife species composition, distribution, and populations; and location of key refugia or hotspot habitat for Threatened and Endangered Species (TES), keystone and MIS species.

2. How have management activities affected aquatic/fish and wildlife biodiversity, distribution, and populations; and especially fragmentation of fish and wildlife species populations which threatens species viability?

Parameters: Large woody debris, pool habitat, bank stability, streamside cover and substrata composition, bank width to depth ratios, core late/old seral forest habitat, edge/patch and matrix habitat, cover/forage habitat, nesting/(fawning)/rearing habitat, security habitat, dead wood habitat, and fish and wildlife species composition, and distribution and populations.

3. Where are the known problem areas that are contributing to reduced fish and wildlife habitat capability?

   Parameters: Location of management activities and natural events affecting fish and wildlife habitat abundance, condition, and distribution.

Issue #5: Past management activities and alteration of natural disturbance processes, including fire exclusion, have changed the function, pattern, composition, structure and the density of vegetation within the watershed.

Key questions:

1. How have the array of landscape patterns of plant communities and seral stages in the watershed changed over time?

   Parameters: Past and present landscape matrix (pattern analysis), size, structure, TES species, noxious weeds, roads, and vegetation composition.

2. What caused the changes in the landscape patterns of plant communities and seral stages in the watershed?

   Parameters: Past and present distribution of condition class and seral stages; magnitude and intensity of fires in past century; management influence in terms of logging, grazing, and fire suppression.

3. How have management activities and alteration of disturbance processes affected the watersheds ability to withstand catastrophic events?

   Parameters: Historic vs. current mortality, disease, and fire occurrence.

Issue #6: Meet peoples needs for uses, values, products and services within the limitations of maintaining ecosystem health, diversity, and productivity to best meet current and future needs.

Key questions:

1. How should the watershed provide for the future human uses and needs?

   Parameters: Timber harvest opportunities and trends, grazing, and road access.

2. How should Thompson Reservoir provide for the future human uses and trends?

   Parameters: Recreation and irrigation.

STEP 3

DESCRIPTION OF CURRENT CONDITIONS

STEP 3. DESCRIPTION OF CURRENT CONDITIONS

Step 3 deals with the current range, distribution, and condition of the relevant ecosystem elements within the watershed. It documents the more detailed analyses completed for the core topics and other ecosystem elements identified in the characterization of the watershed and issues and key questions. Current Condition refers to the time period from about 1945 to present.

Erosion Processes

Erosion means the wearing away of the land surface by detachment and movement of soil, organic matter, and rock fragments through the action of moving water or wind. Once this material moves from its position in the landscape it is considered to have eroded. Much of this material is deposited along the way where it becomes part of the soil mantle. However, once these soil or rock particles reach a stream channel it is considered sediment. It is estimated that only about 10 to 20 percent of the total erosion becomes sediment.

Any management activity that exposes mineral soil, decreases the natural porosity of the soil, increases overland flow, reduces vegetative growth, or reduces slope stability has the potential to cause accelerated erosion. Also, these same management activities can increase soil compaction, puddling, displacement, and burning which in themselves may result in an increase in accelerated erosion as well as a reduction in site productivity.

The management activities which have effected erosion to the greatest extent are road building, timber harvest with its associated landings, skidtrails, skidroads, and temporary roads, grazing, and fire. These activities often change the physical properties of the soil, the infiltration and percolation of water, and consequently the amount of water that flows over the land surface.

The current erosional condition of the watershed reflects management influences which began in the late 1800's with the introduction of logging, road building, and grazing from large herds of sheep. By 1950 a national market had developed for lumber, and logging increased significantly. Harvest records indicate that many areas have been logged two or three times since then. In addition, in 1981 the Coyote Fire burned over a large area of the south-central portion of the watershed. All of these factors have resulted in cumulative effects to the soil over time with a resultant increase in accelerated erosion rates. The effects of the wildfires, however, have diminished over time and are assumed to have returned to natural levels. Most erosional effects due to grazing occur within riparian zones with minimal levels occurring on the uplands. Bank erosion is discussed under the "Species and Habitat" section of this analysis.

During the assessment phase of this analysis, data was collected on Current Disturbances (see Ecosystem Assessment Guide, pp.V-1,2,3). The intent of this assessment was to determine the extent of all lands in an adverse condition. This included all system roads, landings, spur roads, and skid trails as well as lands detrimentally compacted, puddled, displaced, or eroded. All subsheds within the watershed were mapped as follows: Light - adverse soil impacts occur on less than 10% of the subshed; Moderate - adverse soil impacts occur on 10 -

20% of the subshed; and High - adverse soil impacts occur on more than 20% of the subshed.

In addition, four timber sale harvest units were intensively monitored to determine prior impacts. One even-aged and one uneven-aged harvest unit within each of two subbasins, the West Fork of Silver Creek and Thompson Reservoir, were sampled with random transects. Results were 31% and 41% for West Fork and 45% and 36% for Thompson Reservoir. All four sample sites were within areas that that had been previously mapped "High", ie, as having been impacted over 20%. Although limited in scope, these intensive monitoring results tend to support prior sampling done over the entire watershed for the Current Disturbances module.

The following table shows the estimated percent of each watershed that is in the "Light/Moderate" category, ie, from 0 to 20% of the soil is in an adverse condition, and the "High" category, ie. more than 20% of the soil is in an adverse condition:

Estimated Current Disturbances of Subsheds(%):

Subshed	Light/Moderate	High
West Fork Silver Creek	39%	61%
Guyer Creek	27	73
Indian Creek	26	74
Squaw Creek	58	42
Benny Creek	54	46
Silver Creek	35	65
Thompson Reservoir	50	50

The tables on the next page show estimated current accelerated erosion rates for roads and timber harvesting. It is these management activities which generally have the greatest effect on increasing upland erosion rates over natural levels. The figures should be considered as indicative of relationships with the various activities rather than as absolutes because of the many interrelated variables that influence the erosional process. No actual soil loss rate monitoring data is available. Calculations were based on a "Guide for Predicting Sediment Yields From Forested Watersheds", US Forest Service, Northern Region, Intermountain Region, 49 p., 1981.

Estimated Erosion Relating to Roads(Tons/yr)*:

Subshed	Total Road Mi	Total Road Ac	Basic Erosion Rate	Geologic Er Factor	Mitigation % Reduction	Erosion Rate(Tons)
West Fork	128	279	5,000 t/sqmi	.46	45%	551
Guyer Ck	81	177	5,000 "	.35	45%	266
Indian Ck	65	142	5,000 "	.42	45%	256
Squaw Ck	81	177	5,000 "	.40	45%	304
Benny Ck	136	297	5,000 "	.42	45%	536
Silver Ck	92	201	5,000 "	.49	45%	423
Thompson R	22	48	5,000 "	.48	45%	100

Estimated Total: 2,436 t/yr

* The road area includes the distance from the toe of the fill slope to the top of the cutslope. This distance is estimated to be 18 ft. on average. It includes all system roads and are assumed to be cross drained. The "Geologic Erosion Factor" adjusts the "Basic Erosion Rate" to reflect inherent soil loss rates for different geologic rock types. The "Basic Erosion Rate" represents a stable value from 3 to 6+ years after initial construction. The "Mitigation % Reduction" further reduces erosion rates according to various mitigation measures. The calculations for the Thompson Reservoir Subshed excludes lands inundated by the reservoir.

Estimated Erosion Relating to Timber Harvest(Tons/yr):

Subshed	Total Acres	% Impacted	Basic Erosion Rate	Geologic Er Factor	Erosion Rate(Tons)
West Fk	24,001	27%	90 t/sqmi/yr	.46	419 tons
Guyer Ck	11,064	29%	90 "	.35	158 "
Indian Ck	8,833	30%	90 "	.42	157 "
Squaw Ck	12,411	26%	90 "	.40	182 "
Benny Ck	26,383	27%	90 "	.42	421 "
Silver Ck	16,275	31%	90 "	.49	348 "
Thompson R	6,116	28%	90 "	.48	116 "

(Estimated total:1,800 tons)

The logging system used for this evaluation was clearcutting with tractor yarding. Temporary roads, skid trails, and landings are assumed to have been water-barred and seeded as standard mitigation. Calculations were based on erosion rates four years after the initial disturbance. Soil loss rates relating to any current logging activities are not a part of these estimates.

Current conditions of mass movement is not a concern within the watershed. No mass movement is known to exist within any of the subbasins. However, the potential does exist for debris avalanches to occur on Hager Mountain and for slumping to occur within the headwaters of the West Fork Silver Creek and Guyer Creek. Minimal logging and road building in these areas have reduced the potential for mass movement.

Hydrology

Silver Lake District Hydrologist, Tom Freidrichsen, estimated flows in West Fork Silver Creek and Guyer Creek using available stream flow records. These were obtained from the United States Geologic Survey (USGS) for lower Silver Creek for the period 1905 to 1987. Other periodic instantaneous flow records were obtained from the Oregon-Water Resources Department. These records were obtained randomly and do not provide a complete flow record for streams in the watershed. In addition, USGS streamflow records from Bridge and Buck Creek are adjacent to the Silver Creek watershed and were used in estimating flow. The USGS records for the Chewaucan River (1927-1987) provides the most complete long term records for a river system within the area of the Silver Creek watershed.

Thompson Reservoir has a significant influence on the hydrology of the watershed. The reservoir serves as a collection point for over 50% of the landbase in the watershed and influences base, mean and peak flow in lower Silver Creek. Release of water from the reservoir is dependent upon irrigation needs and is regulated by the Silver Lake Irrigation District. Westfork Silver Creek is not affected by Thompson Reservoir because the stream confluence is below the reservoir.

A. Base Flow

Minimum streamflow occurs during late summer and early autumn (August, September, October and November) in perennial streams within the watershed. This decline in discharge is due to a combination of natural factors including low precipitation, reduced drainage from the soil and bedrock, and sustained high evapotranspiration. Base flow, or summer low flow, is important for maintaining aquatic and riparian habitat and as a late-season water source for wildlife and livestock.

The volume of base flow varies depending upon the location within the watershed. Generally, third order streams originating in the western half of the watershed have perennial flow. These streams are Guyer, West Fork Silver and North Fork Silver Creek. Base flows average around 3 Cubic Feet/Second (CFS) for West Fork Silver Creek, 2 CFS in Guyer Creek, and less than 1 CFS in North Fork Silver Creek. Conversely, streams on the eastern portion of the watershed flow only in response to direct precipitation or spring snow melt.

Short reaches of Benny and Squaw Creek have perennial flow at locations where springs enter the channel. This flow quickly goes subsurface and dissipates.

With the exception of 1/2 to 3/4 CFS that seeps from the Thompson Reservoir dam, Lower Silver Creek has periods of no flow. Following the irrigation season, water is shut off at the reservoir (around October 1). There are no legal requirements to maintain instream flow below this reservoir.

B. Mean Flow

The table below shows that mean flows are highest in the months of April and May for all streams in the watershed. This occurs regardless of Rosgen Stream Type, perennial flow characteristics, aspect or elevation. Intermittent streams have a shorter period of flow, with the highest mean monthly flows occurring in May, and very little flow occurring before February or after July. The exception occurs when rain on snow events create runoff during December or January. Due to the inaccessibility of the watershed during this period, no flows have been measured at that time.

Mean flows (in excess of base flows) are less flashy on the western portion of the watershed due to the influence of pumice soil. Base flows occur between August and September and are consistently 2-3 CFS in perennial streams, with no flow in intermittent streams during late summer and autumn. The exception to this are small portions of intermittent streams that are spring fed and where water quickly goes subsurface due to lack of sufficient flow. This occurs in Squaw, Benny and Indian Creeks. Flow can also occur as a result of runoff from intense thunderstorms. Estimated mean monthly flows are shown below.

Estimated Mean Monthly Flows (CFS)

Month	West Fork Silver	Guyer	Lower Silver	Lower Benny	Squaw
Oct	3	2	9	0	0
Nov	3	2	7	0	0
Dec	5	3	7	0	0
Jan	5	3	13	0	0
Feb	7	4	15	0	0
Mar	10	6	49	5	8
Apr	19	10	83	7	17
May	20	15	125	36	32
Jun	15	9	66	10	6
Jul	7	4	42	0	0
Aug	3	2	35	0	0
Sep	3	2	23	0	0

C. Peak flow

In the Silver Creek watershed, peak flows generally occur from rain on snow events or during spring snowmelt. Summer thunderstorms may be responsible for peak runoff events in localized areas of the watershed, especially in areas where residual soils are found, or where forest fires have burned at a high enough intensity to create high water repellency in the soil.

Peak flows within lower Silver Creek generally do not occur as a direct result of runoff or precipitation. Thompson Reservoir was constructed in 1927 for purposes of storing water for agricultural irrigation. Prior to the construction of the reservoir, a peak flow of 1800 cfs was recorded in the stream channel. This high of a peak flow is presently unlikely to occur because peak flows in tributary streams of Benny, Squaw, Guyer and Indian Creeks are stored in Thompson Reservoir and seldom are routed to lower Silver Creek through the emergency spillway. The stored water is then released later in the year when it is needed for irrigation purposes. Exceptions may occur in some years when the reservoir is at storage capacity prior to peak flows in tributary streams. However, USGS statistical analysis shows that this is very unlikely to occur.

Estimates of flow by Friedrichsen (USDA Forest Service District Hydrologist at Silver Lake) show that peak flows with a 50 year return period can equal 173 CFS in West Fork Silver and 106 CFS in Guyer Creek. The following table shows the estimated peak discharge for different return intervals.

Estimated peak flow discharge in CFS, for indicated recurrence intervals in years, and annual exceedence probability, in percent

Return Period(yrs.) Consecutive Days	2 50%	5 20%	10 10%	20 5%	50 2%	100 1%	Stream
1	47	83	109	145	173	201	West Fork Silver
7	39	63	77	93	104	113	West Fork Silver
1	29	51	67	89	106	124	Guyer
7	24	39	47	57	64	69	Guyer

The table above shows that Guyer Creek provides a small portion of the peak runoff that is stored in Thompson Reservoir. Peak flows equaled 1,800 CFS in 1905, thus, 201 CFS would provide only a small part of the entire flow that occurs in lower Silver Creek. The majority of flow occurs from the non-pummice zone intermittent channels of Benny, Squaw, Thompson and lower Silver Creeks.

Intermittent streams in the watershed are located within pumice and residual soil areas. Indian Creek is the only major intermittent stream that occurs within the pumice zone. Streams in residual soil areas have higher runoff per square mile than Indian Creek. Benny Creek, Squaw Creek, streams in Thompson subshed and lower Silver Creek are located in residual soil areas. The 50 year peak flow events are estimated at 490 CFS in Squaw and 1,160 CFS in Benny Creek. Indian Creek is within the Pummice Zone and can potentially have an instantaneous peak flow of 250 CFS for the 50 year event.

Peak flows have the potential to be higher with increased drainage efficiency from roads. An Oregon State University Thesis by Wemple, under the direction of Gordon Grant, focussed on the hydrologic interaction of forested roads with stream networks. The thesis found that nearly 60% of the road network drained to streams and gullies, and are therefore hydrologically integrated with the stream network (cited reference Elliot et. al., 1996). The 60% figure, from Wemples study, was used to estimate the percent increase to drainage efficiency in this watershed. The following tables list stream drainage densities that include perennial, intermittent and ephemeral channels. Estimated total drainage density from road networks are also included in the table. These densities are lower than actual on the ground conditions because GIS data does not show small private roads, temporary roads or skid roads. Closed roads are considered to contribute to the overall drainage efficiency and are therefore included in the following table.

OVERALL DRAINAGE DENSITY
(Drainage Density on Combined National Forest System Land and Private)

Subshed	Stream Drainage Density (Mi/Sq.Mi.)	Road Density (Mi/Sq.Mi.)	Total Estimated Density (Mi/Sq.Mi.)	Increase in Drainage Network
West Fork Silver Creek	1.7	3.4	3.7	220%
Guyer Creek	2.0	4.7	4.8	240%
Indian Creek	1.8	4.7	4.6	260%
Squaw Creek	1.6	4.2	4.1	260%
Benny Creek	1.5	3.3	3.5	230%
Silver Creek	1.7	3.6	3.9	230%
Thompson Res	0.8	2.3	2.2	350%

D. Cumulative Watershed Effects (CWE)

The natural range of variability for forest canopies depends on the species, soils, elevation and aspect. The Fremont Forest Plan , Standards and Guidelines of 60% canopy closure may be un-realistic in a natural environment for certain species. This should be considered when analyzing the level of impact. These were developed by the forest silviculturists.

Natural Range of Variability
Canopy Closure by Vegetation Type

Dominant Vegetation Type	Canopy Closure (%)
Ponderosa Pine	26-55
Mixed Conifer	41-70
Lodgepole Pine	41-70
<25% any Species	26-55

The following level of impacts are for the Silver Creek watershed and can be compared to Table 22 (Watershed Impact Limits) from the Forest Plan. This next table uses canopy cover and road density to develop the level of impact for the subsheds.

	% Land Impacted	
Subshed	By Entire Subshed	By Suitable Forest Lands Only
West Fork Silver Creek	27	36
Guyer Creek	26	30
Indian Creek	34	45
Squaw Creek	30	44
Benny Creek	34	44
Silver Creek	33	43
Thompson Res	21	40

The above summary shows that the Fremont National Forest recommended impact limit of 30% has been equaled or exceeded in all of the drainages except Guyer Creek. Additionally, on a watershed basis, all streams equal or exceed the 20-30% level referenced by Troendle that results in increased streamflow from the watershed.

Vegetation

A. Upland Forest Vegetation

Current vegetation within the Silver Creek watershed is a mix of both forested and non forested environments. These occur in both riparian and non riparian areas.

Current ecoclass information breaks the forested portion of the watershed into three types: lodgepole pine types (CL), ponderosa pine types (CP), and white fir types (CW). The table below identifies the number of acres in each.

Forested ecoclasses within the Silver Creek watershed

Ecoclass Type	Acres
CL	7,200
CP	63,400 FS and Private*
CW	11,000

*- Private ownership within the watershed is estimated to be 20,000 acres of the CP category.

Of these forested ecoclasses, 4,543 acres were identified as Old-growth in the CP type, 2,563 acres were identified in the CW type, and no acres were identified in the CL type. However 2,117 acres of the CL type were identified as the best late seral lodgepole types as defined in the Forest Plan.

Estimates of seral stage comparisons, done in 1994 within the watershed, are identified in the following table:

1. Seral Stages

Percentage of Silver Creek within Early, Mid, Late and Old Seral Stages

Seral Stage	Percentage in watershed
Early Ponderosa Pine/ White Fir	8.5%
Mid and Early Lodgepole	6.0%
Mid Ponderosa/ White Fir	60.0%
Late Ponderosa Pine/White Fir	14.5%
Late Lodgepole Pine	2.5%
Old Ponderosa Pine/White Fir	8.5%

Current densities within the forested stands are higher than historical levels. At present, about 35-40 percent of forested stands (approximately 24000 acres) have densities that place stands at high risk for significant increases in mortality due to insect, disease and density related mortality to both the understory and overstory trees. Base line densities were calculated using Stand Density Index and Site Index (Cochran, 1994) and are located in the recommendations section of this document.

On the CP sites multi-sized understories are dominated by ponderosa pine with western juniper (Juniperous occidentalis) coming in on the drier edges. Multi-sized white fir is coming in on the CW sites. The result is an increase in overall structure of these stands.

Overall the shrub component within the watershed has increased in density with the exclusion of fire. Not only has there been an increase in density but, generally, there has also been an increase in decadence in this shrub component with the lack of disturbance.

The grass/shrub component within the analysis area has also changed with change in disturbance pattern. Fire exclusion along the desert fringe has gone from herb dominated communities to communities dominated by conifers such as ponderosa pine and western juniper. With the development of juniper woodlands this loss has been significant. In many cases no herbaceous plants or shrubs occur below juniper trees. A similar condition exists in some of the white fir dominated communities where trees such as white fir have outcompeted understory shrub and grass species for available light and water leaving little vegetation in the grass shrub layers.

In areas incapable of supporting trees, former herb and grass dominated communities now support dense stands of decadent stands of shrubs such as big sagebrush (Artemesia tridentata), and antelope bitterbrush (Purshia tridentata). In addition grazing has removed many of the fine grass fuels limiting the potential for fire to carry. Because of this, drier conditions are necessary to start and carry fire in these shrub conditions. When fires do occur they burn with a high severity and with an intensity that kills the already sparce understories of perrennial grass and forb.

Exotic species such as cheatgrass (<u>Bromus</u> <u>tectorium</u>) have replaced native shrubs decreasing habitat for wildlife such as grouse. Kentucky bluegrass (<u>Poa</u> <u>pratensis</u>) has encroached upon riparian zones competing for nutrients and water with developing aspen seedlings.

Lack of fire since the advent of fire control has resulted in an increase in fire intensity from low to moderate-high. The main conditions resulting in the increase in intensity is the increase in density, an increase in overall fuel loading (due to an increase in density), insect and disease related mortality, and an increase in ladder fuels in many stands. In August 1996 a moderate to high intensity wildfire burned approximately 4,000 acres within the watershed. Significant tree mortality occurred in many areas due to the high densities prior to the fire. The fire was lightning caused, lasting approximately 2 weeks. Islands of green trees remain standing along with significant standing dead. Within large burn areas islands of grass and shrubs remain to reseed the fire area. A monitoring program of natural seeding was placed at Alder Ridge in October of 1996. Other fires (since 1950) that were greater than 100 acres in size are listed in the table below:

2. Fire

FIRES WITHIN THE WATERSHED FROM 1950 TO 1995 (Greater than 100 acres)

Year	Name of Fire	Size
1981	Coyote	6,926 acres
1966	Tool Box	750 acres

Locations of these fires can be found in the fire shop in the Fremont National Forest Supervisors office.

Currently, an aggressive underburning program has been implemented on the District. The following table shows underburning acre attainments since 1986.

UNDERBURNING WITHIN THE SILVER CREEK WATERSHED SINCE 1986

YEAR	ACRES
1986	1,326
1987	105
1988	190
1989	300
1990	100
1992	537
1993	2,145
1994	1,420
1995	1,625
1996	4,790

The main purpose of this program is to reduce overall fuel loads, however, secondary benefits are an overall reduction in density in many stands that are suffering from overcrowding. Discussions with the two certified silviculturists on the District identify that this reduction of density is mainly in the 0-2 inch diameter classes with little change in the overall structure.

3. Productivity

Current timber production potential within the watershed is as follows:

Productivity Range(cu.ft.)*	Mean Productivity(cu.ft.)*	Number of Acres
13-30	24	10,070
31-40	36	10,945
41-50	45	7,953
51-60	55	5,079
61+	75	5,347

* Timber productivity is expressed in cu. ft/ac/yr

4. Insects and Disease

Aerial surveys from 1987 to 1995 show that three species of bark beetles have been actively working in the area. They are western pine beetle in the large diameter ponderosa pine, mountain pine beetle (Dendroctonus ponderosae) in the lodgepole and the small diameter ponderosa pine and the fir engraver in the white fir. Maps of this activity are located in the Appendix (Maps 1-4)

Three species of dwarf mistletoe occur within the watershed. Each of these are species specific to ponderosa pine, lodgepole pine, and white fir. Damage from mistletoe is potentially the greatest in those single species stands with high densities and multilayered canopies. Some stands that have been harvested in the past but have residual overstory, such as some of those located in the eastern portion of the watershed, appear to have high potential to have mistletoe rain down on uninfected seedlings and saplings.

A 1993 forest health assessment conducted on the Forest identifies a significant pocket of Armillaria ostoyae in the Alder Ridge/West Fork of Silver Creek area (See map 8 in the appendix). Due to the increased availability of host and increased densities which have created conditions for optimal transmission in the watershed, one can conclude that root rots such as Armillaria are probably increasing where densities are high.

5. Noxious Weeds

Noxious weeds occur within the watershed. Currently there are three species that have been identified and are considered noxious. They are: Carduus nutans (musk thistle), Centaurea maculosa (spotted knapweed), and Cirsium arvense (Canada thistle). Actual acreage covered by these species is small; 65.46, 14.18, and 1.31 acres respectively. The largest population of these these noxious weeds occurs with musk thistle located at the pole butte cinder pit. Both Musk thistle and Canada thistle have the potential to move great distances due to its light airborne seed. At present musk thistle is believed to have infested the entire district. Canada thistle is mainly located along well traveled roads. Spotted knapweed is moving into the watershed from the north from known heavy infestations located in Deschutes county.

6. Timber Harvest

A variety of harvest activity has taken place within the watershed analysis area since 1945. The following identifies harvest activities that have taken place since 1980 within the Fremont National Forest boundary:

Harvest activities since 1980

Harvest Activity	# of acres
Clearcut	1,329
Overstory Removals	7,022
Final Removal Cut	21
Improvement Cut	2
Shelterwood	462
Partial removal cut	4,601
Commercial thinning	79
Totals	13,516

Maps of the location of these harvest activities are located in the Appendix of this document (Maps 5, 6, and 7).

B. Riparian Vegetation

Vegetation along the riparian systems is variable in their current condition. The dominant plant association is mountain alder (Alnus incana)/douglas spiraea (Spiraea douglasii. Various herbs and grasses also occur within this association. Another similar association, mountain alder/common snowberry (Symphoricarpos albus) seems to occur in similar areas or along with this spiraea association. These associations are typically along the banks of the active channel. Where grazing and/or lowering of the water table has occurred and previously active floodplains are now inactive, such as along portions of Silver Creek, lodgepole pine (Pinus contorta)/Kentucky bluegrass (Poa pratensis) and lodgepole pine/douglas spiraea/forb associations have taken over. Lodgepole pine/douglas spirea/forb communities are also common along Indian Creek.

Western gall rust (Endocronartium harknesii) occurs in many of the riparian zones within the watershed that contain lodgepole pine. This is the result of increased humidity within these areas. In some cases, it has reached fairly significant levels.

In some cases the overstory lodgepole pine also has a mix of ponderosa pine representing the edge between the warmer ponderosa riparian types and the lodgepole types. Similarly the white fir (Abies concolor)/queencup beadlily (Clintonia uniflora) associations occurs on similar sites along Guyer Creek. In many areas along these riparian systems there appears to be a lack of a large tree component along the edges of the active stream channels.

Aspen stands within the watershed are highly scattered and generally small (less than 5 acres) with the exception of the far east end of the watershed along Winter Ridge, where an area of approximately 5,000 acres contains a significant component of predominantly aspen stands. Discussions with the soil scientist and forest ecologist identified a potential relationship with the occurrence of aspen, soil characteristics of this area (particularly shallowness of soil) and precipitation which is roughly 5 inches more than adjacent areas. Generally, the Aspen stands within the watershed are in good condition.

C. Sensitive Species

The following plants listed on the R-6 sensitive plant species list occur within the Silver Creek watershed:

Green tinged paintbrush (Castilleja chlorotica)	1,027 acres
Blue leaved penstemon (Penstemon glaucinus)	965 acres
Nodding melica (Melica stricta)	11 acres

Additionally there are 3,500 acres of unoccupied sensitive plant habitat within the watershed.

D. Range

Current range productivity is as follows:

Productivity Range**	Mean Productivity **
70-199	172
200-300	200
301-370	325
1,000-2,783	1,730

** Range productivity is expressed in pounds of air dried forage produced per acre per year.

Current range conditions are generally satisfactory (personnel communication with district vegetation manager). The Yamsay Allotment on the west side of the watershed has not been grazed for the last 4-5 seasons with the exception of some private land within the allotment. Surveys from adjacent BLM land allotments (Silver Creek-Bridge Creek and the Silver Creek Allotment) have been identified as being in generally satisfactory condition (Grazing allotment evaluations for the Lakeview resource area of the BLM 1990, and 1992).

Lack of fire has allowed for the encroachment of juniper in lower elevation areas previously dominated by grass and shrub species. The result in some of these areas is a lowered range productivity due to higher use of water by juniper and less water going to grass and shrub species.

A lack of fire has also allowed for an increase in bitterbrush within the forest and range environment. Currently there is little new bitterbrush seedling establishment and a fairly high component of overmature and decadent bitterbrush.

Stream Channel

A. Fluvial System

1. West Fork Silver Creek

West Fork Silver Creek and the major tributary North Fork Silver Creek do not flow into Thompson Reservoir. The entire length of West Fork Silver Creek is perennial. It originates at year-around springs, and annually exhibits flow through August, September, and October. Peak flows occur as a result of spring snow melt. North Fork Silver Creek has perennial flow that originates at a spring source (T30S, R12E, NE1/4, NE1/4, Sec. 24). Above the spring source, North Fork Silver Creek is intermittent.

This subshed contains 22.8 miles of perennial streams, 24.6 miles of intermittent streams and 17.3 miles of ephemeral streams. The stream has a narrow flood plain and meanders within the valley bottom. The stream gradient averages 2%, with reaches of the stream being slightly higher. Even though portions of the stream are steeper than 2%, the channel morphology displays the same general characteristics as Rosgen type C and E streams, with alluvial depositional areas and low width to depth ratios. Stream flow is relatively low because upland pumice soils tend to absorb water before it reaches the stream. Stream substrates are affected by naturally high levels of sand sized particles within upland pumice soils. Lodgepole pine trees are prevalent within the flood plain and have resulted in large amounts of woody debris within the stream channel. "Jack strawed" lodgepole pine trees within the flood plain make accessibility of the stream channel difficult for livestock and humans. Consequently, riparian areas are presently minimally affected by livestock or have no cattle grazing. Riparian vegetation including alder, willow and sedges are well established along the stream channel, with alder being more dominant than willow.

Current conditions with negative implications include numerous abandoned beaver dams located throughout the stream system. In most cases, beaver dams are no longer active and do not provide pool habitat. Sediment samples taken from potential spawning habitat areas indicate high levels of detrimental sand size material. The frequency of pools is lower than recommended by the Inland Native Fish Strategy. Residual pool depths, obtained from Level II Stream Inventories, are generally less than one foot deep. Additionally, encroachment of lodgepole pine into the flood plain is evidence that the riparian zone has narrowed and that streamside riparian areas have a lower water table than reference conditions.

2. Guyer Creek

Guyer Creek and its tributaries flow into Thompson Reservoir. Guyer Creek originates at a spring source and is perennial for its entire length. Strawberry Creek is an intermittent tributary.

This stream and subshed shows many of the same characteristics as West Fork Silver, including stream morphology, riparian vegetation and soil characteristics. The subshed contains 11.4 miles of perennial streams, 15.1 miles of intermittent streams and 8.0 miles of ephemeral streams. The stream generally has a narrow flood plain and meanders within the valleybottom. The stream gradient averages around 2%, with some reaches being slightly higher. It also is characteristic of a Rosgen Type C or E stream channel. Stream flow is relatively low because upland pumice soils tend to absorb water before it reaches the stream. Stream substrates are affected by naturally high levels of sand within upland pumice soils. Lodgepole pine trees are prevalent within the flood plain and have resulted in large amounts of woody debris within the stream channel. "Jack strawed" lodgepole pine trees within the flood plain make accessibility of the stream channel difficult for livestock and humans. Consequently, riparian areas are presently minimally affected by livestock or have no cattle grazing. Riparian vegetation including alder, willow and sedges are well established along the stream channel, with alder being more dominant than willow.

Current conditions with negative implications include numerous abandoned beaver dams located throughout the stream system. In most cases, beaver dams are no longer active and do not provide pool habitat. Sediment samples taken from potential spawning habitat areas, indicate high levels of detrimental sand size material. The frequency of pools is lower than recommended by the Inland Native Fish Strategy. Residual pool depths, obtained from Level II

Stream Inventories, are generally less than one foot deep. Residual pools in Guyer Creek are approximately 1/3 shallower than pools in West Fork Silver Creek. Additionally, encroachment of lodgepole pine into the flood plain is evidence that the riparian zone has narrowed and that streamside riparian areas have a lower water table than reference conditions.

3. Indian Creek

Indian Creek and Silver Creek (above Thompson Reservoir) reach a confluence about 2.5 miles above Thompson Reservoir and from that point downstream are named "Silver Creek". However, Indian Creek drains a larger area than Silver Creek and flows for a longer period each year. There are no perennial reaches in this subshed, although Indian Creek may at one time have been perennial, and the GIS layer currently shows 2.8 miles of perennial stream in this subshed. The majority of Indian Creeks headwaters (on US Timberlands lands) have been clearcut in the past two decades.

The subshed contains 2.8 miles of perennial stream, 11.1 miles of intermittent streams, and 11.2 miles of ephemeral streams. Flow in Indian Creek is almost entirely from spring snowmelt. Indian Creek subshed has several different stream types. Portions of Indian Creek have gradients that are less than 2% with a meandering flood plain or Rosgen Type C channel. Downcutting has resulted in approximately two miles of these reaches shifting from a Rosgen Type C to a Rosgen Type G, with active erosion taking place. Road 019 parallels the stream and construction of the road in the flood plain has decreased the active flood plain width. The stream channel has downcut within this constricted zone. Other areas of Indian Creek have Rosgen Type B channels that are confined by adjacent slopes, and appear to be stable.

4. Squaw Creek

Squaw Creek and its tributaries are all intermittent and ephemeral streams. The exceptions are short spring fed reaches that quickly become subsurface. Springs include Aspen, Peck, and Puddle. The primary source of water is snowmelt runoff from the gently sloping basalt uplands of the Winter Ridge block fault. Squaw Creek flows into Thompson Reservoir in T31S, R14E, Sec. 5.

Squaw Creek Subshed has a westerly aspect and the flow regime is largely dependent on winter snowpack with peak runoff occurring between the months of April and June. The subshed is an important source of water for Thompson Reservoir and consequently for downstream irrigation users. The subshed contains no perennial stream, 24.1 miles of intermittent streams and 6.3 miles of ephemeral streams. The subshed is long and narrow with Squaw Creek running lengthwise through the subshed.

This stream and subshed shows different flow characteristics than intermittent streams on the western portion of the watershed. Squaw Creek is within a basaltic residual soil zone, and is substantially influenced by "scabrock flats". Flow from the scabrock flats are "flashy" and produce a high volume of water which results in large runoff volumes in the stream.

Squaw Creek is composed of several different stream types. Much of the stream channel is located within alluvial depositional areas that historically had wide flood plains. Currently, most of these reaches are downcut and water generally does not have access to the historic flood plain. The stream gradient averages 2% and exhibits characteristics of Rosgen Type F in these locations. Portions of the stream are confined by gentle side slopes and have bedrock substrate. These portions are generally stable and show characteristics of Rosgen Type B stream channels.

Where channels have downcut, riparian vegetation is sparse and lacks diversity and vigor. Although portions of the watershed have historic beaver use, there are presently no sites occupied by beaver. Historic beaver sites no longer impound water or contribute to the stream system by providing pool habitat. Encroachment of conifers into alluvial depositional channels is evident.

Watershed improvement projects were performed at the lower end of the subshed where loose rock check dams were constructed. These have helped to restore the meadow by raising the water table and currently impound water in pools throughout the year (observed 1996).

5. Benny Creek

Benny Creek and its tributaries Graham Creek, Walker Creek, and Hawk Creek are intermittent streams (10.4 miles of "perennial" stream listed in the GIS data base for this subshed). The primary source of water for Benny Creek is the gently sloping basalt uplands of the Winter Ridge block fault. Its tributaries begin at lower elevations, well below the uplands of Winter Ridge. Benny Creek flows into Thompson Reservoir in T30S, R14E, Sec. 33.

Benny Creek resembles Squaw Creek, with respect to its location in residual soils, stream gradient and vegetation characteristics. The Benny Creek subshed has a westerly aspect. The flow regime is largely dependent on winter snowpack, with peak runoff occurring between the months of April and June. The subshed is an important source of water for Thompson Reservoir and consequently for downstream irrigation users. It has no perennial streams, 48.9 miles of intermittent streams, and 12.9 miles of ephemeral streams.

Benny Creek is within a basaltic residual soil zone, and is substantially influenced by scabrock flats. It is influenced by these flats to a lesser extent than Squaw Creek. Flow from the scab rock flats are "flashy" and produce a high volume of water which results in high runoff events. Much of the stream is located within areas that historically had alluvial depositional areas. Currently, most of the steam has a gradient greater than 2% and exhibits characteristics of Rosgen Type B channels. These portions have a boulder substrate and are generally stable. Small segments of the stream flow through historic alluvial depositional areas with historic flood plains. These areas have downcut resulting in lowering of the water table. Where channels have downcut, riparian vegetation is sparse and lacks diversity and vigor. Although portions of the watershed have historic beaver use, there are presently no sites occupied by beaver. Historic sites no longer impound water or contribute to the stream system by providing pool habitat.

Watershed improvement projects were performed at the lower end of the subshed where gabian rock structures were installed. These have helped to restore the channel by raising the water table. Currently there is vigorous growth of willow in these areas.

6. Silver Creek

Silver Creek is located below Thompson Reservoir. Its tributaries include Auger Creek (intermittent) and several other un-named tributaries. The volume of flow from Silver Creek is controlled by the dam at the north end of Thompson Reservoir. During very low snowpack years, Thompson Reservoir becomes nearly dry by late summer, with no flow being released from the dam. When this occurs, Silver Creek also becomes dry. Silver Creek flows into a small reservoir, (located in T29S, R14E, Sec. 5), which backs water into both West Fork Silver Creek and Silver Creek.

The subshed contains 6.3 miles of perennial streams, 23.7 miles of intermittent streams and 12.2 miles of ephemeral streams. The majority of the stream has a narrow flood plain and is confined by canyon walls. The flood plain is narrow, though not entrenched. It is classified as Rosgen Type C. Portions of the stream are shallow and wide below the Auger Creek confluence, with width to depth ratios greater than 16. Also, flood plain narrowing is evident from pine encroachment in meadow areas. There are several diversions, and stream flows are entirely controlled by the Irrigation District from the outlet at Thompson Reservoir.

7. Thompson Reservoir

Thompson Reservoir is the collection point for several streams and subsheds including Indian, Benny, Squaw, and Guyer Creeks. The majority of streams that originate in the subshed are intermittent or ephemeral and are classified as Rosgen Type C or B streams.

The area within Thompson Reservoir includes 2,600 acres of water surface that accounts for 30% of the total drainage area. The subshed contains no perennial streams, 6.1 miles of intermittent streams, and 5.2 miles of ephemeral streams. The reservoir is a sediment depositional area for streams entering the reservoir. The shallow water in Thompson Reservoir heats to levels that exceed State Water Quality Standards.

B. Channel Condition Rating

Channel condition, which integrates past climatic, physiographic and management influences, is an essential indicator of overall watershed condition. The Section 7 method (Determining the Risk of Cumulative Watershed Effects Resulting from Multiple Activities, Endangered Species Act, Section 7, 1993) identifies pool frequency, temperature, sediment and large woody debris as essential indicators. This procedure was used to evaluate the stream channel condition of the Silver Creek Watershed.

STREAM CHANNEL CURRENT CHARACTERISTICS

Stream	Reach	Bankfull Width Ft.	Wetted Width (Ft.)	Riffle Depth Ft.	Width/ Depth Ratio	Pools (No.)	Residual Pool Depth Ft.	Reach Length Mi.	Pools/ Mile (No)
West Fork Silver									
	1	13	10	1.2	11:1	144	1.2	2.3	62
	2	14	8	1.0	14:1	32	1.2	1.1	29
	3	10	7	1.1	9:1	75	1.3	1.7	44
	4	16	7	1.0	16:1	63	1.0	1.2	53
	5	13	7	1.0	14:1	70	1.1	3.1	23
	6	12	7	0.7	17:1	43	1.2	1.4	17
	7	7	5	1.0	7:1	85	1.1	2.5	34
	8	7	4	0.9	7:1	14	0.9	1.5	9
Guyer Creek									
	1	18	7	2.0	9:1	537	0.8	4.0	134
	2	12	6	1.8	7:1	224	0.7	1.9	118
	3	13	6	1.9	7:1	89	0.8	1.0	89
	4	na	na	na	na	16	0.5	0.9	18
Lower Silver Creek									
	1	32	15	2.6	12:1	19	1.0	0.7	27
	2	36	20	2.2	17:1	29	1.0	1.0	29
	3	35	24	3.8	9:1	26	1.4	0.9	29
	4	38	28	2.2	17:1	20	1.1	1.1	24
	5	36	20	2.1	17:1	24	0.9	1.1	31

STREAM TEMPERATURE °C

Elev. ft	7-Day Average Maximum Stream Temperature 1992	1993	1994	1995	1996	Mean 7-Day Temp	Annual Maximum Stream Temperature 1992	1993	1994	1995	1996	Mean Annual Max
Guyer Creek												
5360	na	na	17.0	15.0	15.6	15.9	na	na	17.4	15.6	16.5	16.5
West Fork Silver Creek												
4460	na	na	27.0	21.2	21.8	23.3	na	na	27.6	21.9	23.2	24.2
4740	27.0	21.0	27.0	22.6	22.6	24.0	28.1	21.9	27.7	23.7	23.7	25.0
4800	na	na	na	na	18.5	*18.5	na	na	na	na	19.5	*19.5
4850	na	na	na	13.7	14.8	14.3	na	na	na	14.5	15.8	15.2
5050	na	13.1	16.4	12.8	13.8	14.0	na	14.3	17.0	13.4	14.6	14.8
5580	18.2	12.7	18.0	12.9	13.3	15.0	19.0	14.1	18.8	13.6	14.0	15.9
6360	na	13.0	17.1	12.5	13.3	14.0	na	13.9	17.7	13.2	13.9	14.7
North Fork Silver Creek												
5050	na	12.7	15.4	12.3	12.9	13.3	na	13.9	15.9	13.1	13.7	14.2
Silver Creek (Below Reservoir)												
4900	na	20.2	na	na	na	*20.2	na	20.9	na	na	na	*20.9
4530	na	22.8	27.2	na	na	25.0	na	23.7	29.1	na	na	26.4

* Insufficient number of years to obtain arithmetic mean.

STREAM TEMPERATURE BY REACH
7-Day Average Maximum
Stream Temperature (Deg C)

Stream	Reach	1992	1993	1994	1995	1996
Guyer Creek	1	na	na	17.0	15.0	15.6
W.Fk Silver Cr.	1	27.0	21.0	27.0	22.6	22.6
	2	28.1	21.0	27.0	22.6	22.6
	3	*22.8	*17.4	*22.2	*18.2	18.5
	4	*17.5	*13.8	*17.4	13.7	14.8
	5	*16.4	13.1	16.4	12.8	13.8
	6	18.2	12.7	18.0	12.9	13.3
	7	18.2	*12.9	*17.6	*12.7	13.3
	8	*18.2	13.0	17.1	12.5	13.3
N.Fk Silver Cr.	all	na	12.7	15.4	12.3	12.9
Silver Cr.	1	na	22.8	27.2	na	na
	2	na	na	na	na	na
	3	na	na	na	na	na
	4	na	na	na	na	na
	5	na	20.2	na	na	na

na - information not available
*-estimated from other temperature stations

PHYSICAL STREAM CHARACTERISTICS

Reach	Channel Type Existing	Channel Type Reference	Pools per Mile Existing	Pools per Mile Reference	Large Woody Debris Existing	Large Woody Debris Reference
West Fork Silver Creek						
1	E4b	E4b	62	48-96	92	>20
2	C4b	E4b	29	66-130	143	>20
3	C4b/E5b	E4b	44	74-146	83	>20
4	C4b/E4b	E4b	53	74-146	382	>20
5	C4b	E4b	23	74-146	379	>20
6	C4b	E4b	17	74-146	330	>20
7	E4b	E4b	34	92-184	252	>20
8	E4b	E4b	9	98-196	473	>20
Guyer Cr.						
1	E4	E4	134	74-146	25	>20
2	E4	E4	118	82-164	8	>20
3	E4	E4	89	82-164	13	>20
4	E4	E4	18	82-164	38	>20
Lower Silver Cr.						
1	C3b	C3b	27	35-70	14	>20
2	C3b	C3b	29	28-55	5	>20
3	E4b	E4b	29	24-49	37	>20
4	C4b	E4b	38	14-42	33	>20
5	C3b	C3b	25	28-55	24	>20

Reach	High 7-Day Av Stream Temperature Existing	High 7-Day Av Stream Temperature Reference	% Substrate Sediment Existing	% Substrate Sediment Reference
W. Fk Silver Cr.				
1	27.0	20.0	28.5	25
2	28.1	20.0	28.5	25
3	22.8	20.0	33.5	25
4	17.5	20.0	43	25
5	16.4	20.0	43	25
6	18.2	20.0	36.5	25
7	18.2	20.0	36.5	25
8	18.2	20.0	28	25
Guyer Cr.				
1	17.0	20.0	43	25
2	17.0	20.0	43	25
3	17.0	20.0	43	25
4	17.0	20.0	43	25
Lower Silver Cr.				
1	27.2	20.0	na	25
2	na	20.0	na	25
3	na	20.0	na	25
4	na	20.0	36	25
5	20.2	20.0	na	25

Silver Creek has 1.5 miles of stream channel that are on lands administered by the BLM. Stream channel conditions have been documented by the BLM as being in good condition, with 5% eroding banks.

West Fork Silver Creek has 2.0 miles of stream channel that are on lands administered by the BLM. Stream channel conditions have been documented by the BLM as being in poor to good, with the majority of the stream channel in fair condition. This section of stream has 31% eroding banks.

Water Quality

A. General Discussion

Water quality parameters of stream temperature, fine sediment, macroinvertebrates, suspended sediment and turbidity are addressed in the following write-up. State parameters of dissolved oxygen, bacteria, total dissolved solids and toxic pollutants are not addressed as separate subjects, because data is not available.

The Oregon Department of Environmental Quality developed a list of streams that do not meet requirements of the Clean Water Act. This list list was submitted to the Environmental Protection Agency (EPA) and now composes the 303(d) list. The following streams and criteria are listed in the 303(d) list.

Water Body	Boundaries	Comment	Segment
Silver Creek	Mouth to Thompson Res		42A-SILVO
Temperature-Summer		USFS Data (1993,1994)	
West Fork Silver	Mouth to Silver Cr. Marsh		42A-SIWFO
Temperature-Summer		USFS Data (1992,1993,1994)	
Biological Criteria- Summer		USFS DATA (1989, 1990,1994 BCI=65	

B. Fine Sediment

The USDA Forest Service took physical samples from potential spawning habit areas or potential redd areas. Locations of samples and sieve sizes were selected using references from Reiser and Bjornn (1979). This literature identifies detrimental fines as those passing the 6.4 mm sieve and smaller. Six reaches were sampled within the National Forest Boundary. Sieve analysis was performed in the laboratory to determine the percent fines by volume. The average of the five samples per reach is shown below.

USFS PHYSICAL MEASUREMENTS
OF FINES IN SPAWNING HABITAT

Stream	Elevation	% Fines < 6.4 mm
West Fork Silver Creek		
	Above Silver Creek Marsh	31
	Below Silver Creek Marsh	26
	At lower end of Subshed	45
Guyer Creek		
	Above Road 3038 Stream Crossing	41
	At upper end of Subshed	40
North Fork Silver Creek		
	Above Road 3038 Stream Crossing	41

C. Water Temperature

Water temperatures in the Silver Creek watershed were addressed in the 517 East Environmental Assessment and the Yamsay Allotment Environmental Assessment. Stream temperature data collected during the summer months is available for Guyer Creek, West Fork Silver Creek and Northfork Silver Creek. Temperature is an important component of these streams as they support salmonid fish populations including native redband trout, brook trout and stocked rainbow trout. Results of stream temperature monitoring are shown in the Current Conditions section, Stream Channel.

D. Macroinvertebrates

Aquatic macroinvertebrates are an important component of aquatic ecosystems. Macroinvertebrates process vegetative material that enter streams and are an important food source for fish. Species of macroinvertebrates vary greatly depending on the water quality within the stream. Chemical and biological conditions and amount of sediment in the stream all influence macroinvertebrate communities. Macroinvertebrates were used by the Fremont National Forest to monitor West Fork Silver Creek in 1989, 1990 and 1994. Aquatic macroinvertebrate samples along with physical habitat information and water quality test results were sent to the National Aquatic Ecosystem Monitoring Center, in Provo Utah. A Biotic Condition Index (BCI) of each site was obtained by the laboratory that is used to rate and provide general information regarding the integrity and health of stream systems. Through this analysis the following ratings were obtained:

MACROINVERTEBRATE INFORMATION
West Fork Silver Creek

1989 BCI Rating	1990 BCI Rating	1994 BCI Rating
95 (Excellent)	86 & 75 (Good & Fair)	65 (Poor)

E. Summary of Macroinvertebrate information

Macroinvertebrate samples show an overall decline in habitat conditions since monitoring was started in 1989. Overall, the habitat conditions have gone from excellent (BCI 94) to poor (BCI 65). The data from each year is explained below:

1989 Summary - Macroinvertebrates showed warning numbers of taxa tolerant to sedimentation and gave indications of some organic enrichment. Indications were that water quality, instream substrate and a potential for fisheries were good. Presence of cleanwater species indicated there should be suitable spawning substrate available. The BCI value of 94 indicated that this ecosystem was close to its potential; however, it appeared there may be opportunities for management to improve the instream habitat quality and possibly water quality in this aquatic ecosystem.

1990 Summary - Samples were taken from this location in both June and September of this year. The June sample was the best of the two samples, with a BCI of 86. There were indications of sediment and organic enrichment. There appeared to be good potential for a fisheries. The BCI of 86 indicated that this stream was in good condition but could be better. It appeared there may be some opportunity for management to improve instream habitat quality in this aquatic ecosystem. The September sample was rated lower with a BCI of 75. The range of BCI's changed from good to fair. There were also indications of high sediment levels. Compared to data from August 1989, analysis elements indicated a negative trend. There appeared to be a fairly good potential for a fishery at this station. The clean water taxa present indicated that there should be some suitable spawning substrate. The BCI of 75 indicated fair conditions were present in the stream reach. It also indicated that management opportunities may exist to improve the instream habitat quality in this aquatic ecosystem.

1994 Summary - There were indications of sedimentation and organic enrichment. The BCI of 65 indicated poor conditions were present in the stream reach. It appeared there may be opportunity for management to improve instream habitat quality and possibly water quality in this aquatic ecosystem.

F. Suspended Sediment and Turbidity

Baseline monitoring on West Fork Silver Creek was performed between 1979 and 1985. The monitoring location was below the Silver Creek Marsh Campground. Buck Creek and Bridge Creeks (outside of the Silver Creek Watershed) were also monitored for comparison purposes. Monitoring results showed the highest suspended sediment concentrations and turbidity readings of the three streams to be in Westfork Silver Creek. This occurred early in the snowmelt hydrograph, when the lower elevations contributed the highest proportion of runoff to the total flow. This declined as the season progressed. As a result of this monitoring, recommendations were made to emphasize work in West Fork Silver Creek, below the Silver Creek Marsh Campground.

G. Point Sources of Pollution

There are no known point sources of water pollution within this watershed.

Species and Habitat

A. Terrestrial

1. Threatened, Endangered, and Sensitive Species

a) Northern Bald Eagle

Three bald eagle management areas (BEMA's) enclosed by a single proposed bald eagle consideration area (BECA) occur in the watershed. A BEMA at Thompson Reservoir contains an active nest site which has been known since at least 1973. A potential nesting and winter roosting proposed BEMA north of Thompson Reservoir is identified in the Fremont National Forest Bald Eagle Management Plan (1981). An active winter roosting proposed BEMA, formerly identified as a potential roost in the same 1981 plan, is located along Silver Creek. Winter use at this roost was first observed in 1978. Total acres within the BECA are 17,500. Acreage for each BEMA follows.

Active Nest Site BEMA - 5,500
Potential Nest/Roost BEMA - 1,900
Active Winter Roost BEMA - 2,000

Many forest stands within the BECA presently have overstocked understories that are contributing to light mortality of overstory trees, understories infected with mistletoe, and understories of white fir that are competing with or excluding the establishment and growth of preferred ponderosa pine trees. Preferred nest/roost trees are large diameter (>30" dbh) ponderosa pine with large lateral and widely spaced limbs. This overstocked condition has also increased the risk of stand replacing wildfire. The Alder Ridge fire in 1996 posed a serious threat to large diameter overstory trees and future potential habitat within the BECA along Silver Creek canyon.

Past overstory removal of large diameter ponderosa pine in some of the stands within the BECA has eliminated nest/roost trees and changed the habitat capability from suitable to future potential. Stands with future potential presently lack suitable trees, but could be managed to develop future nest/roost trees. The projected number of years to attain suitable habitat in these stands ranges from 60 to 250 years.

The current suitability of forest stands for nesting/roosting in the BECA was ranked into 3 classes in the table below: 1) currently suitable, 2) future potential and 3) low potential or nonsuitable.

National Forest Lands

Suitability	# of stands	Acres
Currently suitable	124	2,900
Future potential	70	1,400
Low potential/Non-Suitable	144	10,400
Total	338	14,700

BLM Lands:

	Acres
Currently suitable	400
Low Potential/Non-Suitable	2,300
Total	2,700

Suitable nest/roost habitat generally has the largest, oldest and most open-structured trees available in the area.

Past road construction and development of campground facilities around Thompson Reservoir have reduced the habitat security and possibly hunting opportunities for eagles below reference conditions. It is suspected that during years when the reservior is maintained at near full water capacity and fishing is good, that recreational boating and fishing activities could directly affect fledgling production.

b) American Peregrine Falcon

Approximately 21 cliff sites have been identified as potential falcon nesting habitat (White, et al. 1980). No surveys of these potential nesting sites have been conducted since 1980. It is unknown if peregrines presently occupy any of the sites. New criteria for suitable peregrine habitat has increased the possibility these sites may be more suitable for occupancy than originally thought. None of the sites have been designated as Management Area 2. Potential sites in each subshed are listed below.

West Fork Silver Creek	2
Silver Creek	18
Squaw Creek	1

Habitat for prey species and hunting around these potential nest sites has improved where the removal of LOS forest has increased the area of more open early seral forest cover types. Habitat has declined where open, park-like LOS pine stands have succeeded to stands with dense understories and mixed conifer composition. The Alder Ridge fire in 1996 also has increased the area of foraging habitat along Silver Creek canyon. Disturbance sources have increased with a higher road density, more commercial logging activity, development of campground facilities around Thompson Reservoir with its attendant increase in boating and fishing activities when reservior levels are high, and greater recreational use of the area.

3. Western Sage Grouse

A lek site is located near the Forest boundary along West Fork Silver Creek. The site is about 80 acres, with about 60 acres in BLM ownership and the remainder in Forest ownership. The earliest recorded survey for the site is from 1959. Eleven birds, the most ever observed, were at the lek. The last time birds (4) were observed on the lek was 1970. No surveys of the lek were conducted from 1971 to 1981. The last known survey date was in 1981 when no birds were observed around the lek area. It is possible that the site has been abandoned or the grouse that formerly used the area have been extirpated. Since the exact location of the site is in question, a description of present habitat conditions is not possible.

2. Keystone Species

a) Big Game

The watershed is located within the Silver Lake Big Game Management Unit for deer and elk, and the South Central Elk Management Zone. Three herd ranges, the Winter Ridge and Yamsay elk herds, and the Silver Lake deer herd occur here. Silver Creek and Thompson Reservoir are the boundary for the two elk herd ranges which cover about the same amount of area in the watershed. The entire watershed is suitable habitat for deer and elk. Generally, all seasonal habitats are in a state of advanced plant succession, and thus have a reduced carrying capacity to support big game.

Deer occur throughout the watershed year round, but their seasonal distribution and density is regulated by weather conditions. Seasonal range areas for both species are listed below.

Big Game Seasonal Ranges

Species	Seasonal Range		
	Winter	Transitional	Summer
Deer	7,400	19,000	69,000
Elk	35,000		67,000

Of the 7,400 acres of deer winter range, 2,700 acres are Forest Service (Management Area 1), 4,500 acres BLM, and 200 acres private. The majority of deer winter outside the watershed to the north and east on the 100,000+ acre Silver Lake winter range.

Elk distribution is more limited to pockets of preferred habitat, but they also occupy the watershed year around. A calving area has been identified in the upper Squaw and Benny Creek subsheds, just to the west of Fremont Point. Foster (1994) found that calving areas were primarily associated with riparian/meadow/mesic soil sites near timber in these two elk herd ranges. Animals from these two herds share common winter ranges. Animals from both herds winter in the vicinity of Foster Butte, Sycan Butte and lower elevations between Foster Butte and Hager Mountain until snow depth pushes them to the north of Hager Mountain. Because elk numbers are still low relative to the amount of available/suitable habitat, the herds are highly mobile and shift frequently among pockets of preferred habitat.

Deer herd numbers peaked during the 1960's. Deer numbers declined during the 1970's, but remained above populations prior to 1960. The population showed a recovery during the 1980's, but remained below the peak in the 1960's. The population declined again during the early 1990's, but relatively high productivity and survival the last 3 years have allowed the herd to reach its population management objective. The current ODFW population management objective for the deer herd is 10,300 wintering animals. In 1996, the herd was estimated to be at 98% of the objective. The population trend during the 1990's appears to be relatively stable, but erratic.

The elk population for the Yamsay herd is approximately 500 animals and for the Winter Ridge herd about 300 animals and both are steadily increasing. Estimates as high as 1,300 animals for the two herds have been reported. Populations expanding their range into previously unoccupied habitat generally exhibit such a growth pattern until their population reaches the carrying capacity of the habitat. The population management objective of 3,000 animals is targeted for attainment sometime in the first decade of the year 2,000.

A major north/south spring/fall migration corridor for deer occurs just to the west of Silver Creek and Thompson Reservoir and east of Alder Ridge. The Alder Ridge wildfire has eliminated cover over a large area of this corridor for at least the next 15 years. Deer may alter their movements in response to both the absence of cover and forage on the area. However, as early seral vegetation becomes established over the burn area, deer may begin to concentrate here during both spring and fall migration. Other major corridors for both deer and elk occur along Squaw, Benny and just north of Chocktoot Creek. These corridors connect the Winter Ridge winter range with summer habitat to the west.

Riparian habitat conditions for fawning, calving and rearing, especially along intermittent stream channels, are still in the degraded condition evident since as early as 1929 (Rameriz 1994). Deciduous woody plants and the diversity of native herbaceous vegetation for forage and cover have either declined or been lost. Wetland and riparian associated vegetation has been slowly recovering from its degraded condition prior to 1945, but woody and diverse herbaceous cover is still less than desired for high quality fawning habitat.

Cover habitat has increased over that present in 1945. A ratio of 40-45% cover to 55-60% forage is recommended by several researchers as being the most suitable habitat conditions on deer and elk seasonal ranges. The increase in the understory component of both white fir and ponderosa pine in forest stands since 1945 has improved cover conditions for deer and elk. Dense thickets of younger understory fir, and to a lesser extent pine, over a greater proportion of the landscape are a significant departure from the open park-like, single story appearance of historical pine forests. To the extent that stands are now overstocked and composed of "off-site" species (ie., climax or subclimax species, white fir, that are adapted to moisture regimes that exceed the long-term average for the site), they represent inherently unstable cover condition. Much of the current loss of cover to natural causes can be attributed to this phenomenon. Attempts to maintain such inherently unstable timber stands for cover may well be self-defeating. Small scale natural disturbance openings in the forest are less common. Mixed conifer and lodgepole pine forests have encroached in wet and dry meadows. Juniper density and distribution have increased dramatically on transition and winter ranges. Tree plantations on regeneration harvest units and wildfire areas are beginning to provide cover in many areas. This increase in coniferous forest is providing more cover for big game. Cover provided by now decadent curlleaf mountain mahogany patches and columnar/subcolumnar bitterbrush stands may be less effective than prior to 1945.

The habitat effectiveness (HE) index and total proportion of hiding cover on deer seasonal ranges, by subshed, is compared to Forest Plan standards and guidelines below:

Subshed	Seasonal Range	Current HE(%)	Forest Plan HE(%)	Current Cover(%)	Forest Plan Cover(%)
Benny	Summer	57	50	41	30
Silver	Summer	48	50	38	30
Silver	Transition	50	60	45	30
Squaw	Summer	58	50	35	30
Thompson	Summer	69	50	44	30

HE and cover data were not available for West Fork, Guyer and Indian subsheds.

Coincidentally, the total area of foraging habitat has declined since 1945. Overstocked forest stands have reduced the density of understory herbs and shrubs through shading, litter accumulation, competition and lack of bare mineral soil for seedling establishment. Despite the loss of forage base, the suitability of forage areas present may be somewhat better. This is explained by the increase in created openings and edge habitat adjacent to denser forest cover (Table SH-T3). Small forage openings interspersed with effective hiding cover within 600 feet of the edge of cover/forage is a more effective habitat condition than extensive, contiguous areas of open park-like LOS pine forest. Two large wildfires (Toolbox, 1966 and Coyote, 1981) created transient large forage areas which were planted to ponderosa pine. Both areas now support a less abundant forage resource, but with hiding cover now provided by the plantations. A large proportion of private land on the Coyote burn was not planted and still serves as a non-forested forage area. Likewise, growth of plantations on regeneration cutting units is gradually reducing forage resources. The increase in the density and distribution of juniper on transition and winter ranges also has reduced the availability and abundance of forage. The recent Alder Ridge fire (1996) has significantly influenced the forage resource on about 3,600 acres of deer and elk summer and deer transition ranges. There has been a short term loss of browse species, but there should be an immediate flush of herbaceous species next spring. Until it can re-establish itself from seed, the greatest impact may be the loss of bitterbrush. The recent upward population trend exhibited by the both the deer and elk herds indicates that an adequate forage base still exists to support the current populations. Therefore, more subtle characteristics of the forage resource not apparent at the landscape analysis scale such as an increase in forage availability, quality and/or quantity may have occurred to compensate for the loss of total forage area.

One particular forage species, curlleaf mountain mahogany, occurring on both transition and winter ranges, is a highly palatable and preferred browse for both deer and elk that merits special attention. Being evergreen, its nutritive value (12% protein) and digestibility ratings (50%) in winter are high compared with other browse species. Curlleaf is one of just a few shrubs that exceeds the protein requirements for wintering animals (Welch and McArthur 1979). Vigorous mahogany patches also provide both hiding and thermal cover. Curlleaf stands in the watershed appear to be in relatively poor condition. Plants are highlined, decadent, even-aged and produce little accessible browse and little reproduction within the understory. High mortality is evident in some patches. Shading, litter accumulation, competition and lack of bare mineral soil have reduced the opportunity for seedling establishment. Most of these characteristics also portray the current condition of bitterbrush stands. Both species are characterized by older age classes in advanced stages of plant succession.

Habitat security has steadily declined since 1945. Road densities now exceed the desired condition for habitat security for both deer and elk on all seasonal ranges in most parts of the watershed (See table SH-T1 next page).

TABLE SH-T1
ROAD DENSITY REPORT
BIG GAME SEASONAL RANGES
in the Silver Creek Watershed Assessment area
ROAD DENSITY by BIG GAME SEASONAL RANGES by SUBSHEDS

SEASONAL[1] RANGE	SUBSHED[2]	ACRES	ROAD[3] MILES	ROAD DENSITY	FOREST PLAN STANDARD
DFF	A	6400	21	2.07	< 1.0
BSU	A	11100	65	3.78	< 2.5 (<1.0)
DFFESU	A	6500	42	4.20	< 1.0
BSU	B	11600	81	4.45	
BSU	C	8500	57	4.29	
DSUEWR	C	280	3	7.02	<2.5 (<1.0)
BSU	D	730	5	4.33	
DSSESU	D	360	1	1.56	< 1.0
DSUEWR	D	6300	48	4.88	
ESU	D	5000	28	3.50	< 1.0
DSUEWR	E	15900	84	3.37	
ESU	E	9500	48	3.21	
DSSESU	E	470	2	2.52	
BSU	E	500	3	4.44	
DFF	F	730	1	0.58	
BSU	F	1540	12	4.85	
DFFEWR	F	6370	34	3.38	
DFFESU	F	3600	19	3.36	
DSUEWR	F	4000	25	4.00	
BSU	Z	6900	24	2.2	
DSUEWR	Z	1900	8	2.87	
DFFESU	Z	2	0	0	
TOTALS					

[1]CODE & DESCRIPTION

BSU=Both Deer and Elk-Summer range
DFF=Deer-Fall transitional range
DSFESU=Deer-Spring & Fall, Elk-Summer range
DSS=Deer-Spring transitional range
DSU=Deer-Summer range
ESU=Elk-Summer range
DWW=Deer-Winter range
EWR=Elk-Winter range

[2]WATERSHED SUBSHEDS

A. West Fork Silver Creek
B. Guyer Creek
C. Indian Creek
D. Squaw Creek
E. Benny Creek
F. Silver Creek
Z. Thompson Reservoir

[3]Numbers are approximate.

b) Beaver

Trapping records from 1952 through 1980 and the presence of old beaver sign both indicate that the transplanting effort in the late 1930's and early 1940's was a success. In 1952, a letter from the Fremont Forest Supervisor requested trapping to remove beaver in the West Fork. Nineteen beaver were trapped that year. Trapping harvest for Silver Creek follows.

Decade	Number of Beaver Harvested
1952-59	52
1960-69	83
1970-79	23

During this same period only 4 beaver were removed from Guyer Creek. The lower harvest in 1970-79 probably was partial the result of a trapping closure order for all streams within the Fremont Forest. This closure was lifted in 1977 for the Silver Lake Game Management Unit for a 10 year period. Since 1988, all streams on the Forest have been closed to beaver trapping.

Old beaver sign indicates that beaver did disperse from the original transplant sites. At one time, beaver were present in all 4 perennial streams and 3 currently intermittent streams (Benny, Strawberry and Squaw Creeks) in the watershed. To supplement populations in the late 1970's, beaver again were released in Guyer and Silver Creek.

Currently, there are only 2 active colonies, one at Silver Creek marsh and the other in upper Guyer Creek. More potential habitat exists than is presently occupied in the watershed. These areas correspond primarily to sites of previous beaver activity. The current habitat condition at these sites has not been evaluated, but is suspected to be at least fair and capable of supporting one or more colonies. Potential habitat on perennial streams presently capable of supporting beaver colonies includes:

Stream	# of Potential Colony Sites
North Fork	2
West Fork	4
Guyer	2

Intermittent streams formerly supporting beaver presently show evidence of riparian habitat degradation and a lowering of the water table. While the riparian vegetation is slowly recovering, degraded channel conditions, the lower water table and altered flow regimes persist. Marginal foraging habitat exists at formerly occupied sites, but successful colonization will be totally dependent on retention of sufficient year around water. Sites on intermittent streams formerly supporting beaver follow:

Stream	No. of Former Occupied Sites
Benny (Hawk & Graham)	3
Strawberry	1
Squaw	1

Indian Creek, although not known to be formerly occupied habitat, also supports riparian vegetation providing potential foraging habitat. However, like other intermittent streams, sufficient year around water may be the factor limiting beaver presence.

3. Management Indicator (MI) Species Associated with Late/Old Forest Cover and Dead Wood Habitat

a) General

Dedicated old-growth forest habitat (Management Areas 3 and 14) occurs over about 4,100 acres. Another 6,900 acres of forest cover have been identified as meeting the criteria for old-growth habitat, but are not designated stands. About 400 acres of lodgepole pine have been designated as replacement stands for old-growth lodgepole habitat. An additional 10,000 acres of forest cover, mostly ponderosa/white fir, has been identified as being in a late seral condition. The abundance, distribution, connectivity and quality of suitable habitat for MI and other species associated with dead wood and LOS forest habitats, especially ponderosa pine, has been significantly reduced since 1945 (See table SH-T2). Species composition and structure has changed from open, park-like, clustered large tree ponderosa pine habitat to a dense, closed, multi-storied pine or mixed conifer forest at higher elevations (especially above 5,500 feet elevation, and north and east aspects down to 5,000 feet elevation). About 20% (2,100 acres) of the early/mid-seral lodgepole pine present in 1945 has succeeded to a late condition class.

Large diameter live trees, snags, and down wood are conspicuously absent from scattered disturbance patches across the landscape, and greatly reduced in abundance and distribution on other areas. Overstocked understories in some stands are causing overstory mortality of large trees and unraveling the late/old seral forest character. High tree density has probably reduced cone production. The forest landscape is now fragmented by disturbance patches of early and mid-seral forest habitats (See table SH-T2). The number of disturbance patches has increased almost 10-fold since 1950, improving habitat conditions for species associated with early and mid-seral forest cover.

The area of interior LOS forest habitat has been reduced 29%, from 42 to 19% of the total forested acres (See table SH-T2). Only 30% of the interior ponderosa pine habitat present in 1945 exists today. The proportion of LOS forest providing interior habitat also has declined 27% and is now only 15% of what existed in 1945. The mean patch size of interior habitat is only 2% of what was present in 1945. The number of interior late/old forest patches has more than doubled since 1945. Late/old forest cover is now strongly influenced by ecotone effects from the significant increase in edge. Disturbance patches have created gaps and significantly fragmented the habitat. At a finer spatial resolution, a high road density (Table SH-T1) has added to the increase in edge and fragmentation of habitat. Many isolated LOS patches are now sink habitats for MI and other associated species whose populations cannot be maintained without continuous immigration from nearby source habitats and populations. Populations of most species are probably lower than historically, and isolation and crowding threaten their stability. The present condition of LOS forest habitat favors those species whose preferred habitat is dense, closed, multi-storied pine, pine associated and lodgepole pine, and negatively affects those associated with open canopied, irregularly stocked, large ponderosa pine.

TABLE SH-T2
TOTAL LATE/OLD SERAL INTERIOR FOREST COVER
IN THE
SILVER CREEK WATERSHED
FROM THE PERIOD 1947 THROUGH 1994

	1947	1994
ACRES	34,500	10,500
NUMBER OF PATCHES	90	190
PATCH DENSITY	0.08	0.09
% LATE/OLD PATCH IN INTERIOR AREA	32	5
MEAN ACRES/PATCH	263	4

TABLE SH-T3
TOTAL DISTURBANCE - PATCH COVER
IN THE
SILVER CREEK WATERSHED
FROM THE PERIOD 1947 THROUGH 1994

	1947	1994
NUMBER OF PATCHES	130	1,190
MEAN ACRES	190	40
TOTAL PERIMETER (km)	643	2,391
MEAN PERIMETER (miles)	3	1
PATCH DENSITY	0.10	1

Disturbance patches are created by wildfire, timber harvest and windthrow.

a) Goshawk

At least eight nest sites are known to exist within the watershed. However, recent activity has only been verified for 3 of these sites. One active nest site has been identified in the upper Benny Creek and one in the Thompson Reservoir subsheds. An alternate nest site also is located in the Upper Benny Creek subshed. Post family fledgling areas have been mapped for all sites.

Overall, habitat suitability and availability for nesting has declined in all subsheds since 1945. The gradual loss, increased fragmentation, and species/structural change of the once more open, large tree LOS ponderosa habitat, with smaller scale horizontal and vertical heterogenity substantially modified nesting habitat conditions. The succession of about 2,100 acres of early/mid-seral lodgepole to late lodgepole may have increased nesting habitat suitability in this forest type. The abundance of prey species associated with open LOS forest cover and deadwood has also declined in overall distribution. Prey species in the present dense, closed, multi-storied pine forests that are dependent on high cone crop production probably are a fraction of the populations supported by the more open, large tree pine forests which produced more abundant cone crops. Local pockets of remaining LOS, especially mixed conifer and lodgepole pine, where tree mortality has recently increased may be experiencing some increase in prey associated with deadwood habitat. Availability of this prey may be compromised by high understory tree densities in overstocked stands. Increased shading from dense understories and accumulated fuels have reduced herbaceoous and shrubby understories that provide food and cover for goshawk prey, increased prey escape cover and hindered flight. Heave slash accumulations in some harvest units likewise limits prey resources. Disturbances have gradually increased since 1945 reducing habitat security for nesting birds. Disturbance patches created since 1945 have probably increased the availability of open/edge foraging habitat and increased the diversity of prey species associated with these conditions. However, the same conditions also attract edge associated raptors such as great horned owls and red-tailed hawks which prey on goshawks nestlings and displace gowhawks from occupied territory. The gradual succession of these patches toward mid-seral structural stages is slowly reducing the amount of this habitat available to goshawk.

b) Pileated Woodpecker

Three active foraging areas have been identified: one each in upper Guyer Creek, upper West Fork Silver Creek, and Hager Mountain. Older foraging sign indicates that potential habitat may exist in the Winter Ridge, upper Benny Creek, Foster Butte and Sycan Butte areas. Approximately 400 acres of MA 14 have been dedicated for these birds around Hager Mountain. Pileated woodpecker average home range size is 900 acres of forest, of which at least 25% should be in old seral condition and the remainder in mature (trees >30cm dbh). Home range sizes for pileated in the watershed may be larger because of the high proportion of less suitable ponderosa pine habitat that occurs in most of the watershed.

Overall, suitability and total acres of foraging habitat, and possibly nesting habitat, have increased since 1945. The increase is a result of forest succession from a single story ponderosa pine to a multi-storied mixed conifer forest with a larger component of white fir in most stands above 5,500 feet in elevation, and many stands on north/east aspects down to 5,000 feet (See tables in Wooley 1994). Contributing to this in recent years is the overstory mortality occurring in larger diameter fir and pine from drought conditions, overstocked stands and increased disease and insect activity.

The snag and down log habitat this situation has created has improved habitat conditions and prey availability. However, because this habitat occurs in relatively small patches and is fragmented by early/mid seral disturbance patches and extensive areas of less suitable ponderosa pine habitat from which the overstory has been removed, isolated source-sink habitats and populations probably exist. This creates a situation wherein most of the dispersing juvenile birds in local populations exist in habitats which cannot maintain the population. The increase in habitat suitability may not translate into an overall increase in the population, but merely to an increase in immigrants into marginal habitat that cannot support productive pairs.

c) American Marten

Hager Mountain, Winter Ridge and the Antler-Buck Semi-primitive area are the 3 general areas that provide potential marten habitat. The only confirmed marten sign is in the Antler-Buck area.

Both habitat availability and continuity have declined in all subsheds, but suitability may have increased in some fragmented patches of remaining LOS forest habitat since 1945. The increase in habitat suitability in is a result of forest succession from an open, single story ponderosa pine to a multi-storied mixed conifer forest with a larger component of white fir in most stands above 5,500 feet elevation, and many stands on north/east aspects down to 5,000 feet (See tables in Wooley 1994). Also, succession of early/mid seral lodgepole to late seral lodgepole on a much more limited scale has improved habitat conditions. Contributing to this in recent years is the overstory mortality occurring in larger diameter fir and pine from drought conditions, overstocked stands and increased disease and insect activity. The snag and down log habitat this situation has created has improved habitat conditions and prey availability for marten. Denser understory and canopied stand conditions provide more mesic conditions for preferred prey species and provide cover from predators. The more complex physical structure, especially near the ground, of multi-storied mixed conifer forest habitat appears to address the three most important life needs of marten. It provides protection from predators, access to subnivean spaces where most prey are captured in winter, and protective thermal microenvironments, especially in winter (Buskirk and Powell 1994). However, because of the overall loss and fragmentation of LOS forest habitat from early/mid-seral disturbance patches and extensive areas of less suitable ponderosa pine habitat from which the overstory has been removed, the potential of remaining LOS forest habitat to support martens may not be any different, and potentially less, than the potential that existed in 1945 with the more contiguous, smaller scale horizontal and vertical heterogeneity present in the less suitable LOS pine dominated forest cover. Bull (personal communications) has found that marten prefer continuous forest cover and multi-canopy forest is important for cover against predation. She noted that home range size, juvenile dispersal distance and mortality increase, and productivity decreases in fragmented forest landscapes.

The loss of moist and mesic riparian vegetation associated with lowered water tables along intermittent and perennial stream systems also has reduced the suitability of foraging habitat for marten. The most important prey of marten, Microtus species, are highly associated with dense herbaceous meadow and riparian habitats.

d) Three-toed/Black-backed Woodpeckers

Only about 2,000 acres of LOS lodgepole pine are available as the most suitable habitat for black-backed woodpeckers. Another 5,000 acres of younger seral lodgepole is future potential habitat. About 20,000 acres of less preferred, but suitable LOS pine/fir habitat with scattered individuals and patches of lodgepole also is available to these birds.

All subsheds have potential habitat for black-backed woodpeckers. However, habitat availability and suitability across all subsheds has declined since 1950 (See table SH-T1). This decline is partially a result of the loss of LOS pine forest and of forest succession in remaining LOS forest from a ponderosa pine to a more mixed conifer forest with a larger component of white fir in most stands above 5,500 foot elevation, and many stands on north/east aspects down to 5,000 feet. Black-backs prefer true pine types for foraging. Also, maximum and mean stand size and interior habitat of LOS forest habitat have declined since 1945. Black-backs prefer larger contiguous stands (>500 acres) to fragmented patches of LOS forest cover interspersed with early/mid-seral disturbance patches. Jackson (1995) also noted that most lodgepole and mixed conifer stands from which lodgepole had been previously harvested were generally of minimal or no value as habitat for black-backed at this time due to a lack of dead trees and the open character of the stands.

Foraging sign has recently increased across the watershed in association with increased bark beetle activity in the LOS pine stands. Overstory mortality occurring in larger diameter fir and pine in recent years from drought conditions, overstocked stands, and an increase in disease and insect activity have created snag habitat to improve nesting habitat conditions and prey availability. Jackson (1995) noted a larger amount of dead standing material in remaining thick stands of lodgepole pine provides fair to good foraging and nesting habitat. The recent (1996) Alder Ridge fire area has the potential to develop into an excellent food source depending on the intensity of salvage logging that occurs over the next few years. The black-backed woodpecker is a specialized species in terms of foraging because its diet is largely bark beetle larvae which are reached by flaking bark chips from tree trunks. They forage almost exclusively on snags and live trees, almost to the exclusion of down log habitat. Local movements and small concentrations of birds occur in response to local temporary sites of high beetle activity. The increase noted in foraging sign may reflect more of a change in distribution of foraging activity than a large increase in bird numbers, especially considering the overall decline in habitat availability/ suitability across the watershed.

4. Dead Wood Habitat Management Indicator Species

a) Primary Cavity Excavators

All subsheds have probably experienced a decline in populations of primary excavating species since 1945. Populations are surmised to be minimally to marginally viable at present (Table SH-T4). Number of acres of potential habitat has declined and distribution has become more restricted as large snag and down log habitat has been reduced through the loss of LOS forest cover. Jackson (1995) noted that snag densities are generally variable with relatively high numbers in areas of light or little management activities and low numbers in areas of intensive management. LOS forest fragmentation has also increased the amount of forest edge and reduced interior LOS area. Edge habitat frequently predisposes species associated with more insular LOS forest conditions to higher risks of predation. Extensive removal of large overstory trees throughout the watershed also has reduced the abundance of future large snag and down log replacement habitat.

The quality of the remaining suitable habitat has improved in recent years due to the increased tree mortality in LOS forest cover, especially lodgepole pine. The snag and down log habitat this situation has created has improved habitat conditions and prey availability. This may be perpetuating a source-sink habitat and population situation wherein most of the juveniles dispersing from these scattered higher quality habitats establish territories in more marginal habitats which cannot support productive pairs.

Excavators associated with open, single-storied LOS ponderosa pine forest cover, like white-headed and Lewis woodpeckers, undoubtedly have experienced the greatest decline in habitat availability/suitability and bird distribution and numbers. This decline is a result of forest succession from a ponderosa pine to a multi-storied mixed conifer forest with a larger component of white fir in most stands above 5,500 feet in elevation, and many stands on northeast aspects down to 5,000 feet. Stand densities also have increased to the detriment of these species which prefer more open understory stand structure.

TABLE SH-T4
PRIMARY CAVITY EXCAVATORS POPULATION VIABILITY VALUES

Subsheds	1994
West Fork	0.40
Guyer Creek	0.50
Indian Creek	0.32
Squaw Creek	0.27
Benny Creek	0.31
Silver Creek	0.32
Thompson Creek	0.34

*Population viability values defined:
0.00 = Non-viable, less than 20% of maximum potential population
0.10 = Marginally viable, between 20 and 40% of maximum potential
0.40 = Minimum viable, between 40 and 60% of maximum potential
0.70 = Viable, between 60 and 80% of maximum potential
1.00 = Highly viable, between 80 and 100% of maximum potential

b) Red-naped sapsucker

LOS aspen clones, the preferred habitat of both red-naped and Williamsons sapsuckers, has very limited distribution throughout the watershed. Approximately 200 acres of aspen may occur in the watershed. About 2,500 acres have been typed as having an aspen ecoclass potential along Winter Ridge. Most of the aspen clones occur along drainage bottoms, around spring and seeps, on north aspects and at the higher elevations. Concentrations of aspen appear along Winter Ridge, upper Guyer Creek, and upper West Fork Silver Creek. Patch size is small (generally <5 acres in size) and patches have a clumped distribution. Many clones are generally in a mature, declining to overmature and decadent condition with little regeneration evident to replace the stand. The limited regeneration that does occur shows light to severe damage by ungulates, especially deer. Most clones also are mixed with conifer species that are contributing to the decline of the stands. The distribution and total acres of aspen are undoubtedly less than what occurred earlier in the century. This loss of preferred habitat for sapsuckers, several neotropical bird species and beaver undoubtedly is a contributing factor acting to limit the populations and distributions of these species and other aspen associated species on the landscape.

B. Aquatic

1. General

Surveys in 1992, identified redband trout (Onchorhynchus mykiss spp.) in perennial streams of West Fork Silver Creek and Guyer Creek. Habitat exists in North Fork Silver Creek, where no fish were found in the survey. Habitat also exists in lower Silver Creek, however, no survey was conducted. In 1968, Behnke was unable to find redband trout in tributaries to Silver Creek, with only brook trout found during this survey, (Behnke, 1992).

Redband trout is a USDA Forest Service Region 6 sensitive species. The inland redband trout are defined as all inland, non-anadromous rainbow (Onchorhynchus mykiss) populations occurring in central and eastern Oregon desert streams. According to Behnke (1992), several desiccated basins west of Alvord Basin and north of Lahontan Basin have the interior redband trout as their native trout species. This watershed is in the Fort Rock Basin and meets this criteria.

Redband trout can be found in a variety of habitats depending on its life stage. Adults are generally found in areas of abundant cover associated with deep pools, large organic material, undercut stream banks, and overhanging vegetation. Juveniles and "young of the year" are often found in shallow stream margin habitats, high cover areas, and interstitial substrate spaces. The redband trout is a spring (March through June) spawner with eggs usually hatching in 4 to 7 weeks and alevins taking an additional 3 to 7 days to absorb the yolk before becoming free swimmers (Sigler and Sigler 1991). The average age at first spawning is typically 2 to 3 years. Reband trout up to 12 inches in length require access to spawning gravels of up to 2.5 cm in diameter with less than 30 percent fine sediment. Generally, water temperatures in excess of 21°C (70°F) are unfavorable and may cause stress to all age classes (Sigler and Sigler 1991). Temperatures of about 15°C, or 58-60°F, are ideal for optimum growth of rainbow trout (Leitritz and Lewis 1980).

The Silver Creek Watershed is within the Summer Lake Basin and provides important habitat for a variety of fish. Streams within the watershed and Thompson Reservoir support populations of several species of game fish including redband trout (Oncorhynchus mykiss), rainbow trout (Oncorhynchus mykiss), brook trout (Salvelinus fontinalis), cutthroat trout (Oncorhynchus clarki), large mouth bass (Micropterus salmoides), and recently introduced hybrid striped bass.

The Oregon Department of Fish and Wildlife annually stocks catchable size rainbow trout in Thompson Reservoir. In 1995, they stocked 96,500 fingerling trout and 21,300 legal size trout (fall spawning rainbow). Non-game fish species found in the watershed include speckled dace (Rhinchthys osculus) and tui chub (Gila bicolor).

According to the Oregon Department of Fish & Wildlife biologist from this area, Tui chub populations in Thompson Reservoir are believed to be out-competing planted fingerling trout. One solution planned in 1996, was for the ODF&W to plant sterile striped bass that will prey on the chub populations. This has been completed. Indications from Anna Reservoir are that the striped bass will not significantly prey on fingerling trout.

Through 1989, ODF&W stocked spring spawning rainbow in Thompson Reservoir. A change occurred after 1989, when the ODF&W started stocking fall spawning rainbow. This was done to reduce the possibility of introgression between native redband trout and stocked rainbow trout. The rational for this is that redband trout spawn in the spring, and in theory, fall spawning rainbow will not cross breed with spring spawning redband. The genetic status of redband trout in the watershed is unknown at this time. Introgression most likely has occurred, however, the extent is unknown. In 1968 Behnke performed surveys of Buck Creek, Bridge Creek, and Silver Creek tributaries. Redband trout were not found in the tributaries of Silver Creek, however, Bridge and Buck Creek did have populations. Behnke found that the trout in the headwaters of Bridge Creek and Buck Creek had little hybridization compared with samples taken in 1904. He theorizes that Buck and Bridge Creek drainages have probably been isolated from each other for several thousand years, and trout species have undergone slight differentiation from each other. Silver Creek, however, is not isolated because of the rainbow trout stocking that has occurred in Thompson Reservoir.

Non-native fish introductions to the Silver Creek Watershed include Eastern brook trout and rainbow trout. The date of brook trout introduction is unknown, however, it would have occurred prior to 1968 when Behnke found them in his survey. Large mouth bass have been introduced illegally within Thompson Reservoir. According to ODF&W, hybrid striped bass were stocked in the fall of 1996.

2. Fish Distribution

Level II stream surveys were done in Guyer Creek (1990), West Fork Silver Creek (1992), and North Fork Silver Creek (1992). Redband trout occurrences were documented in Guyer and West Fork Silver Creeks during the 1990 and 1992 habitat surveys. No redband trout were noted during the 1992 survey of North Fork Silver Creek.

GIS fish distribution layers show redband trout within all perennial streams in the watershed and the lower one mile of Benny Creek prior to its entering Thompson Reservoir. Intermittent channels are used by trout for spring spawning. These fish have been seen in pools behind check dams in Squaw Creek following spring runoff. Due to the flashiness of the watershed, it is questionable if fry have the opportunity to emerge from intermittent channels and return to the reservoir before the stream channel becomes dry.

3. Fish Habitat

Level II stream surveys were done in Guyer Creek (1990), West Fork Silver Creek (1992), and North Fork Silver Creek (1992). These stream surveys included physical measurement of habitat conditions including residual pool depths, average riffle depths, pools per mile, large woody debris (LWD) and width to depth ratios. Forest level monitoring has occurred since 1992, with thermographs placed in perennial streams to determine temperature. Also, in 1996, cores from stream substrate were obtained from potential spawning habitat areas and analyzed in the laboratory to determine the percent fines in the substrate. This information is included in the following table:

Stream	Reach	Channel Type	Rosgen Pool Depth	Residual Riffle Depth	Av. Per Mile	Pools Per Mile	LWD Bed % Fines	W/D Ratio	Highest 7-Day Max Av Water Temp
W Fk Silver Creek	1	C4b	1.2	1.0	62	92	25-30	17	27.0
	2	C4b	1.2	0.8	29	143	25-30	14	28.1
	3	C4b/E5b	1.3	0.8	44	. 83	25-30	15	22.8
	4	C4b/E4b	1.0	1.3	53	381	40-45	14	17.4
	5	E4b	1.1	0.9	23	379	40-45	11	16.4
	6	E4b	1.2	1.0	17	330	30-45	7	18.2
	7	E4b	1.1	0.9	34	252	30-45	6	18.2
	8	E4b	0.9	0.8	9	473	28	6	18.2
Guyer Creek	1	E4	0.8	1.0	134	25	25-30	10	17.0
	2	E4	0.7	1.5	118	8	25-30	8	17.0
	3	E4	0.8	1.9	89	13	25-30	9	17.0
	4	A4	0.5	na	18	38	40-45	11	17.0
Lower Silver Creek	1	C3b	1.0	2.7	29	14	NM	12	27.2
	2	C3b	1.0	2.1	28	5	NM	18	na
	3	B3	1.4	na	29	37	NM	9	na
	4	C4b	1.1	2.3	24	33	36	19	na
	5	B3/C3b	0.9	3.2	31	24	NM	15	20.2

Human Uses

Human use in the Silver Creek watershed has followed along the lines of the dominant Euro-American cultures extractive activities. Economics has been the impetus for resource removal in the Silver Creek area.

A. Timber

Timber harvest has increased significantly since the end of World War II. Economically, timber, specifically ponderosa pine, has had a high monetary value especially in the latter half of the current period. This high value product has driven the timber harvest and road building activities that have been the major human activity. This highly visible activity has focused on the removal of the large old-growth pine for markets outside the local area. Prior to 1945 timber harvest was primarily for local use for community and ranch construction. An interesting aspect to this current period timber harvesting was that large white fir was harvested and used in the local market. During the current period timber volumes removed from the Silver Creek watershed area have varied. From 1945-1965 the average yearly volume removed was about 250M board feet. From 1965-1985 the average yearly volume removed was about 2MM board feet. From 1985-1995 the average yearly volume removed was about 500M board feet. Presently, during the watershed analysis period, removal has been sporadic and will be determined in response to the forest health needs and other issues.

Timber harvesting of the big pine (greater than 21 inches) and road building steadily increased through the decades from the late 1940's onward. Records show that the harvest levels grew annually until the early 1990's when pressure from environmental concerns slowed the rate and amount of timber being harvested.

Today, most of the volume being removed is salvage (dead and dying) and small diameter (less than 15 inches). A small sawmill in the town of Silver Lake operated off and on during the current period, however, this mill has not operated for the past few years. The volume of logs going in and the lumber coming out of this mill has been insignificant in the regional market and employment levels at the mill have been low.

B. Range

During the current period many of the sheep allotments within the Silver Creek drainage converted to cattle allotments. These conversions accelerated after World War II, but had significant slow down periods when the price of sheep was higher. It is difficult to arrive at exact numbers of livestock use within the watershed boundaries because specific records were not kept and land allocations changed drastically after the termination of the Klamath Indian reservation in 1954. Since 1945 the rangelands within the drainage have been dominated by cow/calf pairs, with the last sheep allotment closing in 1964.

Buck Creek, Yamsay, Winter Rim and Foster Butte allotments lay wholly or partly within the Silver Creek drainage basin. The number of cow/calf pairs that are permitted within the watershed for grazing season is approximately 2,210.

A swine permit in the Thompson Valley area was noted. This was probably not in the current period and probably predated the construction of Thompson Reservoir in the 1920's. This type of permit must have been difficult to manage as hogs will eat more than forage and caused tremendous damage to the top soil, virtually plowing the wet meadow areas.

The Silver Creek Range Allotment lies north of the Forest boundary and is managed by the Bureau of Land Management, Lakeview District. This allotment area is approximately 3,000 acres and lies adjacent to Silver Creek. It supports about 200 cow/calf pairs during a spring use period and also about 62 wildlife animal unit months.

The Silver-Bridge Creek Range Allotment lies north of the Forest boundary and is managed by the Bureau of Land Management, Lakeview District. This allotment area is approximately 6,910 acres with the eastern boundary at Silver Creek. It supports about 262 animal unit months (AUM's) during a spring use period and also about 69 wildlife AUM's.

C. Irrigation

A central hydrological feature to the Silver Lake watershed is Thompson Reservoir. This man-made water impoundment structure was built in 1922 and has been in the watershed throughout the current period. The Silver Lake Irrigation District constructed the dam on Silver Creek to create the reservoir. This was in response to grazing problems downstream that had been made worse by extended drought and lightning fires. The reservoir flooded most of Thompson Valley and provided over 17,000 acre feet of water. In 1964 the dam height was increased to provide over 19,000 acre feet of water. In normal years over 85% of the water in the reservoir is used downstream and in drought years the reservoir is completely drained.

D. Recreation

Central to the recreation experience in the Silver Creek watershed is Thompson Reservoir. This body of water, along with East Bay campground on its eastern shore, provides an opportunity for a wide range of recreation activities. Boating, fishing, and nearby hiking and mountain biking are all available, especially early in the recreation season when the water level is high. Aside from Thompson reservoir there is a full service campground at Silver Creek Marsh downstream from the reservoir. The Southern Oregon Intertie trail, segment #18 transects the campground and provides access to this trail system. Hikers can go west towards the Winema National Forest or south and east towards Lakeview.

Deer and Elk hunting is another popular recreation activity within much of the watershed. In the fall and early winter months numerous hunter camps spring up on the many open meadow areas. Some of these "hunter" camps have become dispersed recreation sites, which in turn are now classed as forest camps.

Winter recreational opportunities include developed cross country ski trails, cabin rentals, snowmobile trails, and a State of Oregon Sno-Park.

E. Mining

No commercial mining has occurred within the watershed during the current period. There are several gravel pits that serve as sources for road rock and permits are sometimes given for the collection of rock for landscaping purposes.

F. Tribal Lands

In the extreme southwest corner of the watershed there are some lands that were reservation lands for the Klamath Tribes up until 1954 when the reservation was terminated. However, tribal members still retain treaty rights to hunt, fish and gather on these lands. The tribal council also has a keen interest in activities outside the former reservation boundaries and how these planned activities will affect their treaty rights and traditional camping areas.

STEP 4

REFERENCE CONDITIONS

STEP 4. REFERENCE CONDITIONS

The purpose of Step 4 is to describe how ecological conditions have changed over time as a result of human influence and natural disturbances. A reference is developed for later comparison with Current Conditions over the period that the system evolved. The Reference Conditions step is based on the premise that ecosystems adapted over extended time periods and that the greatest probability for maintaining future sustainability is through management designed to maintain or reproduce natural components, structures and processes. Reference conditions are divided into "Presettlement" and "Historical" time periods. Historical refers to the time period from about 1870 to 1945, and Presettlement for the time period prior to 1870.

Erosion Processes

Historically, upland soil conditions were pristine. Soils eroded at very low rates for the most part because management induced factors contributing to accelerated erosion did not exist. Soils had lower bulk densities and higher infiltration rates throughout the watershed. Water infiltrated the soil to a higher degree and/or flowed naturally over the soil surface without being intercepted, collected, and concentrated by roads.

Soil conditions within riparian zones were also pristine. Soil bulk densities were low and water tables were higher than at present. This contributed to lush vegetative growth and stable streambanks.

Soil compaction and displacement did not exist except only to a very minor extent. This prevented erosion and contributed to maintaining stream baseflows as well as perennial summer flows. Historically, more streams were perennial, and reaches of streams higher in the watershed were perennial.

Mass wasting was a rare occurrence. It was primarily related to initial mountain building where steep slopes were created, such as on Yamsay and Hager Mountains, and also to geologic faulting. Both of these events reduced the natural stability of hillslopes. It may also have been related to natural catastrophic events such as unusually intense wildfires followed by intense storms or rain on snow events. This mass wasting occurred over extremely long periods of time and resulted in localized high levels of erosion for several years.

Natural soil erosion is highly variable throughout the watershed and the ranges are from essentially zero to an average maximum of 1 mm/yr(S.A.Schumm and M.D. Harvey). One mm/yr equates to about 5 tons/ac/yr. This could occur under the most extreme natural conditions such as those resulting from a severe intensity wildfire. Generally, losses were much lower and are estimated to have averaged less than 0.5 t/ac/yr within the watershed. This estimate is based on climatic conditions as well as physical and chemical weathering from bedrock or consolidated deposits over bedrock. Few soils are produced by bedrock weathering at annual rates greater than 1 t/ac.(Alexander, 1985).

During presettlement conditions, natural soil loss rates were essentially zero except when wildfires periodically denuded the landscape. On the ponderosa pine sites low intensity wildfires generally burned over the watershed every 7-15 years. These were caused by lightning or were set by aboriginal people in order to enhance the area for hunting and gathering. Generally, these low intensity fires had minimal impact on the soil surface and erosion rates were not increased to a significant extent.

Occasionally, weather conditions would have permitted higher intensity fires to occur which would have removed variable amounts of organic matter on site and exposed the mineral soil surface to erosional forces. Estimated soil loss rates per acre relating to fire within the major soil groups are shown in the table below. The calculations were based on a "Guide for Predicting Sediment Yields From Forested Watersheds", Forest Service, Northern Region, Intermountain Region, 1981, p.49. The figures represent the <u>first year erosion rates</u> following a moderately intense wildfire.

Moderate burns are defined as fires that char the litter or duff but do not alter the underlying mineral soil and burn between 40 and 80 percent of the plant canopy (Effects of Fire on Soil, General Technical Report WO-7, USDA, 1979, p. 27). Because the watershed burned frequently at intervals of about 7 to 15 years, severe fires were probably not that common. The erosion rates shown in the table would be much higher after a severe fire.

<u>Estimated Erosion Rates Relating to Moderately Intense Wildfire(Tons-1st yr)</u>:

Parent Material	Basic Erosion Rate	Geologic Erosion Factor	Erosion Rate
Basalt/Tuff	550 t/sq.mi.	.42	0.4 t/ac
Pyroclastics	550 t/sq.mi.	.66	0.6 t/ac
Rhyolite	550 t/sq.mi.	1.00	0.8 t/ac
Lacustrine	550 t/sq.mi.	.52	0.5 t/ac
Ash/Pumice	550 t/sq.mi.	.35	0.3 t/ac

Increased erosion rates would have occurred for about 4 years after the fire and then returned to natural levels by year five. Soil losses the first two years are estimated to be the most significant. Losses during the third and fourth year would be only slightly above the natural rate due to natural reestablishment of vegetation.

The natural landscape began to change with the advent of settlement which began in the mid 1800's and continued throughout the Historical period. The first white inhabitants had minimal effect on the land as their primary interests were trapping and exploring. The first major impacts to the watershed were logging and the introduction of grazing by large herds of sheep. Records indicate that 125,000 cattle months and 463,000 sheep months utilized the Fremont National Forest during the peak grazing years of 1909 and 1910. It is assumed that the Silver Creek watershed received comparable grazing intensity. These impacts, along with associated roadbuilding necessary to access timber stands, began the changes to the landscape which resulted in accelerated erosion. Streambank erosion was accelerated primarily by very high grazing intensity while upland erosion was accelerated by a combination of increased logging, road building, and grazing.

Hydrology

A. Base Flow

Low flows occur during the months of August through November, which is the base flow period for the Silver Creek Watershed. The Forest Plan provides recommended monthly in-stream flows for selected streams in Table 23, Pg. 91. These are the minimum flows needed to maintain the stream channel. Recommended flows and actual flows are shown below:

West Fork Silver Creek

	Forest Plan Recommended Mean Monthly Flow (CFS)	Actual Mean Monthly Flow (CFS)
July	2	7
August	2	3
September	3	3
October	5	3
November	5	3

Determining flow that occurred prior to settlement of the area is difficult. Drying of the riparian areas has resulted from a loss of beaver colonies in Guyer and West Fork Silver Creeks. This has resulting in slightly lower base flows than occurred historically.

Intermittent streams in the Silver Creek Watershed have typically downcut through alluvial depositional areas. Consequently, it's estimated that base flows were higher during presettlement times, and with the introduction of logging and grazing during the historical time period, a reduction in base flows began to occur as streams were downcut.

B. Mean Flow

No historic records are available for mean flows in this watershed. Watershed analysis on Thomas Creek (Lakeview Ranger District) in 1995, showed that mean flows shifted as much as 45 days earlier in the year. The analysis focused on road densities, soil compaction, and reduction of canopy as being responsible for the shift in the hydrograph. Similar levels of soil compaction, road density increases, and canopy removal have occurred within the Silver Creek Watershed. Influences from pumice soil in the western portion of the watershed may decrease the effects of roading, compaction and canopy removal. However, over 50% of the landbase in the Silver Creek watershed is within residual soil areas. Results similar to those observed in Thomas Creek would be expected here.

Prior to construction of Thompson Reservoir in 1927, Guyer Creek, Benny Creek, Squaw Creek, and Indian Creek flowed into Silver Creek. Throughout the year, Silver Creek had the combined flow of the four subsheds plus the Thompson Reservoir Subshed. Guyer Creek and portions of both Benny and Squaw Creek may have contributed base flow to Silver Creek. Construction of Thompson Reservoir resulted in regulation of flows in Silver Creek. Due to regulated flow for irrigation, base flows below the reservoir are presently higher than they were before the dam was constructed, and mean flows during the spring runoff months are now lower than they were historically.

C. Peak Flows

Peak flows may occur from rain on snow events or during spring snowmelt. Summer thunderstorms may be responsible for peak runoff events in localized areas of the watershed. Analysis in other watersheds (e.g. Thomas Creek) have shown that peak flows were increased as a result of roading and soil compaction from logging. Similar levels of soil compaction and road density increases have occurred within both the Thomas and Silver Creek watersheds. Therefore, it is probable that reference peak flows were lower than presently occur.

Peak flows below Thompson Reservoir are lower than historic flows. This has occurred because the Thompson Reservoir usually captures peak flows as they occur from contributing subsheds. These flows are then stored and control released later in the season for irrigation purposes.

Vegetation

A. Forest Upland

1. General Discussion

From the ecologist report (Wooley, 1994) which was based on historical records and observations; the following two tables (next page) identify the general forest condition prior to 1947:

Timber type classifications prior to 1947

Timber type***	Acres
Ponderosa Pine Large	64,890
Ponderosa Pine Small	2,487
Ponderosa Pine Seedling	
Sapling	
Pole	1,924
Fir/Hemlock	697
Lodgepole Pine Large	0
Lodgepole Pine small	
medium	9,788
Mixed Pine Large	660
Ponderosa Pine Woodland	3,449
TOTAL FOR FORESTED TYPES	83,898
Grass, sagebrush, brush	17,852
Other types	8,000

*** See Appendix maps and data section for definitions.

Percent of Silver Creek Watershed by Seral Stage Prior to 1947

Seral Stage	Percentage of Watershed
Old/Late	78
Mid Ponderosa pine	3
Early Ponderosa pine	2
Early and Mid Lodgepole Pine	12
Old Lodgepole Pine	0
Woodland (Undefined)	4

It appears that white fir dominated communities were relatively scarce before the advent of fire control on public lands. Wooley (1994) noted that observers in 1947 did not recognize todays white fir ecoclasses.

2. Insects and Disease

Western pine beetle and mountain pine beetle both had a significant role in the development of the landscape features that occurred in this watershed prior to 1947. The fir engraver (Scolytus ventralis) probably was present but its effect was much less significant than it is today due to the lack of host species.

Mountain pine beetle outbreaks probably killed large numbers of ponderosa and lodgepole pine. In the case of lodgepole pine, increased mortality could be expected in stands that contained 30-80, 9+ inch trees per acre (TPA) (Eglitis, 1993). Subsequent fire destroyed remaining stands creating growing space for regeneration.

The western pine beetle is well known historically as one of the most common insects associated with these large, old-growth ponderosa pine forests that regularly burned in presettlement times. Because of the dominance of these large old-growth ponderosa pine and poor growing conditions, particularly when stressed by drought and coupled with similarly sized late successional species which could allow for the development of large populations of these beetles, high levels of mortality could and probably did occur. In reference type conditions these beetles probably utilized natural processes more to develop large populations. Various disturbances such as a tree struck by lightning, a root rot center, or trees that had reached biological rotation were factors affecting focus trees that increased pine beetle development for attack of other stressed trees.

Root rot, such as Armillaria root rot (Armillaria ostoyae), is extremely variable in its virulence. However, all conifers are susceptible if they become stressed. The most susceptible are grand fir and white fir. The least is lodgepole, and ponderosa becomes infected when stressed by factors such as drought or intertree competition. Historically, it can be assumed that Armillaria probably acted throughout the watershed as an opportunist in infecting firescarred, overmatured, stressed, damaged or weakened ponderosa pine or white fir (Hessburg et. al, 1994).

Dwarf mistletoe was probably a fairly minor component in regards to reference conditions in the watershed. On dry site ponderosa types, severely infected trees would torch during natural underburns. However, with frequent natural underburns there was little potential for stand replacement type fires which meant that dwarf mistletoe was probably always able to maintain a presence in the watershed. In addition, these frequent fires simplified the canopy structure and density, thus limiting the potential for spread of mistletoe. In stands dominated by lodgepole pine types, mistletoe was probably very similar to today due to the general characteristics of lodgepole pine stand development. Severe buildups were probably quite common.

Historical densities within the subshed were generally less dense than they are today. Reference conditions within the white fir and ponderosa types were probably open and single storied. Overall density was relatively low, probably generally on the lower end of full site utilization to potentially open grown conditions. This limited influence of insect and disease to small patches or individual trees that were stressed. A small number of acres within these types were probably able to reach some upper density levels that might be significantly effected by insect and disease. These acres were very small in number and occurred in areas that might have missed a fire cycle. Within the lodgepole pine type, reference conditions were probably similar to today. Young stands that reached high densities were attacked by mountain pine beetle. These stands had significant mortality which was followed by stand replacing fires and establishment of new stands. In pure white fir (above 6,000 feet) stands a similar pattern probably occurred with fir engraver and root rot as the main factors involved.

The potential range of densities within the reference condition was calculated using values identified in Cochran (1994) and is listed on the table below:

Stand Density Index Management zones by Plant Association type

Ponderosa Pine Type

Plant Association	UMZ	LMZ
CPS314, CPS212	161	108
CPH311, CPS215	153	103
CPG211, CPS211, CPS121, CPS311, CPS213	146	98
CPS211, CPS217 *	150	100
CPS217 *	128	86
CPS111	106	71

White Fir Types

CWS313 (PP), CWS114 (PP)**	161	108
CWS313 (WF), CWS114 (WF)**	370	281
CWC411 (PP)**	128	86
CWC411 (WF)**	281	252
CWC311 (LPP)**	170	114
CWC311 (WF)**	281	188
CWH211 (PP)	285	191
CWS117 (PP), CWS112 (PP)	161	108
CWS115 (PP)	172	115

* These are from different plant association guides, the Fremont Plant association guide and the Pumice zone Plant association guide. Both had different site indicies. Each is potentially present in the watershed.

** These are SDI management zones for white fir and ponderosa pine, therefore they have different SDI maximums.

Lodgepole pine types were not listed as many of these probably achieved much higher densities than the upper management zones allowing insects such as mountain pine beetle to cause significant mortality.

Timber harvest in the reference condition was somewhat similar to today but less. Harvest removal was probably limited to overstory removal that was utilized to supply local mills. Harvest was mainly with ground based equipment such as tractors and horses. Significant roads and skid trails appear to have been used to remove this material.

Grass communities generally dominated most of the understory in the forested environment. Shrub development was minimal and in areas such as unburned islands throughout the landscape. Following natural fire species such as ceanothus sp. would increase in number within areas of the fire but would be reduced as new stands of trees developed and took over the sites.

B. Riparian Vegetation

Coniferous forests and associated shrub understories within the riparian zone of the watershed provided large amounts of large woody debris, very stable banks, and high amounts of shading. Deciduous species such as Aspen (Populus tremuloides) also provided some of this shading and a component of large woody debris. In addition, both the conifers and the hardwoods provide a food source, in the form of leaves and twigs, for macroinvertebrates using the stream. Insects and disease acted as a mechanism for returning both hardwoods and conifers to the stream. Root rots such as Armillaria ostoyae, western gall rust, and Phellinus tremulae appear to be the important diseases acting on conifers and hardwoods within the riparian areas. Numerous defoliators, such as tent caterpillars along with bark beetles such as the mountain pine beetle, are examples of insects that have been acting on the riparian in the reference condition. Historical riparian zones contained a large number of trees that were 20 to 40 inches in diameter and in a mature to overmature condition. Meadow ecosystems were a mixture of sedge, grass and shrub species such as Salix.

C. Range

Reference conditions within the grass/forb component of the watershed was a mix of both grass, forbs and shrub communities. Low elevation herb/grass communities were maintained in this in a mostly herb/grass condition with low intensity frequent fires. Native species dominated these communities. Highly scattered species such as juniper occurred but generally were kept out of the system with fire. Shrubs were probably common but highly scattered based on where and when fire occurred. Over the landscape a variety of age classes within the shrub component probably occurred. Species such as bitterbrush were at a much lower density that they are in the current condition.

Stream Channel

A. General Discussion

The existing Rosgen channel types, riparian vegetation communities and aerial photos were used to predict what channel and habitat conditions were like under reference conditions. Pools per mile and LWD are the same as recommended in the Inland Native Fish Strategy. The percent bank instability and shade is based on professional judgement and will vary depending on channel morphology and riparian conditions.

Large woody debris (LWD) is estimated to be greater than 60 pieces per mile for Rosgen type A and B streams. This is based on Level II Stream Surveys across the Fremont National Forest and from recorded frequency of large wood (Overton et al, 1995), where large wood in B Channels averaged 300% of large wood in C channels.

Specific descriptions by subshed and stream are provided below.

Table Fisheries Habitat Conditions in the Silver Creek Watershed

Habitat features under Reference Conditions

Reach	Channel type Existing	Reference	Pools/ Mile	LWD/ Mile	% Bank Erosion	W:D Ratio	% Shade
	West Fork Silver Creek						
1	C4b	E4b	68	>20	<10	<12	>80
2	C4b	E4b	68	>20	<10	<12	>80
3	C4b/E5b	E4b	68	>20	<10	<12	>80
4	C4b/E4b	E4b	68	>20	<10	<12	>80
5	E4b	E4b	68	>20	<10	<12	>80
6	E4b	E4b	73	>20	<10	<12	>80
7	E4b	E4b	135	>20	<10	<12	>80
8	E4b	E4b	135	>20	<10	<12	>80
	Guyer Creek						
1	E4	E4	50	>20	<10	<12	>80
2	E4	E4	73	>20	<10	<12	>80
3	E4	E4	73	>20	<10	<12	>80
4	E4	E4	73	>20	<10	<12	>80
	Lower Silver Creek						
1	C3b	C3b	25	>20	<10	12-16	>80
2	C3b	C3b	25	>20	<10	12-16	>80
3	C4b	C4b	25	>20	<10	12-16	>80
4	C4b	C4b	25	>20	<10	12-16	>80
5	C3b	C3b	25	>20	<10	12-16	>80

B. Geomorphology

West Fork Silver, Guyer and North Fork Silver Creeks had stream morphology very close to the existing conditions. Rosgen Type E systems would have been common. Rosgen Type E streams are very stable and are characterized by low gradient, meandering riffle/pool streams with low width/depth ratios and little deposition. Existing entrenchment ratios are high, meaning that streams have wide flood plains. For example, a stream with a 15 foot bank full width would have a flood plain that is at least 33 feet wide.

Lower Silver Creek had stream morphology very close to the existing conditions. However, portions of the stream would have been narrower and not quite as shallow as they are today. The system would have been a Rosgen Type C stream. This is a low gradient stream, has meandering point bars, riffle/pool bed morphology and well defined flood plains. Entrenchment ratios were high.

Benny Creek would have had very similar stream morphology as it does today, with the exception of areas that are presently downcut in alluvial depositional areas. The majority of Benny Creek fits the Rosgen Type B criteria and is moderately entrenched, has moderate gradient (2-4%) and is a riffle dominated channel with infrequently spaced pools. This system is very stable and also has very stable banks. Areas of Benny Creek that flow through meadow areas are typically downcut. These systems were historically very different and would have been Rosgen Type C or E channels. Meadows were willow and sedge dominated and had beaver dams which helped spread the water over the entire meadow system.

In the past, Squaw Creek was different than it is today. The majority of Squaw Creek is presently a down cut system through alluvial depositional areas. In these areas, streams would have historically been Rosgen Type C or E channels. Meadows were willow and sedge dominated and had beaver dams that helped spread the water over the entire meadow system. Other areas of Squaw Creek are designated Rosgen Type B channels and have changed very little from historic conditions.

The headwaters of Indian Creek were similar to conditions today, with the dominant stream channel being Rosgen Type B. Road 019 parallels the stream in the lower reaches, where a Rosgen Type E stream was historically present. This stream had a functioning flood plain with the water table close to the soil surface.

C. Riparian Condition

West Fork Silver Creek, Guyer Creek, North Fork Silver Creek and Lower Silver Creek had riparian vegetation with diverse native plant communities. Riparian vegetation was most likely very dependent upon interaction with beaver communities along stream systems. Willow, alder and aspen would have been common. Communities of sedges and rushes with other native hydrophytic species would have been common along stream systems. The plant community was dominated by willow and sedge. Lodgepole pine would have been present in the system, however, not as the dominant overstory that exists at this time. Coring of lodgepole pine in the Guyer and West Fork drainages indicate that most trees have grown in the flood plain in the last 100 years.

Historic evidence of beaver is found throughout perennial streams in the watershed. Beaver dams were a dominant feature of the perennial streams in the system. Beaver dams effectively expanded wetted areas, created and maintained wetlands, dissipated the erosive power of floods, stored water for later release and acted as depositional areas for sediment and nutrient rich organic matter. This was a controlling factor in how streams functioned historically. Reaches between beaver dams were typically Rosgen Type E systems with few point bars. Streams meandered through the meadow system and flooded on a 1 to 3 year interval into the flood plains. Stream banks were well vegetated with greater than 80% stable banks. Bank instability was very low and estimated to be less than 10%. Vegetation adjacent to stream banks had an abundance of shrubs and other deep rooted sedges, rushes, grasses, and forbs that allowed the development of stable undercut banks.

Historic evidence of beaver can also be found in both Benny and Squaw Creeks in meadow areas and below confluences with springs. Riparian vegetation adjacent to intermittent streams was dependent upon the stream type. Rosgen Type B streams had narrow riparian corridors. Large trees would have been present and would served as a source of large wood to the channel. Pieces of wood in excess of 60 per mile in these B Type systems are estimated to be reference conditions. Alluvial areas of the stream had very different vegetation with grass/sedge and willows. Ground water was closer to the surface and plant species were aquatic. These areas supported beaver which had a large influence on the vegetation of the meadow areas by spreading water over the flood plain and influencing the ground water table by storing water behind dams.

Water Quality

A. Fine Sediment

Spawning bed material influences the development and emergence of fry. Successful fry emergence is hindered by excessive amounts of sand and silt in the substrate. General habitat guidelines for incubation of salmonid embryos requires less than 25% by volume of fines $\leq$ 6.4 mm (Reiser and Bjornn, 1979). This is assumed to be the reference condition for streams needed to provide viable spawning habitat.

B. Water Temperature

The recommended water temperatures would meet recommendations from the Oregon Department of Environmental Quality (ODEQ). Using this criteria, optimum temperatures for the Silver Creek watershed would have the rolling 7 day maximum at or below 68^{o}F (see pg 20 Synthesis).

C. Macroinvertebrates

For macroinvertebrates, reference conditions of good to excellent would indicate optimum water quality and habitat for trout species.

Species and Habitat

A. Terrestrial

1. Threatened, Endangered and Sensitive Species

a) Northern Bald Eagle

No historic information on bald eagle abundance and distribution exists.

Nest/roost habitat was more abundant, widely distributed and of higher quality prior to 1945. The predominate forest cover in the landscape was open, park-like Late Old Seral (LOS) ponderosa pine stands. These were preferred eagle nest/roost habitat, and were relatively stable and resistant to catastrophic loss from wildfire. Since 1947, this habitat has declined from about 80% to 10% of the total forest area.

A larger prey base, particularly more abundant waterfowl, had the potential to support a greater number of eagles. Initially, the upper Thompson Valley marsh area, and later construction of Thompson Reservoir in 1922, provided habitat for the more abundant resident and migrant waterfowl populations that were known to use the area earlier in the century. Also, a lower incidence of pesticide use in the adjacent agricultural valley may have contributed to higher eagle numbers on the Forest.

Habitat security for eagles was higher because of the low road density and low incidence of human uses in the area, particularly around Thompson Reservoir and during the winter months.

b) American Peregrine Falcon

No recorded sightings or nest sites of peregrines are known for the watershed.

Habitat for prey species and hunting was fair to marginal because the landscape was dominated by LOS open, parklike ponderosa pine forest. Conditions for prey species probably improved with the construction of Thompson Reservoir in the early 1920's. Potential habitat was highly secure from disturbance since road densities, logging activities, and recreational use of the area were low.

c) Sage Grouse

No information was available on grouse occupancy prior to 1959, nor on historic lek sites or habitat conditions. The only historic grouse information available for the Fremont National Forest is for the period 1938 through 1941 when between 400 and 1,600 grouse were estimated to occur on the Forest.

In general, the suitability of grouse habitat probably gradually declined during the period 1870-1945 because of heavy livestock overgrazing on both the uplands and riparian areas. The added influence of high deer numbers on sagebrush winter ranges beginning around 1930 only served to accelerate the decline of preferred grouse habitat.

2. Keystone Species

a) Big Game

i. Silver Creek Deer Herd

From relatively few deer (300-600) in scattered local populations during the early 1900's, the Silver Lake herd gradually increased until numbers exceeded the carrying capacity of the winter range by 1950. The estimated population in 1959 was 12,500 deer. The dynamics of the herd during the first half of the century were primarily tied to weather variations, responses to summer range wildfires, browse abundance on winter range from livestock overgrazing, predator reductions from disease, protection from hunting, and a sharp reduction in competition with livestock.

The seasonal distribution of deer probably was similar to that which exists today. Deer traditionally use the same seasonal ranges over time. Snow conditions generally control the elevational distribution of deer during spring, fall, and winter.

Prior to 1870 deer ranges were probably dominated by bunchgrasses with scattered shrubs due to the recurring frequency of natural low intensity wildfires. Distribution and density of both bitterbrush and curl leaf mountain mahogany probably were both less than they are currently. Initially, heavy livestock grazing (beginning around 1870) and later fire suppression combined to gradually increase upland shrub densities on all seasonal ranges. Browse on winter range was more abundant and in better condition early in the century. However, forage quality and quantity gradually declined as continued heavy livestock overgrazing and higher deer populations from 1900 through about 1945 reduced shrub and herbaceous diversity, productivity and vigor. As early as 1934, winter range at the Forest boundary was noted as a heavy deer concentration area, and by 1943 poor range condition was evident here. At least one dominant age class of bitterbrush dates back to the initial reduction of livestock grazing beginning in the 1930's. Adams (1975) noted a drastic decline in live bitterbrush starting in 1948 on the Silver Lake deer winter range. The decline was related to lack of establishment of new plants to replace those dying from old age. Poor establishment began about 1918. During a 53 year period (1918-1971) only 34 plants/acre, or 0.65 plants/acre/year became established on the winter range. Adams also discovered that 70% of the junipers were established in the 35-year period from 1902 to 1936. Conversion of the bottomlands at the turn of the century to agriculture forced more of the livestock from private pasture to the upland deer ranges, while removing the productive bottomlands from prime deer habitat.

Fawning habitat quality along riparian areas probably was poor. Deciduous woody vegetation and the diversity of herbaceous forage species declined from 1900 through 1945. Prior to 1900, fawning habitat along riparian areas would have been in better condition.

LOS forest cover dominated the landscape prior to 1945. Wooley (1994) speculates that about 60% of the watershed supported single story, open, parklike ponderosa pine forest. Herbaceous and shrub production in these open stands would probably have been greater than present conditions. Limited natural meadows, sagebrush and mixed shrub cover types also provided forage areas for big game over about 20% of the landscape.

Limited logging activity beginning as early as 1920 was opening some forest to produce more forage for deer. Because there were few natural non-forested openings and most openings were relatively large in area, edge habitat was very limited prior to 1945. Deer and elk are both species which frequent edge habitat because of the greater diversity of plant species and communities found along edges and ecotones. With settlement of the valley at the turn of the century came an increase in fire activity, as settlers used fire to enhance upland ranges and to clear areas for agriculture. Fire in the uplands may have enhanced deer foraging habitat, initially, but repeated burning would have reduced the distribution and density of shrub species.

Even though forest cover dominated the landscape (75% of the area), hiding cover for deer in forest stands, especially LOS ponderosa pine, was probably of marginal quality at best because of open understories maintained by frequent, low intensity wildfire. Seedlings and saplings occurred in scattered clusters over the landscape with only a few dense thickets of any notable size. The most suitable cover probably occurred in younger ponderosa, lodgepole and fir/hemlock stands which only covered about 10 to 15% of the watershed. More healthy shrub stands of columnar and subcolumnar bitterbrush, mahogany and serviceberry probably provided better cover than they do presently. The establishment of juniper in the watershed during this period also would have began providing cover.

Habitat security was high. Fewer roads existed and human activities were less. Road density information was not available, but it can be stated that densities were lower prior to 1945 than they are today.

ii. Elk

No assessment information was available on historic elk populations in the watershed. Nor was any information available on the seasonal distribution and use of the watershed by elk. Sightings of elk were recorded in the journals of John C. Fremont. However, annual wildlife reports for the Fremont National Forest between 1926-1933 showed no elk present on the Forest, and only 10 on the Fremont for the period 1943-45. Up until 1980, there were not enough elk in Lake County to consider any recreational hunting seasons.

iii. Beaver

Native beaver populations were supplemented with transplanted animals. In the 1930's, only two sites on Silver Creek, one near the Gowdy Ranch and the other near the Silver Lake Ranger Station, were known to support native beaver colonies. In an attempt to increase beaver numbers on the Forest, a series of transplants occurred from 1937 through 1946. Prior to 1940, beaver were planted on the West Fork and Silver Creek. In 1940, beaver were planted in Guyer Creek and again in the West Fork. The West Fork was again the site of transplants in 1944. It appears from trapping records for the period 1950-70 that the transplants were successful in helping to increase beaver numbers.

No assessment of beaver populations prior to 1935 was available. However, beaver were probably more abundant prior to the arrival of settlers and domestic livestock grazing. Trapping activity undoubtedly increased with the settlement of the Silver Lake valley beginning around 1870. Also, it can be speculated that the heavy livestock grazing which occurred from as early as 1870 through 1945 had adverse effects on habitat conditions.

3. Management Indicator (MI) Species Associated with Late/Old Forest Cover and Dead Wood Habitat

a) General Discussion

The abundance, distribution, connectivity and quality of suitable habitat for MI and other species associated with LOS ponderosa pine forest habitats was significantly greater for the period 1900-1945 than at present. The landscape was dominated by a contiguous LOS open, parklike, clustered ponderosa pine forest. There was virtually no LOS pine associated or lodgepole pine forest identified in the 1947 timber inventory for Lake County. Only about 20% of the forest habitat was unsuitable for species associated with LOS ponderosa forest cover. Most of the LOS matrix was high quality interior habitat unaffected by the influence of edges (Wooley 1995). Large diameter live trees and snags undoubtedly were more common and distributed throughout the forested landscape. Cone production undoubtedly was high in this open, large tree condition. Down wood density and distribution may have been less than present in these LOS stands because of the high frequency of low intensity wildfires, but large wood may have been more common. However, areas burned by higher intensity wildfire which killed the overstory probably supported high snag and down wood densities until these areas reburned.

LATE OLD SERAL ACRES

LOS Forest Type	1947	1994
Ponderosa Pine	64,000	19,000
Pine Associated	800	------
Lodgepole Pine	0	2,100

Ponderosa pine and pine associated total acres of LOS are combined for 1994.

Habitat gaps and fragmentation of LOS ponderosa pine from disturbance patches were less than present (Wooley 1995). The contiguous forest matrix facilitated species dispersal, colonization, genetic interchange and the distribution of species throughout the entire watershed. It is highly probable that because of more abundant and suitable LOS habitat conditions for MI and other species, they were more numerous and widely distributed, especially ponderosa pine associated species (goshawk, white-headed and Lewis woodpeckers, Flammulated owl), than they are today. MI and other wildlife species associated with LOS forest types such as lodgepole pine (black-backed woodpecker and marten) and white fir (pileated woodpecker and marten) possibly would have had more restricted numbers and ranges prior to 1945 than today. Their historical distribution would have been dependent on the distribution and numbers of larger diameter white fir mixed with the LOS pine stands and on the age of lodgepole pine stands.

b) Pileated Woodpecker

Pileated habitat prior to 1945 was more extensive and contiguous through the watershed, but was probably somewhat less suitable than present conditions. Forest cover dominated by more open parklike, single story LOS ponderosa pine probably was lacking some of the structural complexity (down logs, denser canopy, and snags) and densities of the more suitable tree species (white fir) that provide preferred pileated habitat.

c) American Marten

The only known records of historic marten numbers on the Fremont follow.

Year	Numbers
1929	300
1939	240
1940-45	300

Marten habitat prior to 1945 was more extensive and contiguous through the watershed, but was probably somewhat less suitable than present conditions. Forest cover dominated by more open parklike, single story LOS ponderosa pine and younger stands of lodgepole pine probably was lacking some of the structural complexity (down logs, multi-storied trees, snags) and moister site conditions that provide preferred marten habitat. Also, habitat conditions for prey species associated with riparian areas deteriorated significantly between 1870 and 1945.

d) Goshawk

Nesting habitat conditions were more suitable prior to 1945 when contiguous open LOS forest matrix and interior habitat dominated the landscape. The preponderance of open-parklike ponderosa pine LOS forest cover and more area in mature aspen clones provided more abundant and suitable conditions for goshawk nesting. More abundant prey species associated with LOS forest cover and deadwood may have been present, especially species associated with the high cone production that is characteristic of open, large tree pine forest. Smaller scale horizontal and vertical diversity created from natural disturbances within the forested landscape provided diverse habitat for prey species at more of a micro scale than the macro scale regeneration units present today. Younger stands of lodgepole pine may have been less suitable than the more LOS stand structure after 1950. Disturbances from roads and timber harvest activities would have still been relatively low.

e) Northern Three-toed/Black-Backed woodpecker

Black-backed habitat prior to 1945 was more extensive and contiguous through the watershed, but may have been somewhat less suitable than present conditions. All lodgepole pine forest, preferred habitat for these birds, at that time was classified as small and medium structure. These younger stands probably lacked the density of snags characteristic of the older stands present today. Also, the single story, park-like LOS ponderosa pine stands that dominated the landscape provided suitable habitat conditions but snag habitat was probably less common in this more healthy forest condition. Populations of black-backs were probably lower, more stable and less irruptive.

f) Red-naped sapsucker

No assessment information was available on the occurrence of aspen forest over the landscape. However, it can be speculated that with more frequent, low intensity and larger, high intensity wildfires, lower coniferous stand densities, and higher water tables along riparian areas, the abundance, distribution and successful regeneration of aspen clones was probably greater prior to the period of heavy livestock grazing and high deer numbers during the first half of the this century.

More aspen in a diversity of age classes and distributed over a larger area would have provided more available and suitable habitat conditions for aspen associated wildlife species, including the red-naped sapsucker. Because mature aspen is the most preferred nesting habitat for sapsuckers, the numbers of sapsuckers may have been greater and their population more stable because of wider distribution. As aspen began disappearing from the landscape, probably beginning around 1920, populations and distributions of aspen associated species also declined.

Younger stands of lodgepole pine are less suitable habitat than the LOS stand structure present after 1945. The single-storied, parklike LOS ponderosa pine stands that dominated the landscape provided suitable large snag habitat conditions, but total snag habitat was probably less common in this more healthy forest condition.

B. Aquatic Habitat

Historically, perennial streams in the Silver Creek Watershed supported populations of redband trout, speckled dace and tui chub. The exact distribution and populations of these fish are not known. Redband trout in tributaries of Silver Creek are isolated from other perennial streams in the Fort Rock Basin. This has occurred in recent history, since Paulina Marsh has become dry. Prior to drying of Paulina Marsh, Silver Creek, Bridge Creek and Buck Creek were connected. Consequently, Silver Creek and its tributaries are a significant portion of the habit in the Fort Rock Basin. Throughout the arid Oregon Basins, fish have adapted over time to live in extremely harsh environments characterized by great extremes of water temperature and flow. Thus, maintenance of the gene pool is important to maintain a fisheries that can thrive in the harsh environments in this basin.

Historically, willow and beaked sedge were the plant association that was most common along perennial streams. The Riparian Zone Association Guide for the Deschutes, Ochoco, Fremont and Winema National Forest indicates that these plant associations have high water holding capacity with water lowering 1 to 2 feet below the soil surface in September. Beaver were in balance with their food source with sedges and willows trapping sediments, stabilizing banks, and forming narrow and deep stream profiles. Overhanging sedges, willows and banks provided shade and cover for salmonids.

Intermittent streams within the watershed may have supported speckled dace and tui chub populations. Areas of the intermittent stream system had beaver ponds that likely supported fish year around. Additional information on beaver in intermittent stream channels is found in the Species and Habitat, Wildlife section. Generally, the intermittent streams would have supported less fish than the perennial streams of Guyer, West Fork Silver, North Fork Silver, and Silver Creeks.

Human Uses

A. Presettlement

Some of the oldest known archaeological sites in Oregon are found just a few miles north of the Silver Creek drainage. The history of aboriginal people in the area is long and varied. To these people Silver Creek was home, where they hunted game, gathered roots and seeds, and subsisted for thousands of years. These same people were witness to major geological events in the area such as the explosion of Mt. Mazama which became Crater Lake. At the end of the pliestocene era, these ancient people lived along with the megafauna of this era and hunted Mastadons for food. They lived along shores of large lakes and moved amongst the meadows of the Silver Creek area gathering roots and seeds as they matured at the higher elevations of the watershed. These people lived in the Silver Creek area on a seasonal basis that focused around the seasonally abundant plant resources found in Thompson Valley and the upper reaches of the

Sycan Marsh. These paleo Indians probably occupied the area from 9,000 to 10,000 years ago until Euro-American settlement in the area approximately 150 years ago. Impacts to the land was minimal to almost non-existent. They travelled and lived in small bands (10-15 people), dug roots in the meadows and allowed natural fires to burn. Their travel through the area was seasonal on semi-permanent trails.

The types of archaeological sites found in the area are indicative of the hunting and gathering activities of the past Indian peoples. Lithic scatters made up predominately of black obsidian are found throughout the drainage. These represent seasonal hunting activities and seasonal gathering and occupation sites. Other sites of a ceremonial or religious nature are also found in the watershed. These sites are very sensitive and their physical remains are more subtle than other kinds of Indian sites.

B. Historical

The first white people in the area were probably Spanish explorers on their way to gold country or just extending their claim into Alta California. Mountain men, trappers, explorers, and military soon followed. In the winter of 1843 John C. Fremont, along with his partner Kit Carson, journeyed through a part of the watershed to present day Fremont Point. Fremont's trip had an indirect effect on the opening of the area. Settlement in open country near present day Silver Lake began in the late 1800's and began to change the natural landscape. Large scale sheep grazing and logging were the first significantly visible impacts on the watershed. A few homesteads and two lumber mills were the first recorded settlements in the area. During the historical period up until 1945 the majority of lumber produced in the Silver Lake area was used for local use in homes, ranches and businesses.

In the early part of the 19th century grazing became a major part of the human use pattern in the watershed. The Silver Creek watershed, like most of the Forest in 1907, was extremely overstocked and overgrazed. Reducing stocking levels and making improvements to range resources was the major task of the Forest Service at this time.

From 1909 to 1929, Forest-wide sheep numbers went from 110,000-120,000 to about 78,000 with the number of permits remaining the same at 66. This reduction trend was also apparent in the Silver Creek drainage with commensurate numbers.

Cattle permits were reduced from 170 to 71 and head numbers reduced from 26,000 to 10,000, including horses. Although these large numbers of animals had definite impacts on range conditions, the long permitted grazing season was a problem the Forest had to deal with. The low elevations of the watershed in its northern portions facilitated a low snow load and extended growing season. This in turn gave stockmen a range area that could virtually be used year-round. The impacts from this intense human use of the drainage can still be seen in todays landscape.

STEP 5

SYNTHESIS AND INTERPRETATION

STEP 5. SYNTHESIS AND INTERPRETATION

The purpose of Step 5 is to compare Current and Reference Conditions of specific ecosystem elements and to explain significant differences, similarities, or trends and their causes. Information from the previous four steps is synthesized and interpreted. The interaction of biological, physical and social processes taking place in the watershed are explained. The capability of the system to achieve key management plan objectives is evaluated.

Erosion Processes

Soil is considered a nonrenewable resource because soil formation requires very long periods of time. Soil is also considered a basic resource because the abundance and distribution of most other resources depends on soil characteristics. Soil erosion normally removes much more of the surface layers than the subsoil layers. Consequently, proportional nutrient losses are greater at the surface and effects on site productivity are proportionally larger as well. Accelerated erosion usually exceeds soil formation rates whereas natural erosion is in balance with soil formation rates.

Under ideal circumstances soil formation is in balance with, or occurs at a faster rate than soil erosion. The natural rates of soil formation are generally considered to be between 0.1 t/ac/yr and 2.0 t/ac/yr (S.A.Schumm and M.D. Harvey, 1982). Soil development rates within the Silver Creek Watershed are believed to be closer to the lower range because of weather and climatic conditions characteristic of this area.

The two key factors involved in minimizing surface erosion, regardless of climatic conditions or topography, relates to organic matter including both alive and dead, and soil physical properties. The importance of an vegetative-organic matter shield cannot be overemphasized.

The cause of accelerated erosion is directly related to the degree of soil disturbance from all management activities occurring over time. The primary activities are road building, logging, grazing, and burning. These activities remove the surface organic layer that provides protection to the mineral soil layer below. These activities also change the natural inherent soil properties that restricts water movement within the soil mantle. This restriction results in more water flowing over the surface which also contributes to increased erosion.

A. Roads

Analysis of erosional processes within the watershed show that roads are producing the highest rates of soil loss on a per acre basis. Soil loss means that this amount of material will move from one location to another but does not mean that all of this will enter the stream channel. Roads alter the natural drainage patterns and concentrate surface and subsurface flows into ditches, where erosion results. Road surfaces are usually compacted which restricts infiltration of surface flow which further acts to concentrate flow and keep the water moving down the road surface and/or ditchline. Culverts and waterbars that are not properly spaced, maintained, or constructed further aggravate the erosional process.

The spacing of culverts and waterbars are essential to avoid concentrating flows. Roads act as water collection devices and it is imperative that these structures are properly spaced and maintained. This would then avoid concentrating flows to the extent that flowing water erodes either the ditch or soils below the point of diversion. Improperly constructed culverts are often referred to as "shotgun" culverts as they are elevated and drop water to the channel below which increases erosional forces.

Another major factor contributing to erosion relating to the road network is the condition of the soil material available for plant growth. Any road that is constructed by excavating into the hillside will result in subsoil and/or bedrock being the primary growth medium for reestablishment of vegetation. These subsoil materials are lower in fertility and organic matter, higher in clay, stonier, and more droughty than the surface soil. Cut and fill slopes are often steep and continually dry ravel for many years.

The best slope ratio, when considering vegetation establishment and maintenance costs, is generally 3:1 or less with a ratio of 2:1 considered the maximum for successful vegetation establishment on a large scale. On cut and fill slopes steeper than 2:1, vegetation establishment is difficult due to raveling, exposure (south slopes), loss of seed, and soil conditions.

Many cut slopes within the western portion of the watershed consist of ash and pumice subsoil material which is poorly suited for plant growth. This material is essentially unweathered, frothy pulverized bedrock, and is very difficult to revegetate following disturbances.

Miles of road per section ranges from a low of 2.3 mi/sq.mi. in the Thompson Reservoir subshed up to about 4.7 mi/sq.mi. in the Guyer and Indian Creek subsheds. West Fork Silver Creek, Squaw Creek, Benny Creek and Silver Creek are intermediate with 3.4, 4.2, 3.3, and 3.6 mi/sq mi. respectively.

The end result of soil erosion related to the road network is calculated to range from about 1.5 t/ac/yr in the Guyer Creek Subshed up to 2.1 t/ac/yr for Silver Creek and Thompson Reservoir subshed. The other four subsheds are intermediate in estimated soil loss rates and range from about 1.7 to 2 t/ac/yr. These calculations are based on total disturbed road acres as shown for Current Conditions.

Mass movement is not a major concern within the watershed. However, it is related almost entirely to roads constructed on sloping topography. Road excavations reduce the support of soil and bedrock above the road. During situations in which the soil mantle becomes saturated by snow melt, rain-on-snow events, or by seeps/springs, the moisture adds extra weight and lubrication. This reduces soil strength and makes the soil mantle and/or upper bedrock layers more susceptible to mass movement. No mass movement is known to have occurred within any of the subbasins although the potential does exist for the occurrence of debris avalanches on Hager Mt. and slumping within the headwater subbasins of West Fork and Guyer Creeks.

B. Logging

Timber harvesting utilizing conventional logging equipment requires an extensive road network. Primary skidtrails, secondary skidtrails, temporary roads, and landings are necessary with conventional equipment in order to access and move logs. In addition, dispersed harvesting techniques utilized historically within the watershed results in additional soil disturbance, ie. compaction, displacement, and puddling.

The transportation system network results in surface soil disturbances similar to those described above for system roads. Skidtrails, temporary roads, and landings change the natural flow regime of the landscape and tend to concentrate flows just as system roads do. Any activity that acts to concentrate flows increases the risk for overland flow and erosion.

The forested soils within the watershed have a naturally low bulk density which ranges from about 0.7 to 1.2 grams/cubic centimeter for the surface soil layers. This means that these forested soils consist of only about 30 to 50% mineral and organic matter and the remainder is air space partially filled with water. They are very porous with very high water infiltration rates.

Because of this high porosity, the forested soils in the Silver Creek Watershed are very sensitive to compaction especially east of Thompson Reservoir. Monitoring data bears this out. Four timber sale harvest units were intensively monitored. One even-aged and one uneven-aged harvest unit within each of two subbasins, the West Fork of Silver Creek and Thompson Reservoir, were sampled with random transects. Results indicated that adverse soil conditions were 45% and 36% for Thompson Reservoir and 31% and 36% for West Fork, most of which was compaction. Regional standards allow up to 20 per cent of an area to be compacted.

Most areas have been logged several times over the last 50 years and the monitoring data is showing cumulative results from repeated entries. These entries include post harvest activities such as brush piling and site preparation. Slash disposal and site preparation have the potential to adversely effect a high percentage of the surface soils within the harvest unit. Soil compaction may last for at least 40 to 60 years meaning that adverse effects are cumulative over the years.

The cumulative effect of all related timber harvest activities including the harvest road network such as landings and skidtrails, other exposed mineral soil, compaction, and displacement results in an estimated erosion rate of about 116 tons per year within the Thompson Reservoir subshed and up to about 420 t/yr for West Fork and Benny Creek subsheds. Silver Creek soil erosion rates are also relatively high with estimated rates of 348 t/yr. Guyer, Indian, and Squaw Creeks have intermediate erosion rates of about 157 to 182 t/yr for each subbasin. These estimates are erosion rates only and identify estimated rates of soil movement. This does not mean that this amount of soil is entering the stream systems and becoming sediment.

C. Grazing

Almost all soil damage related to grazing is associated with riparian areas such as springs, seeps, and wet and moist meadows. No damage of any significant extent is known to occur on well drained upland soils not associated with riparian areas. Due to their position in the landscape, riparian soils have restricted internal drainage and the water table remains at or near the surface much later into the summer months as compared to upland soils. Wet and moist soils are very susceptible to damage because soil strength decreases rapidly as the amount of moisture in the soil increases. Soil strength is at a minimum when saturated.

Riparian areas tend to concentrate cattle especially later in the growing season when upland forage has cured out and is no longer palatable. Also, drinking water availability is more limiting as ponds and stock tanks dry up. These two factors tend to draw cattle towards riparian areas which becomes most pronounced during August and September.

In terms of pounds/sq.in., cattle exert about as much force on the soil surface as some types of logging equipment. Soil compaction, puddling, and displacement results from this force exerted on a wet or moist surface soil and are very prone to soil damage. Hoof shear on stream banks, bare soil, pedestalling of plants, a crusted/hard soil surface, and hoof prints are indicators of soil damage.

During the early settlement period on the Forest overgrazing was extensive. Records indicate that season long grazing was the rule and extended for up to 8 months. For example, in 1910 there were 26,000 cattle and 110,000 sheep (1957 Range Table). This is about 450,000 permitted aninmal unit months (aum's) for the Forest and indicates the kind of use which occurred. It is assumed that proportional use occurred within the Silver Creek Watershed. Current permitted use on the Fremont National Forest is 71,000 aum's which is about an 84% reduction from the 1910 level. In addition, grazing strategies have been modified.

This intensive over-grazing and resultant gully erosion in meadows is documented in "Erosion on the Fremont National Forest", by Reginald A. Bradley, Deputy Supervisor, Fremont National Forest, 1915. He states in part: "There are many instances of erosion due to grazing and in every case, as far as is known, cattle and horses were responsible".

"All over this Forest there are sage brush flats with channels of varying depths and steep banks which are continually sliding, being washed away every time there is abnormal flow".

"There is little doubt that these flats were originally small meadows, well irrigated by the water which used to spread all over them, there being no definite creekbed. Some of these flats are still meadow, with the grass dying out from lack of water and the sage brush coming in. In others there has been no erosion and the water spreads out as it always did, thereby supplying succulent forage and conserving the moisture, keeping up a gradual flow until later in the season".

Later in the document Bradely states: "There are a great many areas on this Forest where erosion is occurring, due to over-grazing which occurred before the National Forest was established, and some where the erosion has been arrested, or partially so".

He documents a specific example on Dog Mountain Creek located outside of the watershed on the southern portion of the Forest: "Before this area was grazed the whole of the flat, approximately 200 acres, was a fine mountain meadow with a small stream running on to it and spreading out, naturally irrigating the grass, no pronounced channel being anywhere in evidence. Then came grazing by cattle and horses - principally cattle. Soon it was heavily overstocked and erosion commenced". "The causes of erosion on areas like the above and the conditions which led up to it are plain, especially to those who have had the opportunity of watching the gradual change over a long period".

It is evident from documents such as that quoted above and other historical accounts that the current condition of riparian areas within the Silver Creek Watershed was initiated in the late 1800's to 1930's. The severe over-grazing which occurred during that period of time resulted in the excessive removal of the protective vegetation. Gully erosion soon followed as the meadow had lost its protective mat and springtime flows cut down into the mineral soil.

The current condition of most of the degraded meadows within the watershed is not the result of the 1964 flood as some people believe. In most areas the damage had already occurred as evidenced by the concern of the Deputy Supervisor in 1915. Also, most of the channel downcutting is not related to road building and logging as very few roads and only limited logging had occurred by that period of time.

D. Burning

The frequent low intensity fires which burned over the lower and middle elevation ponderosa pine sites at intervals of 7 to 15 years are not believed to have increased erosion to any significant extent. These fires burned at a low intensity due to a lack of fuel buildup. Also, standing conifers drop needles continually which would have provided mineral soil cover on any exposed areas. Current prescribed underburning is similar to those low intensity fires and accelerated erosion is not a concern. However, at higher elevations and north aspects wildfires burned less frequently, but with a higher intensity.

Severe fires did occur historically and continue to occur today. It is estimated, however, that high intensity fires are more common now than they were historically due to fuel buildup which has occurred over the last 50 years. Aggressive fire fighting efforts have resulted in greatly increased quantities of fuel per acre as well as changed the plant community. The invading white fir understory has provided ladder fuels which allows fire to reach the crowns much more readily.

The end result of severe intensity fires regarding surface erosion was probably similar when comparing historical versus current conditions. These kinds of wildfires, regardless of when they occurred, expose the surface mineral soil to erosion. They also result in hydrophobicity of the soil surface which reduces infiltration of water and increases erosion risk. Moderately intense wildfires are estimated to result in erosion rates of from about 0.4 to 0.9 t/ac during the first year. Erosion losses would be considerably higher for a severe fire. The major change, comparing historic with current conditions, is related to the frequency of the event rather than the result. Soil loss rates are comparable today to historic conditions. However, the frequency at which severe wildfires occurred is estimated to be much higher under current conditions, thus resulting in greater total losses.

Hydrology

A. Base Flows

1. General Discussion of Base Flow

Low flows occur during the months of August through November. These are assumed to be base flows for the Silver Creek Watershed. The Forest Plan provides recommended monthly in-stream flow for Silver Creek, Table 23, pg. 91. Base flows are higher in July and August than Forest Plan values, but they are lower than recommended in September through November. This implies that the stream is not flowing to potential base flow levels throughout the year.

Base flow has decreased in the watershed since reference conditions. Lack of stream flow data makes determination of pre-settlement base flows impossible. Base flows naturally decrease during the late summer and early autumn months. This decline in discharge is due to a combination of natural factors including low precipitation, reduced drainage from the soil and bedrock, and sustained high evapotranspiration. However, management activities including road building, logging, livestock grazing and the decline in the number of beaver dams have also helped to reduce base flow in the watershed. These are discussed below.

2. Baseflow Responses to Road Building

Water available for base flow is intercepted by roads. Thus, roading is partially responsible for decreased base flow in perennial streams. Studies in the mountains of central Idaho showed that roads intersect the soil and bedrock when they are constructed through steep mountain terrain. A consequence of this type of road construction is that subsurface flow is intercepted by the road and transformed into surface flow. These flows are commonly carried in ditches along the inside of roads until they are discharged into the nearest culvert, where water is then detoured from its normal downslope movement through the soil (Megahan, 1972). This same interception of subsurface flow is occurring within the Silver Creek Watershed.

Road densities within the Silver Creek Watershed range from 2.3 mi/mi^2 in the Thompson Reservoir subshed to 4.7 mi/mi^2 in Guyer and Indian Creek Subsheds. Roads in the pumice zone have often cut through the pumice soil into the underlying residual soil. These roads intercept subsurface flow and provide more efficient paths for water transmission. Therefore, less water is available for base flow than would have occurred before roads were constructed. This is also supported by a United States Geological Survey (USGS) study performed in the eastern United States. This study showed that the rate of ground water discharge into streams, or base flow, is inversely proportional with drainage density squared (Carlston, 1963). Roads increase drainage density according to the study by Megahan, 1972. Using formulas in the USGS study, base flow could be reduced as much as 85% below Reference Conditions in the Silver Creek Watershed.

3. Baseflow Responses to Logging and Compaction

Timber harvest can decrease evapotranspiration, thus, making more water available for baseflow. A study in the South Umpqua Region showed that baseflow increased by 196% in a totally clearcut watershed, with smaller increases in shelterwood and patch cut areas. This report also identified that flow decreases with regrowth of vegetation. Negligible increases in flow are expected after 30-35 years. In areas with compacted soil or where subsurface flow is intercepted by road cuts and ditches, soil moisture may be reduced. Impacts from compacted soil and interception from roads may be more persistent than changes from timber harvest (Harr et.al., 1979). This possible increase in base flow is therefore negated because of very high understory densities, soil compaction, and high road densities that exist in the Silver Creek Watershed.

Canopy cover can be determined by using Satellite Imagery (ISAT) that is available in GIS. This can be determined for different vegetation types. The following table provides the percent crown closure and the acres of each major vegetation type.

Percent Crown Closure

Subshed	Average Canopy Ponderosa Pine	Average Canopy Mixed Conifer	Average Canopy < 25% any Species	Average Canopy Lodgepole Pine
West Fork Silver	39% 2,209 Acres	38% 8,572 Acres	19% 6,819 Acres	51% 1,036 Acres
Guyer Creek	40% 1,470 Acres	38% 6,094 Acres	20% 2,030 Acres	52% 1,241 Acres
Indian Creek	42% 483 Acres	32% 2,994 Acres	19% 3,265 Acres	52% 292 Acres
Squaw Creek	40% 364 Acres	33% 4,164 Acres	19% 3,904 Acres	52% 306 Acres
Benny Creek	40% 797 Acres	35% 10,154 Acres	19% 10,223 Acres	54% 253 Acres
Silver Creek	39% 1,555 Acres	32% 5,165 Acres	19% 5,930 Acres	51% 208 Acres
Thompson Reservoir	39% 698 Acres	33% 1,816 Acres	19% 2,075 Acres	55% 71 Acres

The natural range of variability for forest canopies depends on the species, soils, elevation and aspect. The Forest Plan Standards and Guidelines of 60% canopy closure may be un-realistic in a natural environment for certain species. For the Silver Creek Watershed, recommended canopy closure for different species were recommended by silvilculturists on the Fremont National Forest.

Natural Range of Variability
for
Canopy Closure

Dominant Veg Type	Canopy Closure (Percent)
Ponderosa Pine	26-55
Mixed Conifer	41-70
Lodgepole Pine	41-70
<25% Any Species	26-55

Comparison of actual canopy closure with the desired natural range of canopy closure in the watershed shows that all vegetation types except ponderosa pine and lodgepole pine are below the natural range of variability. This could lead to the conclusion that excess water is available from the watershed, as shown by Harr. However, the canopy closure values listed above do not distinguish between overstory or understory. The Forest Silvilculturist has identified that understory densities are high overall and in some areas are twice natural densities. Any future treatment of the dense understory will reduce the overall canopy closure and move the canopy closure further outside the reference range, for a short time period. However, treatment may only result in minimal lowering of canopy closure, because many of the trees are below existing overstory. Also, with proper spacing of trees, crowns would quickly expand and canopy closure would be regained. This existing dense understory is using available moisture that would have been available to the overstory trees. Per the Forest Silvilculturist, evidence of this moisture loss in dense stands presently exists with trees showing stress and susceptibility to disease.

In arid situations where water is limited, potential savings in water by partial cutting is often used by residual trees (Baker, 1988). In summary, little excess water is available for base flow as a result of canopy reduction.

4. Baseflow Responses to Historic Grazing

Historic livestock grazing has led to lowered base flow in the Silver Creek Watershed. Livestock grazing can affect the riparian environment by changing, reducing, or eliminating vegetation, and eliminating riparian areas through channel widening, channel agrading, or (degrading) lowering of the water table (Platts, 1991). A study of almost 250 miles of National Forest system riparian areas showed that grazing conflicts with riparian-dependent resources were most common in Rosgen B type stream channels with fine-textured soils and with most C type channels (Clary and Webster, 1989).

The Silver Creek Watershed has similar C Type channels characteristics as compared to the above study. Primary examples of lowering of the water table are alluvial depositional areas of Sqaw, Benny and Indian Creeks. In these Rosgen C type systems, streams have downcut and now have lowered water tables.

Down cutting of stream channels most likely originated from overgrazing that occurred in the late 1800's and early 1900's. During the late 1800's and early 1900's, there were 450,000 permitted animal unit months (AUM's) of grazing on the Forest. These figures included 176,000 sheep head months and 75,000 cow head months. During the period of 1880 to 1900 sheep number were high. In 1910 sheep numbers peaked on the Fremont National Forest. These numbers have been drastically reduced since that time. During this early period, utilization standards were not applied to riparian areas, as they are today. Through over grazing a chain reaction of events led to deterioration of stream bank riparian vegetation and consequently a loss of the channel stabilizing effects of this riparian vegetation.

Accelerated loss of streamside and instream cover lead to downcutting of the channel. Plant communities have changed from willow sedge communities to lodgepole/mountain alder communities. Existing high levels of lodgepole pine use available moisture in the flood plain that was historically available for base flow prior to the lodgepole pine encroachment.

Grazing has been excluded within exclosures in lower Benny and Squaw Creeks. Additionally, gabian structures and loose rock check dams have been installed. These areas were historically downcut several feet, however, the water table appears to be moving close to the ground level and the area now has a functioning flood plain in portions of the stream within the exclosure. This indicates that these areas have the potential to recover rapidly with intense riparian management along with grade control structures.

5. Baseflow response to change in Beaver Community

Lack of beaver ponds is resulting in lower base flows than could potentially exist in the watershed. As shown in the "Species and Habitats" portion of this document, the number of beaver colonies on National Forest system land is below historic levels and is currently below the potential for the watershed. Beavers were historically active in Guyer, West Fork, North Fork and Lower Silver Creeks. They also had colonies in intermittent channels of Squaw, Benny and Strawberry Creeks. Trapping is presumed to be the primary reason for the decline in the number of beaver.

Beaver ponds back up water that subsequently is stored in the bank and floodplain. Bank storage increases the water table, enhances summer flows, and causes more even distribution of stream flow throughout the year (cited references Olson and Hubert, 1994). Loss of base flow in the watershed is well correlated with the loss of beaver colonies in the Silver Creek Watershed. Coring of lodgepole pine trees along West Fork Silver and Guyer Creeks showed that most trees have been on site for less than 100 years. Prior to 100 years ago, these areas were dominated by beaver ponds and had flooded riparian areas with high water tables. Through trapping, beaver colonies were lost, maintenance on beaver dams ceased and dams downcut or were washed out. The loss of dams and intense grazing practices resulted in downcutting of the stream channel and loss of the water table. The lowered water table gave lodgepole pine the opportunity to encroach on the flood plain. Concurrently, alder increased and willow declined. Water used by lodgepole pine is not presently available for base flow. Shading by these trees decreases the opportunity for restoration of willow habitat.

In intermittent streams, there have been similar occurrences. Beaver were trapped, channels downcut and the water table was lost. The loss of beaver colonies resulted in a loss of stored water in the adjacent flood plain and subsequent loss of base flow in the summer months.

The species and habitat portion of this document emphasizes that habitat is available for beaver colonies. Re-establishment of beaver dams along perennial streams would provide increased water tables and improve base flow in the perennial streams in the watershed. Re-establishment of beaver dams along intermittent streams would provide improved water tables in the immediate vicinity of the beaver dams, however, this would only provide base flow for a short distance away from the beaver dams.

6. Effects of Reduced Base Flow on Other Resources

Reduced base flows and loss of water table have affected other resources including fish populations, riparian vegetation, wildlife, recreation and agricultural crops that depend on irrigation.

Fish populations are affected by lower volumes of water. Lack of flow affects pool habitat by decreasing pool size and increasing water temperatures. Also, less water is available for maintenance of riparian communities that are important to wildlife resources for water and habitat. Loss of the water table has decreased aspen and willow communities and increased lodgepole pine. The subsequent resulting changes are the loss of beaver habitat and beaver ponds. This negatively affects water quality parameters and is discussed in the Water Quality section of this document.

Agricultural crops that depend on irrigation water from the Silver Creek Watershed are negatively affected by decreased flow during summer months. Less water is being produced from the watershed during this period, therefore, less water is available for irrigation purposes.

Decreased base flow results in decreased recreation opportunities by reducing the volume of water in Thompson Reservoir, thus reducing water recreation opportunities.

7. Summary of Base Flow

Base flows have decreased in the watershed. This shift has been induced by beaver trapping, livestock grazing, timber harvest, road building and lack of fire. Decreased base flows affect water quality, fisheries potential and recreation opportunities, as well as, negatively affect stream morphology.

B. Mean Flows

1. General Discussion of Mean Flows

Mean flows in the watershed have undergone a slight shift in both timing and magnitude. In a recent watershed analysis of Thomas Creek, the timing of runoff is now about 45 days earlier. Shifts in timing resulted from increased road densities, compacted soil from logging, and loss of canopy. Within the Silver Creek Watershed, compacted soil from logging operations and increased drainage efficiency from roads are also projected to affect mean flows. These are discussed below.

2. Change in Mean Flow from Forest Canopy

The past level of timber harvest in the Silver Creek Watershed is within the range that can result in changes in stream flow. Harvesting can speed up snow melt because it often results in exposure of snow to direct solar radiation and thermal re-radiation. Thinning apparently exposes the entire snowpack to a greater radiation load and can result in earlier melting. In contrast, small openings can delay melting significantly relative to larger openings (Troendle, 1983). The removal of large areas of vegetation by wildfire or timber harvesting has the potential to increase the amount of runoff and change the streamflow regime. Research indicates that when 20 to 30% of a watershed is in a cutover condition, measurable changes in streamflow can be detected (Troendle and Leaf,1981).

Using satellite imagery (ISAT) to obtain canopy closures for the watershed, the following is a summary of the percent of the subshed impacted by loss of canopy closure.

Subshed	Subshed	% of Subshed Impacted Suitable Forest Lands
West Fork Silver Creek	27	36
Guyer Creek	26	30
Indian Creek	34	45
Squaw Creek	30	44
Benny Creek	34	44
Silver Creek	33	43
Thompson Reservoir	21	40

The results of the above table shows that most subsheds have reached or exceeded the limit of 20% to 30% watershed impacts that would result in increased amount of runoff, as indicated by Troendle. Using this research, it is apparent that the timber harvest in the watershed may be increasing flow in the watershed. Also, all subsheds except Guyer Creek exceed the 30% watershed impact limit, Forest Plan Standard and Guidelines for suitable forest land.

3. Change in Mean Flow from Road Building

High road densities and increased drainage efficiency associated with roads may result in a shift in mean flows in the Silver Creek Watershed. Road building can result in earlier runoff by providing a more efficient drainage system for runoff. Research shows that as much as 15% of the total precipitation is transmitted laterally downslope in the first 12 inches of the soil profile. Normal hydrologic functioning may be drastically altered where logging roads incise the soil mantle and intercept large quantities of water (Burroughs and Marsden, 1972). This situation occurs in the residual soil areas, however, is unlikely to be occurring to a lesser degree in the pumice soil areas.

The number of channels that collect water and direct it to the main stream systems in the Silver Creek Watershed have greatly increased with the construction of roads. Additionally, roads in the watershed have few drainage structures (waterbars or dips) that can turn the water onto the upland and prevent the direct flow of water to streams. Stream drainage densities of the seven subsheds are calculated from inventories in GIS, and are shown in "Current Conditions".

4. Change in Mean Flow from Compacted Soil

Timing of mean flows in the watershed are shifted as a result of soil compaction. Normal capacities for forest soil infiltration are greater than normal rainfall or snowmelt rates. Infiltration capacities are extensively reduced by compaction (Meehan, Chamberlin, 1982). Soil disturbance can affect size of peak flows in several ways, and depends on the severity and location of the disturbance. The most easily observed hydrologic effect of compaction occurs where soil has been sufficiently compacted to restrict infiltration and produce overland flow. If this occurs, surface water flows directly to a watercourse, for example, road drainage water entering a stream at a culvert where the road crosses a stream. As the size of the watersheds drainage network increases, the runoff process becomes more efficient, and a greater amount of water arrives at the watershed outlet than would otherwise be the case (Harr et.al., 1979). Skid trails are a major portion of the compacted soil within the analysis area. Skid trails can intercept water and direct it to the stream channel, similar to roads discussed above. Field observations are that skid trails in the watershed have insufficient drainage structures (waterbars) that turn the water onto the upland and prevent the direct flow of water to streams.

5. Affects on Other Resources

Mean flows are important to providing water quantity for fisheries habitat and maintenance of riparian areas. Forest management may be affecting these parameters with the trend of higher mean flows in the winter months and lower mean flows in the spring. Mean flows may decrease in summer months as a result of roads, degraded stream conditions, and encroachment of lodgepole pine into the stream riparian areas.

6. Summary of Mean Flows

Management of the watershed has created the condition that would produce earlier runoff. The effects of this is minimized by the presence of Thompson Reservoir, which stores this runoff. The total volume of water that is produced from the reservoir may have increased slightly as a result of timber harvest. However, timber harvest has generally been through individual tree selection versus large clear cut blocks. This has impacted canopy closure by less than 34 per cent. Therefore, any increases in runoff from the subsheds would be small and savings during the summer months would not occur because of the dense understory.

C. Peak Flow

1. General Discussion

Several factors have the potential to affect peak flow including road building, reduction of canopy cover, and soil compaction. These are discussed below.

2. Peak Flow Responses to Road Building

Peak flows in the Silver Creek Watershed are estimated to be higher than natural conditions. Roads influence this by increasing drainage efficiency and synchronizing timing of flow. A USGS study showed that drainage density is directly related to flood runoff as measured by the mean annual flood, $Q2.33=1.3\ D^2$ (Carlston, 1963). An Oregon State University thesis by Wemple under the direction of Gordon Grant, focused on the hydrologic interaction of forested roads with stream networks. This thesis found that nearly 60% of the road network in Wemples study drains to streams and gullies, and are therefore hydrologically integrated with the stream network (cited reference Elliot et.al., 1996).

The recent Upper Thomas Creek Watershed analysis showed that mean annual flow (Q2.33) increased about 2.5 times the historic levels. Larger relative increases in flow occurred with the 100 year event. Similar results would be expected in Benny, Squaw, Silver and Thompson subsheds. However, the subsheds that are located in the pumice zone (Indian, Guyer, West Fork Silver), would not experience the same increases. Observation of streams in the pumice zone shows little evidence of flooding, even though these areas have high road densities, high compaction and large amounts of canopy removal in the case of Indian Creek subshed. The highly absorptive characteristics of the pumice soil creates a condition with little overland or subsurface flow through these soils. Consequently, the volume of peak flows from the pumice zone are thought to be much less susceptible to changes in management than the streams in the residual soil areas.

3. Peak Flow Increases from Soil Compaction

Soil compaction is leading to large increases in peak flow in the watershed. Compacted soils from logging operations have been measured in the watershed with a range of 35 to 40%. Compacted soils were discussed in the mean flow section and influence peak flows similarly. They are discussed in more detail in the Erosion section.

Research shows that when 15% of the watershed is in a compacted condition, it can increase peak flows by 50%. The author cautions that all areas of compacted soil do not contribute toward increased runoff to the same degree. Never-the-less, percentage of compacted soil in a watershed appears to be a good indicator of increased size of peak flows (Harr et.al., 1979). The pumice soil is compacted in the Guyer, West Fork and Indian Creek drainages. The compacted soil could potentially cause increased peak flows, however, observations are that large increases in peak flow within pumice soil areas are not occurring. The depth of soil compaction averages around 1 foot. The pumice soil in the top one foot is likely retaining substantial amounts of water from snow melt, and even with compacted soil conditions, this is not substantially adding to increased peak flows. The compacted soil has other ramifications, with regards to moisture retention and ability of trees to obtain water from this layer. The compacted soil provides a barrier for tree roots and can decrease growth in trees. However, compacted residual soils are resulting in increased peak flows, as described by Harr.

4. Summary of Peak Flows

Increased peak flows are occurring in the Silver Creek Watershed. Most of the increases are occurring in the eastern portion of the watershed in the Benny, Squaw, Silver and Thompson Reservoir subsheds. The increased peak flows occur because water is being directly channeled to the stream system as a result of the increased drainage efficiency of the road system and from increased drainage efficiency of compacted soil.

Peak flows are important for providing flood water and sediments to adjacent flood plains. As discussed earlier, the dimensions of the stream channels adjusts to the amount of water that flows through the system, with bankfull flow determining the dimensions of the stream channels. Increased frequency of peak flows and the magnitude of peak flows has occurred in the eastern portion of the watershed. This is resulting in ongoing adjustments to the stream channel. Evidence suggests that increased runoff from reduced evapotranspiration and interception losses alone do not increase high flows sufficiently to be of concern. Much greater flow increases, however, may be caused by synchronization of snowmelt in intensely harvested small basins or in conjunction with rain-on-snow events (Meehan and Chamberlin, 1982). Within the watershed, roads and compacted soil are projected to have the largest direct relationship on increased peak flows, with reduced canopy cover also contributing to a lesser degree.

In many of the alluvial deposition areas (meadows), stream channels are now downcut and flood water is confined to the stream channel and cannot fan out over the flood plain during high flows. This condition does not provide energy dissipation and is resulting in erosion of streambanks. Additionally, high energy flows are not conducive to establishment of beaver dams because dams constructed in this type of system quickly wash out. The lowering of the water table results in a degraded stream system and a loss of riparian vegetation, loss of beaver habitat, and decreased flood plain width. These factors can result in decreased shading and increased stream temperatures.

D. Cummulative Watershed Effects

Section 7 of the Endangered Species Act provides a method of Cumulative Watershed Effects analysis (CWE) that can be used to assess levels of impacts. In addition, Forest Plan standards and guidelines call for a maximum of 30% of commercial forest lands to be impacted by timber harvest or other activities. Other activities may include removal of vegetation by wildfire and/or insect and disease. Research indicates that when 20 to 30% of a watershed is in a cutover condition, measurable changes in streamflow can be detected (Troendle and Leaf, 1982). The amount or magnitude of change depends largely on the vegetation type, intensity of harvest or disturbance, and the climatic and physiographic conditions.

Harvested areas, areas disturbed by wildfire, and areas disturbed by insects and disease are considered to be hydrologically recovered when the leaf area index (LAI) is sufficient to return transpiration rates to reference or historic conditions and when canopy closure is sufficient to prevent excess snow accumulation. This canopy closure provides shading characteristics that emulates reference or historic levels of solar radiation to the snow pack. Canopy closure is obtained from satellite imagery (ISAT) and is used instead of LAI to quantify recovery. In this analysis the level of impact is assessed by subshed by determining the percent of crown closure ISAT.

The current condition can then be compared to reference canopy closures that are determined by District Silvilculturists. When canopy closure reaches the reference condition range it is determined to be hydrologically recovered. At this point the canopy is assumed to provide the desired level of transpiration, shading and snow accumulation characteristics that allow it to function as it should in the reference condition. Other impacts that affect water quality are roads and compacted soil from logging.

Vegetation

A. Forest Upland

Alteration of historic fire regimes, along with increases in timber harvest activity are the main factors involved with the differences between the reference and current conditions within the forested environment. Two basic effects of these factors are evident within the watershed. They are:

1) There has been a reduction in the amount of late and old seral conditions from 78% in 1947 to 9% in 1994 and an increase in the amount of mid-seral ponderosa pine stands from 3% in 1947 to 60% in 1994.

2) There has been an overall change in stand structure from generally single story, open parklike ponderosa pine stands to multistoried stands with small, dense diameter stands of both white fir and ponderosa pine beneath scattered overstory ponderosa pine.

Inherent disturbance regimes for the pine and pine associated type in the reference condition is one of frequent to very frequent fires (10 to 75 years). The current condition is one where fires are infrequent to very infrequent (75 to 300 years).

In the reference condition, the pine associated (CW) types appeared as open parklike stands with large diameter pine in the overstory and a highly scattered understory of both ponderosa pine and white fir. Little of this understory material ever reached significant size as moderately frequent, low intensity ground fires usually killed these trees. Grasses and herbs were the dominant species in the non tree layer.

In the current condition, timber harvest removed the overstory ponderosa pine and lack of fire allowed for the development of a multistory layer of white fir beneath residual large diameter pine. Overstory removals removed much of the larger diameter material leaving very dense stands ranging in size from small to mid-sized trees. Where overstory removal did not occur, residual large diameter overstory pine is under significant stress due to competition for moisture and nutrients from the understory trees. A similar stand development pattern occurred in the drier ponderosa pine (CP) types that occur from the desert fringe up to the mid elevations where white fir becomes more prevalent. In this CP type, development of an understory layer was a mix of both juniper and ponderosa pine along the desert fringe and generally ponderosa pine as elevation increases.

In some cases, the shrub component has increased within the non tree layer of these forested stands due exclusion of fire. In many cases fire has been removed from these stands for 70 to 80 years resulting in dense stands of evenaged shrubs that are of low vigor and decadent. This is especially true with bitterbrush within the watershed that generally is in poor condition. In other cases overall density of the tree layer has limited the non tree layer to virtually non existant due to competition for moisture, nutrients, and light.

Historically, very frequent fire prevented young trees from getting established on pine type sites resulting in large open pine stands. In the current condition, lack of fire has caused a significant increase in the survival of this understory layer composed of juniper and ponderosa pine. The result is high density small tree sized stands that are under stress. There has also been an increase in the shrub component which is in a decadent condition.

In the higher elevations, pure stands of white fir and lodgepole pine probably have not been affected by the lack of fire within the watershed as much as the ponderosa pine and ponderosa pine associated types. Historically, these lodgepole and white fir dominated areas had a fire frequency which was probably in the neighborhood of 100-200 years. The resulting fire probably consumed much of the standing biomass. The overall increase in density in the current condition is not that different from the historic nor is the fuel hazard. Generally speaking, fires were of relatively high intensity in the historic condition. The non tree component generally consists of a variety of herbs, shrubs, and grasses that vary in amount dependent on density and moisture condition and available light.

The above changes in structure and density have also effected the insect and disease conditions within the watershed as well. The most obvious change is the effect of the fir engraver (Scolytus ventralis). In the 1947 timber type maps, little white fir was noted within the pine associated stands. In the reference condition, fir engraver probably maintained itself within the system by killing scattered white fir that had been stressed by drought, fire damaged trees, those attacked by root rots (Hessburg, 1994), or within highly scattered dense stands where trees were of low vigor. In the current condition, fir engraver is providing the same ecosystem function with the exception that with the current increased acreage of white fir within the watershed, there has been a noted increase in mortality.

Historically, western pine beetle (Dendroctonus brevicomis) was probably active throughout the watershed killing large diameter ponderosa pine where it was low in vigor due to a variety of conditions such as poor soils. When drought occurred, increases in western pine beetle probably occurred. In the current condition where a large proportion of the large diameter material has been removed through overstory removal, western pine beetle only is of a concern where there is residual large diameter pine with a dense understory. Stands in this condition are under stress for moisture and nutrients, thus putting them at high risk for either fir engraver mortality to white fir or loss of the large overstory pine to western pine beetle.

With the increase in small diameter ponderosa pine (8-20 inches) density, there has been an increase in the risk for mountain pine beetle attack. Aerial surveys show that from 1987-1995 there has been scattered pockets of mountain pine beetle in ponderosa pine throughout the watershed (See map 1 in the appendix).

Historically, dwarf mistletoe in ponderosa pine was probably relatively scattered and non-damaging within the watershed. Fire historically only allowed for scattered small pockets to maintain themselves over time. When individual trees or small stands of trees reached significant levels of mistletoe infections (Hawksworth ratings of 5-6) they were typically torched by fire. Currently, with increased density of ponderosa pine within the watershed, conditions have been created that allow for much higher infection rates than occurred in the reference condition. Eglitis et al., (1993) identified that potential for spread is greatest in single species stands with multilayered canopies. The current condition is providing many stands in a condition for maximum spread of mistletoe.

Armillaria root disease spread is also of a much higher potential than in the reference condition. Overall increases in stress to all species in the watershed as well as increases in the white fir component which is one of the most susceptible species, has resulted in increases of potential occurrence of Armillaria.

B. Riparian Vegetation Condition

Riparian systems have also been altered from the reference to the current condition. Grazing, timber harvest, and dam construction appear to be the main effects of change. The result has been lowered water tables, lower flow levels, narrowing of riparian systems, and reduction in floodplain acreage due to harvest along streams. The result of this is encroachment within reference condition floodplains of conifers such as lodgepole pine and ponderosa pine. Aspen stands in the current condition appear to be stable. Most are showing adequate regeneration in order to maintain themselves. In some cases the lack of fire within the watershed appears to be allowing for encroachment of conifers within these stands, causing a decrease in vigor and limiting the potential for regeneration. In some instances, grazing from cattle has limited the success of these clones through the consumption of regeneration for long enough periods (greater than 4 years) to force aspen to utilize all of its nutrient reserves. Historical fire may also have allowed for somewhat larger patches of aspen in some areas.

C. Range Condition

Grazing, exclusion of fire, and exotic species have significantly effected the grass, shrub and herb components of the watershed. Fire exclusion has allowed for juniper and pine to encroach upon historic herb/grass dominated communities. This exclusion of fire has allowed for the development increased amounts of shrubs, small trees such as juniper, and a decrease in grasses and herbaceous plants. Grazing has removed many of the fine fuel grass components from these communities making them somewhat more fire resistant. However under drier conditions they probably will burn more severely than fires within the reference condition. In addition, many of these shrubs such as bitterbrush and mountain mahogany (Cercocarpus ledifolius) have become decadent or have grown beyond the reach for use by wildlife such as deer as forage. Exotic species such as cheatgrass have invaded portions of the watershed effecting the ability of native species to reinhabit sites following fire and decreasing overall diversity of these systems.

Current range allotment management plans, including some allotments such as the Yamsay allotment located on the west half of the subshed which have not been grazed in 4-5 years, have shown an overall improving trend. Historical grazing areas along riparian systems have been effected through the removal of vegetation, trampling and downcutting. Changes in grazing practices have led to an improving trend in the vegetation along these riparian systems but still leaves them narrower than occurred historically with lowered water tables decreasing the size and numbers of floodplains.

Stream Channel

A. General Condition

The morphology of channels results from the laws of physics acting on stream features and fluvial processes. Leopold (1964) identified width, velocity, discharge, channel slope, roughness of channel materials, sediment load and sediment size as factors affecting channel morphology. If the factors are altered, it sets up channel adjustments that affects the morphology of the channel. Channel adjustments are predictable based upon changes in stream flow magnitude and/or timing, sediment supply and/or size, direct channel alterations and change in riparian vegetation and the amount of large wood in the channel (Rosgen, Catena Report, 1994).

The stream channel condition integrates past climatic, physiographic and management influences, and is an essential indicator of overall watershed condition. The method chosen to evaluate stream channel conditions uses the Section 7 Method of the Endangered Species Act. This method compares the channel and fish habitat conditions with the desired condition. For this analysis the desired condition will be the same as the reference condition. The intent is to allow a comparison of variables that could be limiting to fish populations in a given watershed. Recommended key variables include the following:

- Primary pools (pools per mile),
- Temperature (degrees F or C),
- Sediment (percent surface fines, embeddedness or substrate fines),
- Large woody debris (pieces per mile)

If all four variables are evaluated, the two which provide the most restrictive condition rating should be carried forward for determination of Channel Condition.

B. Pool Frequency and Depth

Pool frequency, expressed as pools per mile, is a key feature which can be used to describe habitat quality. Interim objectives are provided in the Inland Native Fish Strategy, 1995, for pools per mile. These should be used in evaluating the channel condition for this analysis. Pools per mile vary depending on the stream channel width. The objectives are as follow:

	Pools per Mile		
Wetted Width (ft)	Good	Fair	Poor
5	184	92-183	<92
10	96	48-95	<48
15	70	35-69	<35
20	56	28-55	<28
25	47	24-46	<24
50	26	13-25	<13
100	18	9-18	<9

Also, the depth of pools and pool refugia are important fisheries habitat features. Using recommendations from Rosgen (personal communication, 1995), streams in healthy condition should have the maximum pool depth equal to 3 times the mean riffle depth at bankfull. Level II Stream Inventories can therefore be used to estimate the desired pool depth for streams. These are shown in the following table:

Reach	W/D Ratio	Bankfull Width (FT)	Riffle Depth (FT)	Reference Residual Pool Depth (ft)
West Fork Silver Creek				
1	17	13.0	1.0	2.0
2	14	11.5	0.8	1.6
3	15	10.0	0.8	1.6
4	14	10.5	1.3	2.3
5	11	10.7	0.9	1.8
6	7	7.0	1.0	2.0
7	6	5.5	0.9	1.8
8	6	6.0	0.8	1.6
Guyer Creek				
1	10	10.5	1.0	2.0
2	8	10.7	1.5	3.0
3	6	7.0	1.9	3.6
4	Not applicable (Rosgen Type A channel)			
Silver Creek				
1	12	32.0	2.7	5.4
2	17	36.0	2.1	4.2
3	Not applicable (Rosgen Type B channel)			
4	19	38.0	2.2	4.4
5	15	35.0	2.3	4.6

C. Temperature (°F)

Water temperature controls the rate of biologic processes and is of critical concern for fish populations and a primary indicator of habitat and channel conditions. Oregon Department of Environmental Quality standards for stream temperature are for a (7) day moving average of the daily maximum temperatures. Standards on the forest include the following:

Temperature:

68°F (20.0°C)

50°F (10°C) in waters that support Oregon Bull Trout

Based on these standards the following habitat rating is recommended:

	Water Temperature (°C)
Good	<15.6
Fair	15.6-20.0
Poor	*>20.0

*20°C is used as the threshold for identification of fair temperature in this watershed. In 1996, incremental monitoring showed that mean 7 day maximum temperatures increased from 14.5°C to 18.5°C in the Silver Creek Marsh (this section is in excellent condition with beaver dams, sedges and willows and is estimated to be in reference condition). Marshes were more prevalent in the reference conditions than exist today (and stream temperatures were therefore higher because of increased solar radiation in the marsh areas). Biologically, water temperatures in excess of 21°C (70°F) are unfavorable and may cause stress to all age classes (Sigler and Sigler 1991). Thus, recommended temperature ranges are increased from 17.8 to 20°C.

D. Sediment

Sediment levels in streams which exceed the stream's natural sediment capacity can have significant effects on habitat for salmonids. These effects can be directly linked to individual fish species and life stages. There are a variety of ways to measure sediment levels relative to fisheries concerns. Three of these measurements are: (1) percent surface fines, (2) cobble embeddedness, and (3) direct measurement of fines in the potential spawning substrate. For this analysis direct measurement of fines in the potential spawning substrate is used.

Habitat Condition	Percent *Fines in Substrate
Good	<20
Fair	20-25
Poor	>25

*Fines include material 6.4 mm and smaller (Reiser and Bjornn, 1979).

The following table provides comparison of the existing condition and the reference condition for the streams in the watershed. Perennial streams have had Level II Stream Inventories performed and therefore have the most quantitative data. Intermittent streams will be evaluated in the following section.

Fisheries Habitat Conditions in the Silver Creek Watershed
Compared with Habitat features under Reference Conditions

Reach	Channel Type Existing	Channel Type Reference	Pools per Mile Existing	Pools per Mile Reference	Large Woody Debris Existing	Large Woody Debris Reference
			West Fork Silver Creek			
1	E4b	E4b	62	48-96	92	>20
2	C4b	E4b	29	66-130	143	>20
3	C4b/E5b	E4b	44	74-146	83	>20
4	C4b/E4b	E4b	53	74-146	382	>20
5	C4b	E4b	23	74-146	379	>20
6	C4b	E4b	17	74-146	330	>20
7	E4b	E4b	34	92-184	252	>20
8	E4b	E4b	9	98-196	473	>20
			Guyer Creek			
1	E4	E4	134	74-146	25	>20
2	E4	E4	118	82-164	8	>20
3	E4	E4	89	82-164	13	>20
4	E4	E4	18	82-164	38	>20
			Lower Silver Creek			
1	C3b	C3b	27	35-70	14	>20
2	C3b	C3b	29	28-55	5	>20
3	E4b	E4b	29	24-49	37	>20
4	C4b	E4b	38	14-42	33	>20
5	C3b	C3b	25	28-55	24	>20

Reach	Mean Stream Temperature °C Existing	Reference	% Substrate Sediment Existing	Reference
	West Fork Silver Creek			
1	27.0	20.0	28.5	<25
2	28.1	20.0	28.5	<25
3	22.8	20.0	33.5	<25
4	17.5	20.0	43	<25
5	16.4	20.0	43	<25
6	18.2	20.0	36.5	<25
7	18.2	20.0	36.5	<25
8	18.2	20.0	28	<25
	Guyer Creek			
1	17.0	20.0	43	<25
2	*17.0	20.0	43	<25
3	*17.0	20.0	43	<25
4	*17.0	20.0	43	<25
	Lower Silver Creek			
1	*22.8	20.0	na	<25
2	*22.8	20.0	na	<25
3	22.8	20.0	na	<25
4	*21.5	20.0	38	<25
5	20.2	20.0	na	<25

na - Information not available

E. Overall Channel Condition Rating Summary

The following is an evaluation of the key variables for channel condition and shows that habitat conditions vary from good to poor, depending on the stream and the reach. This table evaluates the key variables using the Section 7 Method (draft revision Fremont N.F., 1996).

Reach	Pools Rating	Temp Rating	Sediment Rating	LWD Rating	Overall Channel Rating
			West Fork Silver Creek		
1	Fair	Poor	Poor	Good	Poor
2	Poor	Poor	Poor	Good	Poor
3	Poor	Poor	Poor	Good	Poor
4	Poor	Fair	Poor	Good	Poor
5	Poor	Fair	Poor	Good	Poor
6	Poor	Fair	Poor	Good	Poor
7	Poor	Fair	Poor	Good	Poor
8	Poor	Fair	Poor	Good	Poor
			Guyer Creek		
1	Fair	Fair	Poor	Good	Poor
2	Fair	Fair	Poor	Poor	Poor
3	Fair	Fair	Poor	Poor	Poor
4	Poor	Fair	Poor	Good	Poor
			Lower Silver Creek		
1	Poor	Poor	Na	Poor	Poor
2	Fair	Poor	Na	Poor	Poor
3	Fair	Poor	Na	Good	Poor
4	Fair	Poor	Poor	Good	Poor
5	Poor	Poor	Na	Good	Poor

na - Information not available

INTERMITTENT STREAMS

Subshed	Overall Rating	Description of Rating
Benny	Fair	Rosgen Type B Channel Reaches are mostly stable with adequate large wood in the channel.
	Poor	Areas with Rosgen Type F Channels are unstable laterally, have degraded and confined channels and have lost riparian vegetation.
Squaw	Poor	A high percent of this stream has unstable banks and has degraded and confined channels and have lost riparian vegetation. Overall large wood is adequate.
Indian	Poor	This has an actively degrading stream channel adjacent to the road. It appears to lack large wood.
Thompson	Fair	Intermittent and ephemeral channels appear stable. May lack large wood in channel.

F. Summary

In summary, all of the streams in the watershed with the exception of intermittent streams in the Thompson Reservoir subshed and steeper sections of Benny and Squaw Creeks, have been rated poor. . Additionally, the watershed impact limits and road densities move this watershed into the highest risk rating, as defined by the Section 7 Cumulative Watershed Effects Method. The following are explanations of the ratings for the different stream systems.

1. West Fork Silver Creek

a) Stream Channel Morphology

West Fork Silver Creek has an active flood plain with Rosgen type C and E characteristics. Because portions of the channel are 2% or greater, the channel shows some characteristics of Rosgen Type B streams, however, this is minor. Both Type C and E systems have active flood plains and are the desired morphology for this stream. Historically, beaver dams had greater influence on the channel morphology, with wider flood plains around beaver dams, higher water tables from stored water behind dams. Riparian vegetation was less dominated by lodgepole pine and alder and had larger amounts of willow and sedge. These factors resulted in a stream system that stored sediment behind dams and had active flood plains with deep pools. The stream system has changed because beaver dams are mostly degraded, flood plains are less active, and pools have filled in with sediment. These are discussed below.

b) Pool Rating

The overall pool rating for this stream is poor. This is unexpected, because of the large amount of wood in the stream channel. As documented in the Yamsay Allotment EA, large wood helps to create pools in stream systems, and high pool numbers were expected. The stream channel is a Rosgen Type C or E channel and is riffle/pool dominated. According to Luna Leapold (View of A River, 1995), pool frequency is dependent on stream channel morphology. Bank full widths of 11 feet (mean for West Fork Silver) would have between 68 to 96 pools per mile. The mean frequency for pools in this stream is 34, which does not meet the frequency that would normally occur in a system with this stream morphology.

High sediment levels were observed in the stream substrate. Sources of these sediments are discussed further in the following section. Lack of pools in the stream may be partially a result of high sediment levels that have been flushed into the stream system and subsequently filled pools. A report to the Interior Columbia Basin Ecosystem Management Project, 1996, concluded that the effects of land-use practices had reduced habitat complexity. The quantity and quality of pool habitats decreased in managed streams. Despite differences in stream size and land-use history, the magnitude and direction of these changes were consistent. Only where entire watersheds, or at least the headwaters, were designated roadless/wilderness areas did pool habitats consistently remain unchanged or increased. The sources of sediment were attributed to historic high levels of grazing, loss of riparian vegetation and large woody debris, and rapidly developing road networks that increased runoff, sedimentation and roads next to streams or in the flood plain (McIntosh et al, 1995).

The majority of the identified causes of reduced habitat identified in the report to the Eastside Ecosystem Management Project have occurred in the Silver Creek Watershed. High levels of logging in the uplands have created roads that help to channel runoff and sediment. The number of stream crossings and roads within 300 feet of the stream channel is high. Roads crossing ephemeral streams have been identified as a major source of sediment to the stream system (Bilby et al, 1989). The effects of roads in the watershed are projected to be a large source of sediment that is filling pools in the stream. Also, disturbances to soil have occurred in stream channels, particularly intermittent and ephemeral streams. Prior to development of Best Management Practices and Forest Plan Standard and Guidelines, logging activities often included skidding logs in ephemeral and intermittent stream channels. This not only reduced the storage capacity of these channels by removing large wood, but also disturbed soil that resulted in downstream sediment. These disturbances have created the opportunity for sediment to enter the perennial stream system and create increased levels of fines that help to fill pools.

Historically, sections of West Fork Silver, Guyer, North Fork Silver, Benny and Squaw Creek had marshy areas that were created by ponding of water behind beaver dams. Trapping of beaver for fir significantly reduced the number of beaver and ponds within the stream channels. Beaver colonies and the resulting number of beaver dams in the perennial streams have decreased, as documented in the Species and Habitat portion of this analysis. This decrease in beaver populations has resulted in a change from streams that have marsh areas and high water tables to defined channels with a narrower flood plain. Historic ponds retained trapped sediment. When beaver populations no longer maintained the dams, large scale failure of beaver ponds introduced large quantities of sediment into the stream systems. This sediment is now a major contributor to filling of pool habitat in the stream.

Large wood in intermittent and ephemeral channels is less than 20 pieces per mile. This has occurred from cutting and removal of large trees that would have naturally been a source of wood to the channel. Large wood helps to trap and retain fine and course sediment (Bilby et al, 1989). Loss of large wood has provided a direct avenue for sediment to enter ephemeral and intermittent streams and eventually to reach perennial streams.

c) Temperature

Stream temperature in West Fork Silver Creek varies between 16.4°C and 27°C. The State of Oregon has set the standard of 17.8°C (20°C is recommended for this watershed, pg 20). West Fork Silver Creek qualifies in this category with temperature ratings ranging from poor to fair. The largest increase in the stream temperature occurs within the Silver Creek Marsh and in the meadow below the marsh. A portion of this meadow is within an exclosure on National Forest System Land and a portion is in private ownership. The reach from the headwaters to the Silver Creek Marsh, and the reach from the below the meadow to the confluence with Silver Creek, shows little change in stream temperature. These reaches have good riparian vegetation and good shading. Historically, increased solar radiation and heating of water may have occurred as a result of large surface area of water stored behind beaver ponds (discussed in more detail in the Synthesis Water Quality Section). However, pockets of cool water were most likely present because of the influence of beaver dams. Also, deeper pools would have been present as a result of having less sediment in the stream system. Overall, the effects of increased solar radiation may have been negated by the higher levels of ground water and deeper pools within the stream system. However, it is possible that increased surface area from beaver dams created a situation where temperatures were higher than they are today.

d) Sediment

Sediment samples from potential spawning substrate areas showed fines varied between 26 and 45%. The rating from stream sediment was poor in all situations. However, two areas were slightly above 25% (the limit between poor and good) and other areas were well above this, with 41 and 45% substrate fines. Recommended thresholds for fine sediment, from the reference section of this document, are to have less than 25% by volume of fines $\leq$ 6.4 mm in size. Sources of fine sediment are discussed in the pools section above. The stream is located in a pumice zone and would have naturally high levels of sediment. However, monitoring showed that in the upper portions of the watershed, where less impacts occurred from logging, that fine sediment was at 28%. Below the Silver Creek Marsh and private pasture in West Fork Silver Creek, sediment levels were recorded at 26%. Areas between these stations were between 41 and 45% substrate fines. Review of aerial photographs identified heavy impacts from logging in adjacent uplands. Also, current conditions identified high levels of road crossings and road density in this watershed area. These impacts along with sediment flushed from decomposing beaver dams are projected to be the primary sources of sediment in the system. The connection between beaver dams in the marsh and the lower levels of sediment below the marsh indicate the importance of maintaining beaver habitat and populations in the stream system.

e) Large Woody Debris

Large woody debris in the stream system rated as good for all areas. A high level of downed lodgepole pine is present in the stream that provides the source for large woody debris. According to the Forest Silvilculturist, coring of the trees in this areas shows that most trees are less than 100 years old. Older trees were found on high points in the flood plain, indicating that lodgepole pine was present in historic time, however to a much lower level. Historically, large wood would have been composed of a mixture of species with lodgepole pine being a less dominant component of the large wood. Large wood would have been less prevalent, because lodgepole encroachment into the flood plain is a relatively recent occurrence in the stream system. Instead, flood plains would have been open with more sedges, shurbs, and less coniferous trees.

f) Overall Rating

This stream has good shading but has limiting factors mostly created through loss of beaver habitat and from high sediment loads. Previous analysis of this stream have identified the stream as having large amounts of wood and cool temperature and rated it in fair to good condition. However, these positive factors are overshadowed by lack of pool habitat, areas of high temperature fluctuations, and poor spawning substrate that is created by excessive amounts of fines in the system. Therefore, using the Section 7 method, this stream has a poor rating for stream channel condition. A road density of 3.4 mi/mi^2 and a watershed impact limit of 26% give this subshed a high risk rating according to the Section 7 Method.

2. Guyer Creek

a) Stream Channel Morphology

Guyer Creek has an active flood plain with Rosgen type E characteristics. Because portions of the channel gradient are 2% or greater, the channel shows some characteristics of Rosgen type B streams, however, this is minor. Type E systems have active flood plains and are the desired morphology for this stream. Water temperatures have only been recorded in one location along this stream. Review of aerial photographs and knowledge of the watershed leads to the conclusion that stream shading is good along this stream, and stream temperatures are also good. The mean 7- day average maximum temperature of 15.9°C is below the reference of 17.8°C (an Oregon State requirement) (20°C is recommended for this watershed, pg 20). Much like West Fork Silver Creek, beaver historically had a greater influence on the channel morphology. Wider flood plains were present around beaver dams and higher water tables existed from stored water behind dams. Riparian vegetation was less dominated by lodgepole pine and alder and had larger amounts of willow and sedge. These factors resulted in a stream system that stored sediment behind dams and had active flood plains with deep pools. The stream system has changed, because beaver dams are mostly degraded, flood plains are less active and pools are filled in with sediment. These are discussed below.

b) Pool Rating

Overall the pool rating for this stream is fair. The stream channel is a Rosgen Type E and is a riffle/pool type stream system. According to Luna Leapold (Leapold, 1995), pool frequency is dependent on stream channel morphology and with bank full widths of 17 feet (mean for Guyer Creek), the number of pools should vary between 44 to 62. The mean frequency for pools in this stream is 90, which well exceeds the frequency recommended by Leopold. Residual pool depth is, however, lower than recommended.

Beaver colonies and the resulting number of beaver dams have decreased. This decrease in beaver populations has resulted in a change in the stream channel morphology. Larger amounts of flooded riparian areas existed historically, which resulted in higher water tables than presently exist in the stream system. Trapping of beaver for fur significantly reduced the number of beaver and ponds within the stream channel. Historic ponds retained trapped sediment. After trapping and elimination of beaver in portions of the stream system, large scale failure of beaver dams introduced large quantities of sediment into the stream. This sediment is now located throughout the stream system, and has been a major contributor to filling of pool habitat. Additionally, flood plains are not as wide as they were historically, because water is not spread out by beaver dams.

Lack of large wood in intermittent and ephemeral channels has been documented in the uplands. This has occurred from cutting and removal of large trees that would have naturally been a source of wood to the channel. Large wood helps to trap and retain fine and course sediment (Bilby et.al., 1989). Subsequent loss of large wood has provided a direct avenue for sediment to be introduced into ephemeral and intermittent streams and eventually to reach perennial streams.

c) Temperature

Stream temperature in Guyer Creek is below the standard of 17.8°C (recommended by the State of Oregon) (20°C is recommended for this watershed, pg. 20). Stream temperatures rate as fair for this stream. Many of the same factors that affect stream temperatures (discussed above) for West Fork Silver Creek apply to Guyer Creek.

d) Sediment

Sediment in the stream substrate of Guyer Creek varies between 41% and 45% in the potential spawning substrate areas. The rating from stream sediment was poor in all situations. Recommended thresholds for fine sediment, from the Reference section of this document, are to have less than 25% by volume of fines $\leq$ 6.4 mm in size. Sources of fine sediment are the same as the discussion for West Fork Silver Creek, above. Similar levels can be found in West Fork Silver Creek, as in Guyer Creek. Roads, logging and loss of beaver dams are considered to be the primary reasons for high levels of fine sediment in the stream system.

e) Large Woody Debris

Large woody debris in the stream system rated from poor to good. There does not appear to be a relationship between large wood and the number of pools in this stream. The average amount of large wood in Guyer Creek is 21 pieces per mile. Overall, this stream meets large wood criteria. Historically, large wood may have been less prevalent, for similar reasons as discussed for West Fork Silver Creek. Instead, flood plains would have been open with more sedges and less coniferous trees.

f) Overall Rating

This stream has good shading but has limiting key variables mostly created by the loss of beaver habitat, upland disturbances from logging, and road construction. This stream has less limiting key variables than West Fork Silver Creek. Temperature and pools are within reference ranges. Sediment is still very high and outside of levels that will provide acceptable spawning habitat. Overall, large wood is close to the recommended standard of 20 pieces per mile. The poor rating comes primarily from the high sediment loads into the system. A road density of 4.7 mi/mi^2 and a watershed impact limit of 26% give this subshed a high risk rating according to the Section 7 Method.

3. Lower Silver Creek

a) Stream Channel Morphology

Lower Silver Creek is influenced by Thompson Reservoir. Historically, Lower Silver Creek received the majority of water from intermittent channels of Benny, Squaw, Silver and Indian Creek. This flow was a direct result of runoff from snowmelt and subsided by July. The only perennial flow into Lower Silver Creek was from Guyer Creek. Flow from Guyer Creek would have only provided minimal flow needed to fill pools in Silver Creek. Very likely, Lower Silver Creek had well defined bankfull widths that would pass the bankfull flows provided by the upstream system. The small flow that occurred later in the year from Guyer would have been confined to the thalweg and the pools. Temperatures most likely started out within State standards as water flowed from Guyer Creek and heated up through the system. Later in the year intermittent flow subsided and water was confined to pools and the center of the channel where it would have received direct solar radiation which may have resulted in temperatures exceeding the present recommended standards of 20.0°C.

Presently Lower Silver Creek has a stream channel morphology that has adjusted to the flows from the regulated reservoir. Flushing flows that move sediment from stream substrates do not occur as often as they did historically, and consequently, stream substrate sediment has a higher level of fines than would have occurred prior to construction of Thompson Reservoir. This is verified by the high level of fines in the substrate when sampled in 1996. A report by Reiser and Ramey, (1985), identifies that large releases from regulated reservoirs are necessary to dislodge fine sediments downstream of the reservoir.

b) Overall Rating

The overall rating for Lower Silver Creek is poor. Generally, there were adequate numbers of pools for a stream with this wetted width, and large wood was acceptable. The limiting variables in the stream were high fines in the substrate and high water temperatures in the stream channel. A road density of 3.6 mi/mi^2 and a watershed impact limit of 32% give this subshed a high risk rating according to the Section 7 Method.

4. Intermittent Streams (Benny, Squaw, Indian and Thompson Subsheds)

Intermittent streams with Rosgen Type B morphology are generally stable and in fair condition. Surveys of Squaw and Benny Creeks showed that these streams have adequate large wood and that bank stability is within forest standards of less than 20% instability. These streams are downcut in alluvial depositional areas. Downcutting has resulted from historic overgrazing of these areas. Historically, these areas had flooded meadow areas and often had beaver habitat. Grazing that occurred at the turn of the century was heavy and these areas lost much of their riparian vegetation and became susceptible to downcutting and degradation. Subsequent high runoff events resulted in the stream channel degrading or downcutting. Currently, the bed of these streams appear vertically stable. Bed substrate has large boulders and cobble and does not appear to be downcutting. However, the banks of these areas are laterally unstable and are highly eroded. These areas are Rosgen Type F channels.

The effects of increased runoff from roads and lack of riparian vegetation in the channels will result in further degradation of these stream channels. The stream channels will continue to erode laterally until they develop an active flood plain. This is verified by Rosgen who writes that these types of degraded streams eventually start to develop a floodplain at the new elevation (Rosgen, 1994). This is important because during the development of the new floodplain, streams are continually adjusting for new sinuosity and eroding banks in the process. This eroded bank material is deposited into the stream channels. This is the case in the alluvial depositional areas in Benny and Squaw subsheds. High road densities and high watershed impact limits give these subsheds high risk ratings according to the Section 7 Method. Thompson Reservoir Subshed has a borderline high/moderate risk rating with a road density of 2.3 mi/mi^2 and a watershed impact limit of 20%.

5. Effects to Stream Channels from Historic and Present Grazing

The Fremont National Forest presently authorizes 58,898 AUM's, with 53,306 AUM's actually used in 1995. This amounts to a 88% reduction in use on the Fremont National Forest. Presently, the Silver Creek Watershed has five allotments within the watershed boundaries which include: Foster Butte, Winter Rim, Yamsay Mountain, Silver Creek(BLM), and Bridge Creek/Silver Creek(BLM).

The allotments include:

FOREST SERVICE GRAZING SYSTEMS
ALLOTMENTS IN SILVER CREEK WATERSHED

Allotment Name	Head Cattle	Season of Use	Grazing System
Yamsay (presently vacant)	210	4/21 - 9/20	Proposing early season use
Winter Rim Rotation	282	6/25 - 9/24	Two Pasture Deferred
Foster Butte	1,367	5/1 - 8/30	Early Season with some mid-season.
Silver Creek (BLM)	200(AUM)	April thru May	Early Season
Silver-Bridge (BLM)	393(AUM)	4/21 - 6/30	Early Season Rest Rotation, 3 pasture

Data from meadow riparian monitoring in 1995 showed that riparian areas within these allotments are not exceeding Forest Plan Standards.

Allotment Name	Pasture Name	Allowable Utilization %	Actual Utilization %
Winter Rim	Fremont	45	29 - 29
	Bagley	45	6 - 24
Foster Butte	Thompson	45	1-8
	Hager	40-45	0-8
	Silver Creek	35 - 30	12 - 14
	Dead Indian	40	0 - 26
	Foster	40 - 45	0 - 26
Yamsay	Guyer	40 - 45	0 - 13
Silver Creek	BLM	*65	*66
Silver-Bridge	BLM	*65	*40

*- For BLM allotments, utilization is based on recommended levels and the average utilization for several years on crested wheat grass.

(Although not a key area, Aspen Spring was monitored with 60% Utilization and 25% soil compaction).

	Reach #	PFC Determination	Allotment
Guyer Cr.	1	PFC	Yamsay
Guyer Cr. Trib	1	PFC	Yamsay
Guyer Cr. Trib	2	FAR/NA	Yamsay
Guyer Cr. Trib	3	FAR/U	Yamsay
W.Fk.Silver Cr.	4	PFC	Yamsay
W.Fk.Silver Cr.	5	PFC	Yamsay
W.Fk.Silver Cr.	BLM	74%PFC, 26%FAR/U	
N.Fk.Silver Cr.	1	PFC	Yamsay
Strawberry Cr.	1	PFC	Yamsay
Strawberry Cr.	2	FAR/U	Yamsay
Strawberry Cr.	3	FAR/U	Yamsay
Strawberry Cr.	4	PFC	Yamsay
Strawberry Cr.	5	FAR/NA	Yamsay
Strawberry Cr.	6	PFC	Yamsay
Silver Cr.	BLM	100% PFC	

PFC = Proper Functioning Condition
FAR = Functioning at Risk
U = Upward Trend
NA = Non Apparent Trend
NF= Non Functional

PFC analysis has not been performed on Benny or Squaw Creeks. Downcut sections of these streams would most likely dictate that they are functional at risk or in the non-functioning category. Headwater springs of Benny and Squaw creek springs are heavily used and would likely meet the non-functional condition in many areas.

Lakeview Resource Area BLM includes the Silver Creek allotment (0713) and the Silver-Bridge Allotment (0700). The Silver Creek Allotment presently authorizes 200 AUM's and the Silver-Bridge allotment authorizes 393 AUM's. Silver Creek allotment is grazed alternating years in conjunction with another allotment, every other year the Silver Creek allotment is rested. The Silver-Bridge Creek allotment uses a spring season, three pasture rest rotation system. Both Silver Creek and Silver-Bridge allotments extend well beyond the watershed boundary, with small portions of each allotment within the watershed analysis area.

Monitoring on the Fremont National Forest shows that early season grazing provides optimum protection of riparian zones. In the spring, cattle often avoid riparian zones because of cold temperatures, soil wetness, and forage immaturity. Therefore, spring grazing encourages cattle to graze uplands where forage maturity and climate are more favorable compared to the riparian zone. As a result, spring-grazed riparian zones have less than half the cattle occupancy compared to fall use. As spring grazing precludes late-summer use, willow browsing is light and seedling survival high. Response of riparian vegetation is good, even on sites in poor condition. Vigorous willow and sedge regrowth provide excellent streambank protection, and water relationships remain favorable to continued willow and sedge production (cited by Kovalchick and Elmore, 1991).

With deferred grazing, cattle soon concentrate in the riparian zone (Kovalchick and Elmore, 1991). This is occurring in the Winter Rim allotment where lack of water outside of riparian zones concentrate cattle within small spring areas throughout the allotment (documented at Aspen Spring). Willow stands can be converted to sedge communities or worse (Kovalchick and Elmore, 1991). Aspen is prevalent in the winter rim allotment. Field observations are that aspen adjacent to riparian areas is heavily impacted by cattle.

In summary, Yamsay, Foster Butte, Silver Creek and Silver-Bridge Creek allotments have early season grazing, which are the best for riparian conditions. The Winter Rim allotment has a two pasture deferred system, which is less desirable for riparian resources. West Fork Silver Creek has a 31% bank erosion (Current Conditions Section) on the portion of the stream within lands administered by the BLM. Recommendations are provided in the Recommendations section to provide livestock distribution on the BLM allotments and for changing grazing systems on the Forest Service Winter Rim Allotment.

Water Quality

A. Water Quality General Discussion

The Fremont National Forest Land and Resource Management Plan (Forest Plan) includes limits of impacts that may occur in commercial forested portions of watersheds. For the Silver Creek Watershed, there is a threshold of 30% that can be impacted at any one time, unless stringent requirements are required by other resources. This threshold no longer applies when a 60% canopy closure is obtained. However, for this analysis, review of historic records and discussions with silviculturists on the Forest shows that a canopy closure of 25-55% is recommended for ponderosa pine and the <25% any species type. A canopy cover of 41-70% is recommended for mixed conifer and lodgepole pine.

Areas classified as ponderosa pine type, have undergone a shift from open park like stands, to stands with denser understories. The Hydrology Synthesis section shows that the existing canopy closure of the ponderosa pine and lodgepole pine types are within the natural range of variability. However, the mixed conifer and the <25% any species type are below their natural range of variability. Additionally, each of the subsheds have exceeded the 30% watershed impact limit in the Forest Plan, pg 80. This high level of impact equates to a high level of watershed disturbance that is resulting in sediment introduction to stream systems.

State water quality parameters of dissolved oxygen, bacteria, total dissolved solids, and toxic pollutants are not addressed as separate subjects, because water quality monitoring data for these parameters is not available. Section 303(d) of the Clean Water Act requires each state to identify streams, rivers and lakes that do not meet State water quality standards. These streams have been included in the EPA 303(d) list. Both West Fork Silver and Silver Creek have been placed on this list. Water temperature and macroinvertebrates indexes are the two limiting factors that have resulted in listing of streams in the Silver Creek Watershed. Water temperatures periodically exceed the maximum allowed by the State and macroinvertebrates show poor habitat in West Fork Silver Creek. These are discussed below.

B. Fine Sediment

Recommended thresholds for fine sediment, from the Reference Section of this document, are less than 25% of fines ≤ 6.4 mm in size by volume in the stream substrate. Instream monitoring was performed in perennial streams of Guyer, West Fork Silver, North Fork Silver, and Silver Creeks, by the Forest Service to determine the percent fines in the stream substrate. Samples were collected in the field and analyzed in the laboratory by sieve analysis. In all cases, the results showed that sediment is higher than recommended. Fine sediments in stream substrates are important parameters for salmonids. Both embryos and fry require accessible inter-gravel voids and adequate water circulation. Also, stream substrate composition is a factor that regulates the production of aquatic invertebrates that process organic material and are used by fish for food supply.

The amount of fine sediments in streams is an important factor to embryo survival. The relationship between rainbow trout embryo survival and percent substrate particles smaller than 6.4 mm is illustrated below. The percent survival used in this table were obtained from (Bjornn and Reiser, 1991). Using reference conditions of 25% or less fines in the substrate, embryo survival would be at least 60%. Under present conditions the survival rate averages 20% for the four streams monitored. The range of survival is from 0% in North Fork Silver to 34% in West Fork Silver Creek. Embryo survival varied depending on the areas of streams monitored in the Silver Creek Watershed. Results are shown below.

USFS PHYSICAL MEASUREMENTS
OF FINES IN SPAWNING HABITAT

Stream	Reach		Fines in Substrate %	Percent Embryo Survival
W.Fk Silver Cr.				
	1		28	50
	2		28	50
	3		33	35
	4		43	15
	5		43	15
	6		36	30
	7		36	30
	8		28	50
		Mean	34	34
Guyer Cr.				
	1		41	20
	2		41	20
	3		45	10
	4		na	-
		Mean	42	17
Silver Cr.				
	1		na	-
	2		na	-
	3		na	-
	4		36	30
	5		na	
		Mean	36	30
North Fork Silver Cr.				
	1		60	0
	2		na	-
				0

na - information not available

C. Fine Sediment from Roads

Roads are contributing large amounts of sediment to streams in the watershed. Estimates of erosion are shown in the Erosion Current Condition section of the Watershed Analysis. They show a soil loss rate of over 24,400 tons from roads and 1,800 tons from timber sales each year. Of this, 10 to 20 % of the erosion can enter the stream as sediment. Sediment entering streams from roads is delivered by processes including surface erosion, mass soil movements, failure of stream crossings, diversion of streams by roads, washout of road fills, and accelerated scour at culvert outlets (Furniss et.al., 1991).

Road surface erosion has been observed to severely affect streams below right-of-ways (cited references Furniss et.al., 1991). The distance that eroded material travels below the fillslope determines the degree of sedimentation in streams. A study of sediment travel distance below fill slopes shows that more than 95% of the relief culverts can be prevented from contributing sediment to streams if the travel distance is 300 feet or more. Roads with broad-based dips have nearly 100% of the contributing sediment stopped within a travel distance of 100 feet (Burroughs and King, 1989). Rosgen showed an empirical relationship where the number of stream crossings has a direct affect on the amount of sediment that enters the stream. Also, the position of the road in the watershed has an effect on the sediment delivery. The higher on the slope that the road is constructed from the drainage network, the less probability for delivered sediment to occur. Erosion may occur, but it is less likely to be routed to the stream (Rosgen, 1991). These parameters were considered in the retrieval of GIS road data where stream crossings and roads within 300 feet of streams were identified. A map in the appendix shows the locations of roads within 300 feet of streams and stream crossings. The map should be ground verified, however, it does provide good estimates of locations where roads could be closed or mitigations performed. Lengths of roads and number of stream crossings are shown below.

ROADS WITHIN 300 FEET OF STREAMS
AND
ROAD CROSSINGS

Subshed	Total Road Miles	Total Stream Miles	Miles of Road within 300 Ft of Perennial and Intermittent Stream	Number of Crossings per Mile of Stream
West Fork Silver	129	65	47	1.4
Guyer	81	34	26	1.5
Indian	61	26	14	2.4
Squaw	82	30	24	1.5
Benny	137	62	49	1.5
Silver	90	42	30	1.8
Thompson	32	13	6	2.1

There are 237 miles of roads adjacent to 272 miles of stream channel. Of these, 41 miles of road are within 300 feet of ephemeral streams (not shown in table above). The effects of this high road density is that a large amount of sediment is introduced to the stream system.

D. Fine Sediment from Upland Timber Harvest

Until recently, with implementation of the Inland Fish Strategy, stream vegetation buffers specified in timber sales have been minimal. In many cases, buffers have been non-existent. Studies have shown a buffer distance that is about one site-potential tree height (120 feet in this watershed), would be effective to remove sediment in most situations (Forest Ecosystem Management Assessment Team, 1993, FEMAT). Intermittent and ephemeral streams also contribute sediment as pointed out by the FEMAT document. Any non-permanently flowing drainage features having a definable channel and evidence of annual scour or deposition (intermittent or ephemeral) are important and often over-looked components of aquatic ecosystems. Therefore, lack of buffer widths in many of the past timber sales has resulted in existing conditions that do not provide minimum requirements for preventing sediment from entering streams.

Estimates of erosion from timber harvest activities are shown in the Erosion Current Condition section of the Watershed Analysis. The amounts of erosion that reach the stream are largely dependent upon buffer strips.

E. Fine Sediment from Streambanks

Eroding streambanks are a primary source of fine sediment in the Benny and Squaw subsheds. Streams have downcut several feet in the alluvial depositional portions (meadows) of these systems. The result has been large amounts of fine sediment eventually settling in Thompson Reservoir. Meandering streams in meadows have downcut and are now deeply entrenched Rosgen F Type channels. During floods, water moves at high velocity and transports large amounts of sediment within these streams. In proper functioning streams, the floodplain dissipates energy and streambanks remain stable. This is not the case in the Silver Creek Watershed alluvial depositional areas where streams are downcut and streambanks are eroding. The downcut streams are now unstable and will proceed through an evolution where they meander across the entire floodplain and introduce large amounts of sediment into the stream channel. This is verified by Rosgen who writes that these types of degraded streams eventually start to develop a floodplain at the new elevation (Rosgen, 1994). This is important because, during the development of the new floodplain, streams are continually adjusting for new sinuosity and laterally eroding banks in the process. This eroded bank material is deposited into the stream channels. This is the case in the majority of alluvial depositional areas in Benny and Squaw Subsheds.

Benny and Squaw Creeks have had grade control structures (loose rock check dams and gabian baskets) installed immediately above the reservoir in the stream channel. These structures are providing elevation controls to prevent the stream channel from downcutting further. These appear to be functioning well, with the water table rising and vigorous riparian vegetation establishing adjacent to the stream bank.

Perennial streams of West Fork Silver, Guyer, and Silver Creeks appear to have little erosion of the stream banks. Consequently, abnormally high levels of sediment is not entering perennial streams from stream banks.

F. Sediment from Beaver Dams

Historically, wider flood plains existed around beaver dams and higher water tables occurred from stored water. Riparian vegetation was less dominated by lodgepole pine and alder, with larger amounts of willow and sedge. These factors resulted in a stream system that trapped sediment behind dams and on flood plains. Beaver colonies and the resulting number of beaver dams in the perennial streams have decreased, as documented in the species and habitat portion of this analysis. Degraded beaver dams has resulted in deeper stream channels and a narrower flood plain. Sediment concentrations are now higher within spawning areas and pool habitat areas.

G. Large wood in Intermittent and Ephemeral Channels

Lack of large wood in intermittent and ephemeral channels has been documented in the Alder Ridge EA. Also, ocular estimates from this watershed analysis indicate that this is a common occurrence across the watershed. Typically, large trees have been harvested for timber and have not remained as a source of large wood in intermittent and ephemeral channels. Large wood helps to trap and retain fine and course sediment (Duncan et al, 1987). A study in Southwestern Washington shows that approximately 34% of surveyed road drainage points entered streams, mainly first or second order channels. Thus, the delivery of road sediment to larger streams often depended on its transport through smaller channels (Bilby et al, 1989). Woody debris has been shown to be extremely effective at retaining sediment in small systems by both slowing water velocity upstream and thereby causing sediment in transport to be deposited. In this fashion, large wood provides storage of sediment in the tributaries that may be contributing to the maintenance of water quality and productive fish habitat (Duncan et al, 1987). Thus, high sediment levels in the perennial streams may be partially due to the lack of large wood sediment storage in the ephemeral and intermittent streams.

H. Fine Sediment Summary

Fine sediments in stream substrate is an important parameter for salmonids. Sampling and analysis of sediments in streams shows that the percent fines have reached a level that is detrimental to salmonids (see also Species and Habitat section). Erosion from roads in close proximity to streams are resulting in sediment. A 300 foot buffer is needed to prevent sediment from reaching the stream on roads with culverts and 100 feet is need on roads with broad-based dips. The status of roads with or without culverts was not determined in the analysis, and all roads within 300 feet of streams were identified on a GIS generated map. Additionally, past harvest practices have provided inadequate buffer strips to prevent fine sediment from entering stream systems. Loss of beaver dams has created the situation where sediment storage in the flood plain is reduced. Also, lack of large wood in the tributary streams has reduced the sediment storage capacity of these channels. Downcut streambanks are a major source of sediment in intermittent streams of Benny, Squaw and Indian Creeks.

I. Stream Temperature

1) Stream Temperature in Perennial Streams

Elevated stream temperatures have been recorded in West Fork Silver and Silver Creeks. Water temperature is identified as a limiting factor within this watershed and is responsible for both Silver Creek and West Fork Silver Creeks being included on the EPA 303(d) list. Elevated temperatures are occurring as a result of reduced riparian vegetation from grazing, changes in stream channel morphology, heating within Thompson Reservoir, and heating within marsh areas.

Riparian vegetation has changed along perennial streams within the watershed. Historically, middle elevation and upper elevation reaches of Guyer, West Fork Silver, and North Fork Silver Creeks had riparian vegetation with higher levels of aspen, willow and sedge, with less lodgepole pine present. This would have occurred in the immediate proximity of beaver dams. Coring of trees in the flood plain shows that lodgepole pine trees have increased significantly in the last 100 years. This has occurred from lower water tables that resulted when beaver dams downcut and from loss of riparian vegetation during heavy grazing in the 1870's to 1930's. Lodgepole pine has become the dominant plant community within the flood plain. Eventually, dead lodgepole trees pine fell into the flood plain and across the stream channel and has prevented access to the streamside riparian areas by livestock. Shading from lodgepole pine and downcut channels provided the environment for mountain alder to become dominant immediately adjacent to the stream channel. This change in water table and shift in vegetation has resulted in the present high levels of shading to the stream channel. Less direct exposure to solar radiation now occurs because water is shaded and there are no longer large open areas of water that are exposed behind beaver dams. Thus, present stream temperatures may be lower within Guyer, West Fork Silver, and North Fork Silver Creeks, than existed historically.

Temperature monitoring above and below the Silver Creek Marsh and below the private meadow area and Forest Service exclosure on West Fork Silver Creek show large temperature increases within these areas. Stream temperatures below the Silver Creek Marsh are as high as 27°C. The State of Oregon has set the standard of 17.8°C for streams without Bull Trout (20°C is recommended for this watershed, pg 20). The largest increase in the stream temperature occurs within the Silver Creek Marsh and in the meadow below the marsh. A portion of this meadow is within an exclosure on National Forest System Land and a portion is in private ownership. Water temperature increases within the marsh is primarily from direct solar radiation to exposed water within the marsh. Conditions within the private meadow are unknown. Elevated water temperatures within the Forest Service exclosure are from lack of riparian vegetation adjacent to the stream channel. This occurred as a result of heavy historic grazing along this reach.

Presently, early season grazing occurring in these pastures provides the optimum grazing scenario for riparian vegetation. Grazing is not presently contributing to large increases in stream temperature.

2) Stream Temperature in Intermittent Streams

In the Benny and Squaw Creek drainages, Rosgen C and E Type streams (meadow areas) are downcut in the majority of cases. This down cutting most likely originated from overgrazing that occurred in the late 1800's and early 1900's. These reaches have intermittent flow and have little influence on stream temperature, since most of the flow occurs from snowmelt period.

3) Effects of Thompson Reservoir on Stream Temperature

Water exiting from Thompson Reservoir has been recorded at 20.2°C for the **seven day maximum average**. The highest recorded stream temperatures entering the reservoir from Guyer Creek was 17°C. From this information, it can be concluded that the reservoir is responsible for water temperature increases that exceed the State of Oregon standards of 17.8°C (20°C is redommended for this watershed, pg 20). Therefore, water in Silver Creek below the Reservoir is affected by water storage and regulation in the reservoir. Temperatures have been recorded at 27°C below the reservoir for the **7 day maximum**. This is well above the 17.8°C required by State standards (20°C is redommended for this watershed, pg 20). The stream channel below the reservoir has a width to depth ratio of 17, which is very close to the recommended width to depth ratio of 16 for Rosgen Type C channels. However, this high of a width to depth ratio does allow increase in stream temperatures from solar radiation.

Historically, flow in lower Silver Creek would have ceased and resulted in a very low wetted width in the summer and fall months. Guyer Creek would have provided the only perennial flow during this period. Water temperature would have increased from a lack of shading. However, pools would have been deeper from less sediment. Sediment build up occurs from a loss of flushing flows below regulated dams (Reiser et.al., 1985). This is apparently the case in lower Silver Creek where substrate fine sediment has been measured at 36%.

4) Summary of Stream Temperature

Water temperatures in West Fork Silver and Silver Creek are greater than State of Oregon Standards. Portions of these streams occasionally reach temperatures in the lethal range for salmonids.

Solar radiation to the shallow water of Thompson Reservoir is resulting in elevated stream temperatures (at the reservoir outlet), that are above State of Oregon DEQ standards. Beaver dams have downcut in reaches of Guyer, West Fork Silver and North Fork Silver Creek that have resulted in defined channels and increased shading. Even with excellent shading conditions, stream temperatures often exceed the State of Oregon requirement of 64°C. Lower water tables have decreased base flow and consequently may have negatively affected stream temperature in these streams. Filling in of pools with sediment has decreased deep pools for temperature refugia during both summer and winter months.

J. Macroinvertebrates

Aquatic macroinvertebrates are an important component of aquatic ecosystems. They process vegetative material that enter streams and are an important food source for fish. Species of macroinvertebrates vary greatly depending on the water quality within the stream. Macroinvertebrates were used by the Fremont National Forest to monitor West Fork Silver Creek in 1989, 1990 and 1994. During this period, aquatic macroinvertebrate samples along with physical habitat information and water quality test results were sent to the National Aquatic Ecosystem Monitoring Center, in Provo Utah. A Biotic index of each site was obtained by the laboratory that is used to rate and provide general information regarding the integrity and health of stream systems. Through this analysis the following ratings were obtained.

MACROINVERTEBRATE INFORMATION
West Fork Silver Creek

Location	1989 Rating	1990 Rating	1994 Rating
West Fork Silver Creek	95	86 & 75	65

Further details of these ratings are included in the Current Conditions section of this document. The water quality trend, as it relates to macroinvertebrates, is an overall decline in habitat conditions. The trend shows that the habitat conditions have gone from excellent (BCI 94) to poor (BCI 65). In 1994, there were indications of sedimentation and organic enrichment. This supports sediment information obtained from core samples of stream substrate in potential spawning areas.

Species and Habitat

A. Terrestrial

1. Threatened, Endangered, and Sensitive Species

a) Northern Bald Eagle

Timber harvest, plant succession and fire suppression have reduced the abundance, distribution and quality of suitable eagle nesting/roosting habitat from that present on the landscape prior to 1945. Overstory and partial removal and regeneration timber harvest treatments in Late Old Seral (LOS) ponderosa pine stands have removed preferred nest/roost trees and temporarily eliminated some once suitable nest/roost stands. Plant succession and fire suppression have resulted in an increase in stand densities which is beginning to contribute to mortality of large overstory trees (preferred for nests/roosts) from drought, and endemic insect and disease. Higher stand densities may also suppress the growth rate of trees and thereby the development of large tree characteristics preferred for nesting/roosting. Plant succession also is causing a change in plant species composition in many stands from a true pine to a mixed conifer condition. Mixed conifer stands are less suitable for nesting/roosting.

Epidemic insect and disease outbreaks or catastrophic wildfire could potentially alter the present condition and amount, or totally eliminate suitable nesting/roosting habitat at any time. The potential for occurrence of these events has increased in the past 50 years with the increase in forest understory densities, dead and down fuels, managed stands and recent drought conditions. The recent (1996) Alder Ridge fire posed a serious threat to eagle habitat along Silver Creek. Although some suitable and future potential habitat was lost, the potential for a greater loss of the most preferred habitat certainly existed.

An increase in snowmobile use and commercial logging activities on the Forest road system, and recreational use around Thompson Reservoir are the primary reasons for increased disturbance to eagles since 1945. Increased human activities around the reservoir also may be limiting hunting opportunities through disturbance of migrant and nesting waterfowl prey species.

Nesting/roosting habitat on Forest lands should be maintained in a condition similar to what currently exists in the short term, and potentially increase in abundance and quality over the long term if treatments are implemented to reduce stand densities and fuel loads, accelerate development of large tree characteristics preferred for eagle nest/roost trees, and limit disturbances from human activities during the nesting/roosting periods. A fairly aggressive underburning program initiated in recent years within the Silver Creek subshed is an important step toward the future security and development of nesting/roosting habitat. Potential nest/roost habitat quality on private forest lands undoubtedly will decline as the LOS ponderosa pine stands are converted to younger age classes through timber harvest and large overstory pine mortality occurs in overstocked stands.

b) American Peregrine Falcon

Even-aged timber harvest treatments in the vicinity of Silver Creek canyon have gradually increased foraging habitat suitability for falcons since 1945. More open habitat conditions for hunting prey species now exists. However, habitat for prey species and hunting will gradually diminish as early seral forest stands mature. Large open hunting areas on Forest lands will not occur in the future under a predicted strategy of uneven-aged forest management. This loss of prey and hunting habitat will reduce the availability and suitability of habitat for peregrine occupancy.

Plant succession from an open, parklike, single story LOS ponderosa pine forest cover to a multi-storied pine or mixed conifer forest has reduced the suitability of hunting habitat for peregrines. Dense understory vegetation interferes with flight and provides more escape cover for prey. Fire suppression is primarily responsible for succession to denser forest stands. Prescribed underburning may help maintain more open understory conditions for hunting.

Insect and disease outbreaks or catastrophic wildfire potentially could alter the present condition and amount of habitat for prey species and hunting, at any time. The potential for the occurrence of these events has increased in the last 50 years. The recent (1996) Alder Ridge fire created what should develop into some highly suitable hunting area for peregrine falcon. The increase in recreational use around Thompson Reservoir could affect migrant and nesting waterfowl prey availability for pergrine.

c) Sage Grouse

Current and historic ungulate grazing (both livestock and deer) have probably altered the plant composition, structure and cover in the lek area to the detriment of grouse reproduction and survival. Grazing has reduced nesting and escape cover. Forbs, an important spring/summer forage for adults and young, also have been reduced in cover.

2. Keystone Species

a) Big Game

Seasonal big game ranges and migration corridors on private and federal lands have been extensively altered since 1945 by the cumulative effects of commercial timber harvest, livestock grazing, plant succession, fire exclusion, wildfire, and transportation corridors for public and industrial access. The recent drought, and insect and disease outbreaks in forest stands are making additional modifications to all seasonal ranges and migration corridors on all ownerships.

The amount and distribution of effective cover has increased, and conversely, total area of foraging habitat has declined since 1950. The combination of plant succession and fire suppression have been the primary factors responsible for the changes in cover and forage habitat conditions described earlier under the reference and current conditions for big game. The recent drought, and insect and disease outbreaks are reducing the effectiveness of unstable cover conditions as mortality occurs and more stands are treated by prescribed underburning and mechanical harvest to reduce stand density. Despite the decline in forage base, the suitability of forage areas now may actually be somewhat better than what was present prior to 1945. This is explained by the increase in created openings and edge habitat adjacent to denser forest cover as a result of timber harvest treatments, plant succession and fire suppression (Table SH-T3). Most recently, the Alder Ridge Fire of 1996 will help to improve forage conditions for deer and elk for at least the next 30 to 40 years.

Even though the total forage area is smaller than prior to 1945, larger deer numbers since 1950, and more recently an increasing elk population, indicates that an adequate forage base still exists to support the current populations. Therefore, more subtle characteristics of the forage resource not apparent at the landscape analysis scale; such as an increase in forage availability, quality, and/or quantity may have occurred as a result of timber harvest treatments, wildfires, and reduced livestock grazing to compensate for the loss of total forage area. Negative aspects of timber harvest treatments evident in the watershed include compaction and slash accumulations which reduce plant growth and productivity, and more open canopies which reduces forage quality. The collective subtle effects of timber harvest treatments on forage resources are at best conflicting, but at the landscape level it appears that treatments have had some positive effects on forages for deer and elk.

Fire suppression has had both positive and negative implications for cover/forage resources for deer and elk. Initially, suppression probably helped both mountain mahogany and bitterbrush to become more widely established in greater abundance than would have occurred under natural wildfire regimes.

However, more recently fire suppression has contributed to the decline in the availability, abundance and quality of forage species, particularly as shrub productivity and reproduction declines with plant succession. This decline is evident in ponderosa pine stands where the increase in litter from needle cast and larger woody debris, and the increase in stand density is suppressing herbaceous and shrub forage production. In the absence of disturbance events, especially in forested stands, shrubs like mountain mahogany, evergreen ceanothus, serviceberry and bitterbrush are becoming more decadent and less productive with age, and seedling establishment has been poor. Failure of seedling establishment can be attributed to shade intolerance of seedlings, competition for water and other soil nutrients by trees, allelopathic response to litter, and over utilization of seedlings by a variety of wildlife species. The absence of fire also has resulted in an increase in the density and distribution of juniper which also has reduced the availability and abundance of forage, but has increased the amount of cover at lower elevations. Continued protection from fire could eventually result in the loss of some shrub stands.

Ungulate grazing since 1880 has altered species composition and reduced the abundance, distribution and diversity of native deciduous and herbaceous forage species, especially forbs and aspen. Present livestock and big game use continue to suppress recovery of the forage base to its potential productivity. Initially, livestock grazing may have increased upland shrub densities on seasonal game ranges. But, continued overgrazing by livestock and later too many deer caused a reduction in shrub productivity, vigor and seedling establishment which has contributed to the decadence and degraded condition of these now old plant communities. Recent cursory observations of upland shrub seedling establishment, productivity, and vigor indicates that there are at least isolated incidents where grazing by livestock and deer at current stocking levels are actually helping to maintain shrub condition and establishment.

Loss of riparian deciduous vegetation, primarily willows and aspen, and lowered water tables in riparian areas as a result of over grazing has altered the abundance and distribution of fawning/calving and rearing cover and forage in these areas. Recovery of riparian vegetation is gradually occurring around many stream and spring areas under present livestock management. Heavy livestock grazing also removed vegetation competing with tree seedlings which allowed denser regeneration and juniper to establish and reduced forage availability in the understory. Livestock have removed herbaceous cover and reduced the fine fuels that carry fire through rangelands which improves forage quality and productivity for big game. Livestock grazing will continue to influence the availability, abundance and composition of forage and cover for deer and elk, especially in meadow-riparian areas, on winter range and on private land.

Access for timber harvest has reduced the security of habitat for deer and elk. Road prisms have reduced the amount of available habitat and vehicle traffic on roads has displaced big game from habitat near open roads and in effect further reduced the amount of available habitat adjacent to roads. Roads have also increased the vulnerability of big game to hunter harvest. An increase in commercial timber operations and recreational uses on Forest lands on all seasonal ranges, has contributed to the decline in habitat security. In the absence of a transportation management plan, the trend will be toward the loss of more habitat and security, and greater vulnerability of deer and elk to harvest. If road closures and obliterations are implemented, habitat availability and security will increase.

Gradual growth of the early and mid-seral stands on all forested lands, future forest management with an emphasis on uneven-aged forest cover to restore and conserve late/old seral forests on federal lands, and continued fire exclusion on all lands will most likely result in at least a short term trend toward reduced levels of forage and more cover habitat for deer and elk. Prescribed underburning and mechanical thinning should help maintain forage production, and compensate to some extent for the loss of forage from the succession of forest cover. Management of ponderosa pine forest for a more open, parklike structure could over the long term actually result in a trend toward an increase in forage resources. It is conceivable that with the increasing risk of catastrophic wildfire from overstocked stands and the buildup of fuel loads from recent tree mortality caused by insect and disease outbreaks, future abundance of forage habitat may be more commensurate with historic levels.

Recent project wildfires, Alder Ridge in 1996, are indicative of the wildfire threat to unstable cover conditions that presently exist on the landscape. Deer and elk numbers undoubtedly will mirror the trend in forage resources with a slight lag in response. Recreational hunting and viewing opportunities and the dollars these recreationists contribute to local economies will fluctuate with the change in deer and elk numbers.

The elk population undoubtedly will continue to increase unless regulated by either sex hunting. More elk could potentially reduce the carrying capacity of the habitat for deer and precipitate a decline in deer numbers. If elk numbers are limited to the threshold where this affect on deer occurs, then deer numbers should remain relatively stable. The deer population then will fluctuate primarily in response to mortality from severe weather conditions, followed by high fawn recruitment during favorable conditions if the trend in forage resources remains static or improves. Also, more elk, which are primarily grazers, will increase the competition for forage resources with livestock. Heavier elk grazing in riparian areas could eventually compound damage to streambanks through trampling and removal of vegetation. An increase in soil erosion and stream sediment could ultimately result from higher elk numbers. Any significant increase in elk and deer numbers could potentially alter plant succession and suppress plant productivity.

b) Beaver

Livestock grazing, fire suppression, and plant succession have contributed to a decline in beaver habitat and numbers that probably began around the beginning of the century. Fire suppression and plant succession have reduced the availability and abundance of some important deciduous forage species. Shade intolerant and fire associated species such as aspen, willow, and alder have undoubtedly declined in density and distribution as decadent stands are replaced by denser stands of shade tolerant coniferous species. Livestock grazing has reduced the availability and abundance of summer herbaceous and winter deciduous forage species, and altered channel conditions and flow regimes to the extent that habitat needs for water may no longer be met in some stream systems. Down-cut and wider channel conditions also have reduced the site potential along some streams to support deciduous forage species and have increased the probability of dam blowouts during high flows. Upland timber harvest and road construction have contributed to altered runoff and stream flow regimes to the detriment of preferred beaver habitat conditions.

Some indicators of habitat recovery, especially riparian vegetation, are evident along isolated pockets of stream reaches, but the future trend in beaver numbers and habitat availability and suitability is predicted to remain relatively static, especially along intermittent stream systems. Degraded channel conditions seem to be the primary factor influencing beaver recovery. As fire suppression continues, plant succession advances, forest stand management along riparian areas tends toward more uneven-aged systems over longer rotations, and livestock continue to compete with beaver for important forages and alter channel conditions by damaging banks, beaver habitat conditions and populations will change little.

Trapping harvest and transplant records indicate that direct removal of beaver from the watershed also has affected populations and most probably distribution too. It appears that trapping pressure was heavy from settlement through sometime around 1920 and again from at least 1950 through 1970. The trapping closure order initiated in 1988, and still in effect, has probably protected beaver from being completely removed from the watershed.

In the absence of beaver, wetland habitat is more limited along with associated plant and animal diversity and productivity, water and sediment storage and transport are altered, and nutrient cycling and decomposition dynamics change. Also, seedbed development for deciduous species (cottonwood, alder and willow) declines as streambed scour from dam breaching ceases where beaver are absent from the system. Beaver ringing of mature cottonwood does not occur and growth of younger age classes from sprouts is lost.

3. Management Indicator (MI) Species Associated with Late/Old Forest Cover and Dead Wood Habitat

a) General Discussion

Available and suitable LOS forest and dead wood habitat has decreased since 1945 primarily as a result of timber harvest activities and wildfire. Insect and disease infestations, blowdown, fire wood cutting, hazard tree removal, road construction, and in some instances fire suppression also have contributed to the loss of habitat. These disturbance agents have removed large diameter live trees, snags and down wood, reduced patch sizes and connectivity, and diminished the amount of high quality LOS interior habitat and overstory canopy cover. Increased gaps and fragmentation have in turn increased the amount of lower quality LOS ecotone habitat. Wildfire frequently increases the amount of dead wood habitat over the burn area, but the follow up salvage treatment generally removes most of the large dead wood from the area.

True ponderosa pine has experienced the greatest reduction in dead wood and LOS forest habitat. Past management practices of overstory and partial removals of pine, as well as fire suppression, have produced forest stands previously dominated by open large diameter pine that are now characterized as mixed stands with more shade tolerant white fir understories. Also, large areas of pine were removed by regeneration harvest treatments.

Succession of forest cover above 5,500 feet and on warm fir sites at lower elevations, toward a mixed conifer composition, appears to be providing more habitat for pileated woodpecker, marten and other associated species as these forest stands progress toward the LOS condition. More mixed conifer habitat and overstocked stands on some sites as a result of plant succession and fire suppression have reduced the suitability of LOS habitat for other species such as goshawk, Lewis' and white-headed woodpecker, and flammulated owl which prefer more open understories. Overall abundance and distribution of these species has most likely declined from historic levels. Succession of about 20% of the early/mid seral lodgepole pine to late seral pine has created additional habitat for associated species such as black-backed woodpecker. A recent surge in beetle activity in these stands has increased habitat suitability.

The loss and fragmentation of available dead wood and LOS forest habitat since 1945 has reduced habitat availability and suitability and led to isolation of individuals and single pairs in smaller LOS patches, amid large areas of forest habitat where large overstory trees are uncommon or early/mid seral forest habitat that may no longer meet the habitat needs of LOS associated species. Isolation and crowding of individuals and pairs into these patches threatens the stability of some species. Sink populations in marginal habitat patches cannot maintain themselves without continuous recruitment from source populations in preferred habitat conditions. Pockets of more preferred mixed conifer habitat that presently exists for such species as marten, pileated woodpecker and a few other cavity dependent species may not equate to many more individuals because of the fragmented nature of the patches. Smaller populations of cavity excavators with more restricted distribution means less predation on insect populations. Strong populations of woodpeckers can actually help suppress epidemic outbreaks of insects that cause extensive forest mortality. Few marten mean higher rodent populations which damage or kill tree seedlings.

Under an assumed forest management scenario on private lands similar to present management, LOS forest and dead wood habitat that has been or is eliminated and replaced by early/mid seral forest will never again be a part of the landscape. Forest habitat that matures on private lands in the future probably will be harvested before it develops LOS forest characteristics, and will always be marginal sink habitat for MI and other species associated with LOS forest and deadwood habitats. Potential forest regeneration treatments on private lands in the future could continue to create edge habitat for goshawk prey species.

On Forest lands, LOS forest and dead wood habitat should gradually increase in abundance, contiguity, distribution and quality over the long term as forest management shifts to longer rotation uneven-aged treatments and tree plantations grow into mature forests. Smaller openings created by future uneven-aged treatments could create more suitable prey and hunting habitat for goshawks and marten. Edge contrast between existing LOS forest and early/mid seral forest will slowly diminish as tree plantations mature over time and Forest plantations are managed more for forest structural diversity. However, as tree plantations grow into the mid-seral condition class habitat,conditions for goshawk and marten prey species will decline. Road closures and obliterations will help reduce habitat fragmentation. Sanitation/salvage harvest prescriptions and underburning will continue to reduce deadwood habitats, but sufficient snags and down wood should be protected and created through insect and disease and wildfire to maintain stable populations of most deadwood associated MI and other species.

Prescribed underburns and thinning as now proposed should help restore more open parklike stands of LOS pine habitat for associated wildlife species. If understory thinning of forest stands is not a priority management action, then existing stands of LOS forest habitat are at risk to potential insect and disease outbreaks and catastrophic wildfire. However, the risk to higher, wetter and cooler true mixed conifer sites would be lower than the risk to lower elevation true pine and warm site mixed conifer stands. The risk for the occurrence of these events has increased in the last 25 years. The Alder Ridge fire in 1996 is an example of an event that resulted in a complete loss of existing and near future potential LOS habitat within the burn area, but created what should shortly provide some high quality early seral, edge and ecotone habitat around the burn area.

Habitat security has gradually declined since 1945 as disturbances associated with a greatly increased road density and extensive timber harvest activities escalated through at least 1990. However, predicted road closures/obliterations and lower levels of timber harvest activities in the future should reduce disturbances to LOS forest habitat and associated species.

It is unlikely that the watershed will ever again provide LOS forest habitat within the range of historic variability. Also, the intermingled ownership pattern will continue to contribute to the gaps and fragmentation of LOS forest habitat that is evident presently. It is highly unlikely that LOS open, park-like, single story pure ponderosa pine forest habitat on federal land will ever be as abundant and contiguous as it was prior to 1945. However, more acres of LOS mixed conifer should be present in the future. Overall, the future abundance and distribution of species associated with LOS forest habitat will be less than occurred historically.

4. Dead Wood Habitat Management Indicator Species

a) Red-naped sapsucker

Aspen is gradually being replaced by conifers over time, primarily as a result of plant succession and fire suppression. The decadent condition of mature aspen clones, the change in forest structure to denser conifer stands, encroachment of conifers into meadow areas and along riparian areas, and the buildup of debris on the forest floor has resulted in a decrease in the regeneration potential for aspen. Limited regeneration has occurred unintentionally as a result of timber harvest of mixed aspen/conifer stands. Frequently, the regeneration that does occur is either suppressed or eliminated by livestock and big game grazing. Where stream channels have been down-cut and/or widened and the water table lowered, the site potential for aspen may have been significantly reduced or permanently lost without a substantial investment in channel restoration. Upland timber harvest, road construction and livestock overgrazing have all contributed to the degraded conditions of stream channels and the effects this has on aspen presence and productivity.

As aspen disappears from the landscape, preferred habitat for beaver, red-naped sapsucker, and other aspen associated species is lost. Populations and distribution of these species may shrink as well. Wildlife and habitat diversity will decline. To maintain red-naped sapsucker numbers as identified in the Forest Plan, management actions must be implemented to halt the gradual loss of aspen from the landscape and restore its presence to areas that historically supported clones.

B. Aquatic Habitat

1. Riparian Vegetation and Stream Channels

The redband trout can be found in a variety of habitats depending on its life stage. Adults are generally found in areas of abundant cover associated with deep pools, large organic material, undercut stream banks and overhanging vegetation. Juveniles and "young of the year" are often found in shallow stream margin habitats, high cover areas and interstitial substrate spaces. The redband trout is a spring (March through June) spawner with eggs usually hatching in 4 to 7 weeks and alevins taking an additional 3 to 7 days to absorb the yolk before becoming free swimmers (Sigler and Sigler 1991). The average age at first spawning is typically 2 to 3 years. Reband trout up to 12 inches in length require access to spawning gravels of up to 2.5 cm in diameter with less than 30 percent fine sediment. Generally, water temperatures in excess of 21°C (70°F) are unfavorable and may cause stress to all age classes (Sigler and Sigler 1991). Temperatures of about 15°C, or 58-60°F, are ideal for optimum growth of rainbow trout (Leitritz and Lewis 1980).

The term "limiting factors" relates to those factors that have or continue to limit redband trout populations. Habitat needs of redband trout were selected to assess limiting factors within the Silver Creek Watershed because it is believed addressing these factors will provide healthy, stable aquatic ecosystems that meet the needs of all aquatic dependent species in the watershed.

2. Biotic Factors

a) Barriers to Movement - Agricultural Diversions

The Thompson Reservoir dam is located on Silver Creek above the confluence with West Fork Silver Creek and below the confluence with Guyer Creek. Historically, these streams were connected and fish movement was possible. Currently, the Thompson Dam is a barrier to fish movement that would occur upstream from Silver Creek to Guyer Creek. It is also a barrier to downstream movement, but fish occasionally flush through the spillway and then have access to the downstream reaches of Silver Creek. This consequently provides access to West Fork Silver Creek. Therefore, it is possible for fish stocked in Thompson Reservoir to introgress with fish both upstream and downstream.

b) Spawning and Incubation Habitat

i. General Information

Spawning habitat is considered to be very limited along these streams. High sediment levels provide habitat conditions that are not conducive to embryo survival, and that result in embryo mortality ranging up to 100% in North Fork Silver Creek. The average mortality across the watershed is estimated at 85%.

According to Behnke, (1992), spawning success may be severely limited in low gradient watersheds where reproduction is typically restricted by high sediment loads that blanket redds with silt during spring runoff. Accelerated erosion can favor populations of fall-spawning, non-native brook trout over native western trout. This is the case in the Silver Creek Watershed, where coring of potential redd habitat areas showed high amounts of fines. Brook trout have been observed to out-number redband trout. The level of stress on native redband trout from the stocked brook trout is unknown.

ii. Fine Sediment

The filling of interstitial spaces with fines reduces oxygen flow to the redd, which reduces egg incubation success and alevin survival (Young 1989). Fines can also act as a physical barrier to fry emergence (Weaver and White 1985).

Salmonids are dependent upon aquatic invertebrates for food. Fine sediment covers food producing areas in rubble and gravel areas, reducing aquatic insect habitat and in turn reducing the quality and quantity of food available to salmonids. Fine sediment is well above the recommended 25% threshold in most of the perennial streams within the watershed. The Current Conditions section of this document identifies that substrate from 28 to 60% within perennial streams. The mean values and embryo survival are shown below:

	Mean Fines in Substrate %	Embryo Survival %
West Fork Silver Creek	34	34
Guyer Creek	42	17
Silver Creek	36	30
North Fork Silver Creek	60	0

iii. Gravel Quantity and Quality

The quantity of gravel in stream substrates is not a limiting factor to redband trout. Sampling of stream substrate, within potential redd areas, showed that gravel ranges from 27% to 86%. The smallest volume of gravel was found in North Fork Silver Creek where an average of 40% gravel was measured. However, the high percent of fines in the stream substrates is a limiting factor.

The results of the sediment sampling showed that spawning gravel quality is better in the headwaters and lower reaches of the West Fork Silver Creek, with the lowest level of fines occurring within below the Silver Creek Marsh and below the headwaters. This has occurred because there are less impacts in the headwaters from logging and roading. Also, beaver ponds in the Silver Creek marsh are successfully trapping fine sediments within the marsh and preventing them from being transported downstream. Remnant beaver dams are present throughout the reaches of West Fork Silver, Guyer, North Fork Silver and lower Silver Creeks. These dams have downcut and are no longer effective at providing the sediment trapping characteristics that occur within the Silver Creek Marsh.

iv. Redd Dewatering

Spring spawning trout will use intermittent streams for reproduction (Benke 1992). The use of intermittent streams by redband trout has been documented within the Klamath River watershed on Bly Ranger District (Bob Nichols, personnel communication). Since redband trout are spring spawners, the success of this spawning strategy is largely dependent upon sufficient water in tributaries to allow young to move to the mainstem.

Redband trout spawn in gravelly substrates when water temperatures reach 50°F or more in the spring of the year. While quantitative data is not available concerning spawning times of redband trout in the Silver Creek Watershed, water temperatures reach 50°F from mid May to the first of June depending upon flow conditions and ambient air temperature. Eggs usually hatch in 4 to 7 weeks with swim up occurring in an additional 4 to 7 days (Sigler and Sigler 1987).

The effects of timber harvest, roads, and compacted soil advances the period of spring runoff to earlier in the year. In the Thomas Creek Watershed Analysis, estimates were made that flows advanced as much as one month earlier from the effects of roading, compaction, and timber harvest. The subsheds of Benny, Squaw, Lower Silver, and Thompson Reservoir would be most susceptible to a change in the hydrologic cycle due to roads and compacted soils. The subsheds of West Fork Silver, Guyer, and Indian Creeks are less susceptible because of the high storage capacity of the pumice soil in these subsheds.

The timing of intermittent runoff generally occurs prior to July. Any shift in the hydrologic cycle that advances flows to earlier in the year would decrease the period available for spawning in the intermittent streams. Most of the fish that could spawn in intermittent streams would originate from Thompson Reservoir. The change in the hydrologic cycle would have little biological effect on spawning fish, because the fish in Thompson Reservoir are stocked, fall spawning rainbow trout. Thus, because intermittent streams are naturally dry in the fall, they would not be available for spawning, with or without a shift in the hydrologic cycle.

A reduction in mean flows in early summer have an effect on embryo survival due to dewatering of redds before alevins are able to migrate downstream to Thompson Reservoir. However, this is generally of small consequence, because most of the trout in Thompson Reservoir are stocked, fall spawning rainbow trout and would not have access to intermittent channels during this period.

c) Rearing Habitat

i. General Information

There are few side channels along perennial streams in the watershed. The majority of water is confined to the thalwag portion of the stream and to shallow pools during low flow periods. Because there are few side channels, rearing habitat is considered to be limited. The Hydrology section of this document projected that base flows have decreased as a result of roading, decreased number of beaver dams and subsequent loss of stored water, and increased density of lodgepole pine adjacent to the stream channel.

This loss of base flow negatively effects pool rearing habitat. With reduced amounts of water in late summer and winter, residual pool depth is further reduced which concentrates fish. Under these crowded conditions levels of inter- and intra- specific competition can increase further magnifying negative impacts.

ii. Pools

Pools are important summer and winter habitats for both juvenile and adult trout (Decker and Erman, 1992). Generally, the number and frequency of pools in a stream are a good indicator of the overall quality of the habitat to support trout populations. The frequency and depth of pools is dependent upon the geomorphic character of the streambed, flow and balance of the sediment supply in the watershed. The Rosgen Type A and B channels (small high to moderate gradient streams) have more roughness elements, and thus, numerous small pools. Lower gradient streams (C and E channels) typically have fewer pools per mile but the pools are larger and deeper.

The Level II Stream Surveys show that less pools are present in the upper reaches of West Fork Silver and Guyer Creek than occurred in the reference conditions. This does not appear to be connected to large wood in the channel, because stream surveys show high quantities of large wood do exist.

The residual pool depth is identified in the Current Conditions section of this document. Average residual pool depths and estimated depths of pools that occurred under reference conditions are shown below.

	Existing Residual Pool Depth Ft	Reference Residual Pool Depth Ft
West Fork Silver	1.1	1.8
Guyer Creek	0.7	2.9
Lower Silver	1.1	5.1

This table shows that existing residual pool depths are generally less than half of estimated reference pool depths. According to Behnke (1992), adult trout generally live at depths of 0.3 m (12 inches) or greater in areas where slow waters for resting and protective cover are provided by boulders, logs, overhanging vegetation, or undercut banks. The existing lack of pool depth is a limiting factor for adult fish in the watershed. Pool depths are consistently below reference values and are at the low end of the depths that are used by adult trout. Low pool depths are also susceptible to freezing and may be responsible for trout mortality in the streams.

Pool habitat has been lost by filling of pools with sediment. Several factors have resulted in the conditions that allowed this to occur. One of the major factors occurred when beaver were trapped and abandoned beaver dams deteriorated. These riparian areas were then grazed and stream channels became downcut and more confined with less flood plain. Also, large quantities of sediment are produced from erosion caused by roads and logging impacts and from loss of large wood. These impacts are generally starting in ephemeral and intermittent streams with sediment being quickly transported downstream to perennial reaches. The limiting factors mentioned above occur within the Silver Creek watershed and are negatively affecting biomass of redband trout in West Fork Silver, Guyer, North Fork Silver, and Silver Creek.

d) Adult habitat

Measurement of pools in the streams show shallow pool depths that are marginal for adult resident trout. In Guyer Creek, pool depths are lower than 0.3 m, which is lower than the depth needed by adult resident trout.

e) Overwintering

Because most pools are shallow in perennial streams, they are susceptible to freezing. This condition along with minimal flow reduces overwintering habitat. During winter months reduced pool depth can further stress fish because of colder water temperatures and increased streambed disturbance from ice scour and gouging.

f) Large Woody Debris (LWD)

Large wood in perennial streams functions to produce aquatic habitat by providing hiding cover, substrate for the production of aquatic insects, formation of pool habitat, trapping of fine and coarse sediment, and creation of hydraulic refuge (Sedell, et.al., 1989). Large wood in ephemeral and intermittent channels slows erosion and fosters deposition of organic and inorganic materials. Deposited material then becomes a source of food for macroinvertebrates both on site and to downstream areas. One of the greatest factors affecting stability and productivity of ephemeral and intermittent streams is the amount of late seral forests along their margins (Sedell et.al., 1988).

The large wood in the perennial streams have positive effects of creating increased channel complexity, pool frequency, pool depth, quality of cover, and in the streams ability to store and process organic matter. In the Silver Creek watershed, streams have high levels of sediment and the positive attributes from LWD are reduced by the presence of high amounts of fine sediment (<6.4 mm) in the system.

The amount of large wood within most of the intermittent and ephemeral streams is below that which would be expected under reference conditions. The consequences of this lower value is that sediment that would normally be trapped in the ephemeral or intermittent stream is quickly routed to the perennial streams below.

g) Destabilization of Bank Features

Natural surface erosion and erosion of streambanks occurs over a prolonged period but, under natural conditions, are usually in balance with the bank rebuilding process. Land management activities (i.e. livestock grazing, timber harvest, and road construction) can alter this equilibrium resulting in significant increases in bank erosion and channel instability (Platts, 1991). Bank instability reduces rearing habitat for younger fish by eliminating undercut banks that provide cover. Adult habitat is further affected because undercut banks are lost that would provide pockets of cooler water during the heat of the day for fish to occupy. This is especially important in streams like those in West Fork Silver and lower Silver Creeks that have prolonged periods of high water temperatures.

Bank erosion levels do not appear to be excessive along most portions of perennial streams in the watershed. West Fork Silver Creek does have higher bank instability below the Silver Creek Marsh, however, ocular estimates puts this below the Forest Plan recommended threshold of 20% bank instability.

Excessive herbivory by livestock and other ungulates along with the loss of beaver dams from trapping have resulted in the lowering of the water table along stream channels. This has resulted in altered stream side riparian vegetation communities in the watershed (see Current and Reference Conditions for more information). Plant communities have shifted from willow/sedge communities to lodgepole pine/douglas spiraea with mountain alder association immediately adjacent to the stream channel. Lodgepole pine is much more prevalent in the flood plain and riparian areas than reference conditions. Fallen trees create a "jack strawed" condition that presently makes access to the areas by livestock nearly impossible. Banks are stable in these reaches and minimal bank erosion is evident.

h) Shade

Streamside vegetation provides shade to the stream channel and therefore is a significant factor in the regulation of water temperatures (Platts, 1991). The ability of vegetation to provide the necessary shade to a stream is dependent upon the general morphology of the channel, channel orientation to the sun, and the condition and type of streamside vegetation. For example, the amount of shading a stream receives is often greater in narrow steep sided canyons or those streams which flow east or west as compared to those in wider unconstrained channels or which flow north or south. Larger streams require higher adjacent streamside vegetation to obtain adequate shading levels. Platts (1991) found trees provided nearly all of the stream shading on large streams (6th and 7th order) and shrubs and trees on small to medium sized streams. The condition and type of vegetation also affects shading levels. Both canopy density and closure are important factors affecting stream shade (Adams and Sullivan, 1990). On forested streams, the effective buffer width varies based upon ecotype but most shade is provided by vegetation within 90-100 feet of the channel (USDA Forest Service et.al., 1993).

Ocular estimates shows that stream shade is generally high (>80%) throughout perennial reaches of the Silver Creek Watershed. This is because streams are lined with mountain alder and lodgepole pine. Exceptions occur in the Silver Creek Marsh and in the meadow area immediately below the marsh. Temperatures were recorded both above and below the marsh area. The Silver Creek Marsh heated approximately 4^{o}C through the marsh and 6^{o}C below the marsh. The marsh is a pristine area and represents pristine conditions for West Fork Silver Creek. This temperature monitoring shows that the water temperature increase occurs within these areas and also implies that in historic times, when marsh conditions were more prevalent, that water temperatures may have been higher than presently exist.

Stream temperatures have a strong influence on redband trout populations within the watershed. Temperatures in excess of 70^{o}F are unfavorable and cause stress to all age classes (Sigler and Sigler, 1987). Temperatures in excess of 79.9^{o}F (26.6^{o}C) is lethal to rainbow trout (Charlon et.al., 1970). Optimum temperatures for growth and survival of rainbow trout is between 58^{o}F and 60^{o}F (Leitritz and Lewis 1980). However, Benke (1992) reported catching redband trout in intermittent pools with high water temperatures in eastern Oregon. Redband trout that have evolved in closed basin portion of eastern Oregon may have higher temperature tolerances than rainbow trout. Stream water temperatures within the Silver Creek Watershed exceed 70^{o}F (21.1^{o}C) on all perennial streams monitored.

Additionally, temperatures in lower Silver and West Fork Silver have exceeded lethal levels as shown below:

	Elevation	Temp °C
West Fork Silver	4460	27.6
	4740	28.1
Silver Creek	4530	29.1

The change from high numbers of beaver dams and numerous flooded marsh areas, to confined stream channels that are lined with mountain alder, has created a condition where more shade exists today than existed historically. The unknown factors are how historic raised water tables and deeper pools affected stream temperature. However, the temperature increase through the Silver Creek Marsh is a strong indication that areas historically existed with higher water temperatures than are present today. This is important, because redband trout, through natural selection, evolved to live in the higher water temperatures. Possible introgression between planted rainbow trout and native redband trout may have changed the genetics of the redband trout in the Silver Creek Watershed. The ability to withstand higher water temperatures in the Oregon desert basins may have been lost. The exact extent of genetic change is unknown without genetic studies of the fish in the system.

Human Uses

A. Timber

Over a relatively short period of time, post-historic use of the Silver Creek watershed has had indelible impacts upon the forest landscape. Of these, the most visual impact has been that created by logging, road building, and other timber related activities.

Until World War II, timber harvest in the Silver Creek watershed had been sporadic and timber harvest was widely spaced. Post-war years, however, created new demands upon the timber industry as returning veterans met a housing shortage. For several decades the demand held steady, and finally peaked in the 1980's. Present harvest levels within the watershed are now only one tenth of earlier years. However, the intensity of harvesting the watershed has not been without its effects upon the forest landscape.

B. Grazing

Into the early 1900's, sheep were dominant upon the Fremont forest landscape. The Silver Creek Watershed was home to several thousand sheep and an indeterminate number of horses, cows, goats, and pigs that grazed season-long, and in some years, year long.

By World War I, partially due to the Taylor grazing act of 1934, domestic animal grazing within the watershed declined. America had become beef eaters, and synthetic fibers had begun to compete with wool. Gradually sheep herding gave way to cattle production, and the cow is now the dominant domestic animal in the watershed.

C. Thompson Reservoir

In 1922, an earth-filled dam blocked the free-flowing Silver Creek. Thompson Reservoir was created, and the Silver Lake Irrigation District was formed. The reservoir flooded some 1,523 acres of land, and stored 17,620 ac/ft of water. In 1964, the dam height was raised to increase its capacity by another 2,040 ac/ft. This impoundment allowed the downstream users to better time their allocation of water and to extend their irrigation season.

Archaeological sites proliferate in the area of the reservoir. Some are under water, and those above the water line are subject to looting and to possible damage by wave action.

D. Recreation

Thompson Reservoir and its watershed area is a popular recreation site as it contains various bodies of water includings streams, ponds, and the reservoir. The East Bay Campground with its 17 campsites, boat launching facility, trailer parking, and water wells, is a strong attraction. A nominal fee is charged for this use. The East Bay Campground is open from early June to mid-November. Thompson Campground, a Forest Service facility, is located at the north end of Yhe reservoir. No fee is charged at this campground.

Thompson Reservoir provides excellent fishing opportunities for rainbow trout and some incidental fishing for large mouth bass. As reservoir water levels drop during the irrigation season, plants grow on the lake bottom. This unique condition is conducive to producing fish habitat and larger fish. Hiking, bird watching, and hunting are other popular forms of recreation in the Thompson Reservoir Subshed. By strategic closure of roads, the outdoor experience can be heightened by promoting horse packing and outfitter guide services. Other fishing and camping opportunities exist at a dispersed recreation site on BLM lands adjacent to the irrigation reservoir located where the West Fork of Silver Creek joins Silver Creek.

Fields irrigated by water from the reservoir provide important wildlife habitat in the Silver Lake basin. Later in the year, the freshly cut hay fields provide green forage for a multitude of wildlife. This further enhances hunting opportunities for the sportsman.

E. Former Tribal Lands

In the spirit of cooperation with the appropriate tribal representatives, the Forest Service strives to improve and maintain its relationship with the tribes in the management of mutually significant forest resources.

STEP 6

RECOMMENDATIONS

STEP 6. RECOMMENDATIONS

The purpose of Step 6 is to provide management recommendations based on the ecosystem analysis process performed in the previous 5 steps. Monitoring activities are identified that are responsive to the issues and key questions. Data gaps and limitations are also identified.

Interdisciplinary analysis of the watershed was used to establish treatment priority areas and recommendations. Consider all recommendations in relationship to the landscape area to which they are being applied. For example, some recommendations, such as use for prescribed fire, should be applied over large areas such as a subshed. However, other recommedations, such as those relating to riparian areas, may be very site specific. Recommendations for improving conditions are divided into five categories as follows: Erosion Processes/Water Quality, Vegetation, Hydrology/Stream Channel, Species and Habitats, and Human Uses.

The goal of these recommendations are to guide the general type, location, and sequence of appropiate management activities within this watershed based on analysis conducted during the first five steps. The objectives of these recommendations are to:

1) Reduce soil erosion and improve water quality and soil productivity.

2) Increase the overall vigor of stands.

3) Create vegetative patterns that more closely resemble the range of vegetative patterns that would occur based on the inherent disturbance regime.

4) Create vegetative conditions that enhance the many uses that occur, to levels that are within the range of vegetation patterns, that would exist based on the inherent disturbance regime.

5) Improve riparian ecosystems.

6) Improve hydrologic funtion and channel conditions.

7) Maintain and/or improve terrestrial and aquatic species and their habitats.

8) Provide for human needs.

RECOMMENDATIONS

Erosion Processes/Water Quality

A. Soil Resources

Meet Forest Plan Standards and Guidelines for detrimental soil impacts on a cumulative effects basis. Subsoil, seed, fertilize, and mulch where necessary to reduce compaction and increase infiltration. Seed with native species as appropriate and depending on availability.

Reason: Soil impacts exceed Forest Plan Standard and Guidelines by as much as 200%, ie, 30 - 45%, in many areas. Compacted soil in timber harvest units has been identified as the largest soil resource impact. Reduced infiltration from soil compaction affects vegetation growth and hydrologic functioning of the watershed. Increasing infiltration by subsoiling would restore soil productivity and decrease accelerated drainage that results from compacted soil.

B. Road Density

Road management activities should emphasize rehabilitation of existing roads to provide cross drainage and reduce compacted soils. It should also emphasize closing roads to provide maximum open road densities of 1.0 mi/mi^2.

Reason: Reducing the open road density to 1 mi/mi^2 will help meet wildlife management objectives and result in: reduced soil erosion and sedimentation, lower peak flows and a later season runoff, improve spawning substrates, and create less stream bank erosion from un-naturally high flows.

C. Buffers on Roads

Where possible, emphasize road obliteration within 300 feet of perennial, intermittent and ephemeral streams. Emphasis should be given to perennial streams with numerous stream crossings. Obliteration implies the utilization of a subsoiler or tracked excavator to obliterate the road prism and restore the natural hydrologic flow of the hillslope. Emphasis should be placed on buffering roads with culverts and getting water off of the road prior to ephemeral, intermittent or perennial streams. A 300 foot minimal buffer area that provides a separation between the stream channel and the road is recommended. This distance can be decreased to 100 feet for roads with broad-based dips, on intermittent non-fishbearing streams and ephemeral streams.

Reason: Studies have shown that most sediment from roads is trapped within 300 feet of the roads with culverts, while 100 feet is effective for roads with broad-based dips. Obliterating roads within the above ranges and reducing road crossings would eliminate the majority of road related sediment to stream systems (see pg 35, Synthesis, for discussion of recommended filter widths for roads).

D. Road and Trail Obliteration

Obliterated roads and skid trails should have compacted surfaces subsoiled with a subsoiler, unless the road is substantially revegetated. Subsoiling implies the shattering of the compacted roadbed to restore soil condition. Subsoiling should be performed accross the entire width of the surface with a minimum of 80% of the soil in a shattered condition. The pattern of subsoiling should be a J-hook that results in a waterbar and allows water to drain off the road and back to an undisturbed soil surface. Spacing of J-hooks should be those recommended below for drainage structures. On obliterated roads and trails which are not outsloped and J-hooked, water bars should be constructed at the spacing shown below. Also utilize blocking, erosion seeding, and logging slash where feasible in order to control access and minimize erosion.

Reason: Roads have been shown to contribute to the hydrologic efficiency of the watershed by providing high drainage densities and therefore, increasing drainage efficiency. Subsoiling of roads and providing frequent drainage onto the upland soil areas will restore soil productivity and will decrease increased runoff efficiency. This will keep water in the uplands longer into the year. Also, water will move through the soil at a natural rate and will be available later in the season for stream flow.

E. Cross Drainage

Provide the appropriate number and spacing of cross drains on skid trails, skid roads, and temporary roads. The following table is a guide for cross drain spacing:

Gradient Percent	Cross Drain Spacing (Feet)
0-5	200-160
6-10	160-120
11-15	120-100
16-20	100-60
21-30	60-40
31-45	40-25
46+	25

Roads that will have **continued use should have broad based dips** constructed. Dips should be installed on a spacing recommended in the Fremont National Forest -Guide to Erosion Control on Forest Roads and Trails. Spacing = 400 feet/%Slope +100 feet. Broad based dips should be designed with an adverse grade on the downhill side and, where possible, should be armored with aggregate to prevent traffic from cutting through the structure.

Roads that are blocked at the entrance should also have drainage structures installed along the entire length of the road. Broad based dips or waterbars are recommended on the spacing of 400'/% slope +100'. Culverts should be pulled, or alternatively should be inventoried and maintained on a schedule.

Reason: Providing the appropriate cross drain spacing on roads and skid trails will help to keep water and eroded soil in the uplands. This will improve water quality by reducing un-naturally high levels of sediment and by keeping water in the uplands where it can be used by vegetation and where it is available for stream flow later in the season.

F. Riparian Habitat Conservation Areas (RHCA)

RHCA's are portions of watersheds where riparian-dependent resources receive primary emphasis and management activities are subject to specific standards and guidelines. These areas should be managed to meet Interim Riparian Management Objectives as identified in the Inland Native Fish Strategy (INFISH), or the Interior Columbia Basin Ecosystem Management Project (ICEBEMP), when it replaces INFISH. Timber, roads, grazing, recreation, minerals fire/fuels, lands, general riparian management areas are addressed in INFISH.

Examples of allowable silvicultural activities in RHCA's are burning to provide enhanced diversity of vegetation, felling of trees to provide a diverse age structure, and limited end-lining of some trees from the exterior of RHCA's. Skidding, landings or machine piling of slash should not be permitted along lengths of ephemeral, intermittent or perennial streams. Activities within these areas should be closely reviewed by the watershed specialist. Recommended RHCA's are shown below:

Type of Aquatic Ecosystem	RHCA (FT)	Recommended Addition to RHCA (FT)	Total Width Both Sides Stream (FT)
- Perennial Fish Bearing Streams	300	0	600
- Perennial Non-fish Bearing Streams	150	0	300
- Intermittent Fish Bearing Streams	300	0	600
- Intermittent Non-Fishbearing Streams	50	*50	200
- Ephemeral Streams	0	*50	100
- Springs, Marshes, Lakes, Meadows greater than 1 acre in size	150	0	300
- Springs, Marshes, Lakes, Meadows less than 1 acre in size	50	0	100

*The Watershed Analysis Team recommends adding an additional 50 feet to RHCA's for intermittent non-fishbearing streams and also adding 50 feet for ephemeral streams.

Definitions:

Perennial Streams. Normally flows yearlong, except during periods of extreme drought. Have well-defined channels and show signs of washing and scouring.

Intermittent Streams. Carry water most of the year, but cease to flow during the dry season because evaporation, and percolation into their bed and banks, exceeds the available streamflow. Have well-defined channels showing scouring or washing.

Ephemeral Streams. Carry surface runoff and flows only during and immediately after periods of precipitation or the melting of snow. Occur where the contour changes and the landform has a natural depression or swale. Flow creates some scouring or deposition and a definite channel or water transmission path is evident along some or all of the stream channel.

Reason: RHCA's provide the managed habitat for riparian dependent resources. Soil/Water/Fisheries benefit from buffer widths that provide filtering of sediments from upland management. Vegetation management creates a condition that provides shade and a long term source of large wood to the stream channel. Riparian vegetation, that provides bank stability characteristics, should be maintained or enhanced. Within the Silver Creek watershed, sediment from upland sources has been identified as a contributing source of degradation to the stream system. Also, large wood is lacking in the upland tributaries. RHCA's help to provide filtering of sediment. Enhancing RHCA's to provide a long term source of large wood will help to provide sorting and storing of sediment. The result will be less sediment in the perennial streams. This will improve fish habitat for redband trout (see pg 37, Synthesis, for discussion of importance of large wood).

G. Range Management

a) In the Winter Rim allotment, livestock grazing should be managed in order to reduce concentrated use within riparian areas. This would be accomplished through fencing seeps and springs and dispersing cattle away from the isolated riparian areas.

Reason: Livestock grazing has impacted riparian areas throughout this allotment. Improving distribution of livestock would improve riparian resources by decreasing pressure on riparian areas that presently have concentrated use.

b) In the Winter Rim allotment, consider combining with other allotments to develop a three or four pasture rest rotation type grazing system.

Reason: Livestock grazing has impacted riparian areas throughout this allotment. Shifting from a deferred system to a rest rotation system would result in less pressure on riparian resources and improve riparian conditions.

c) On the Yamsay Allotment, use early season grazing where appropriate.

Reason: Early season grazing would be compatible with beaver habitat restoration. Willow use is reduced with early season grazing. By using this system, beaver habitat can be improved with minimal livestock impacts. The benefit would be decreased soil damage within riparian areas and improved growth and vigor of riparian vegetation.

H. Partnerships

a) Develop partnerships with private landowners to improve stream/riparian conditions. Place particular emphasis on providing habitat conditions to meet State Water Quality Standards of temperature (20°C mean 7-day maximum temperature is recommended for this Watershed, per page 20, Synthesis). Emphasize the private pasture above Road 2917 in the West Fork Silver Creek Subshed.

Reason: Stream temperature monitoring above and below this areas shows large increases in temperature. Improving stream temperatures through this area would improve conditions downstream.

b) Perform a lake survey of Thompson Reservoir to determine the minimum pool necessary for overwintering of fish in Thompson Reservoir. Work with the Silver Lake Irrigation District to obtain a conservation pool to provide overwintering habitat.

Reason: A conservation pool will help to maintain trophy size fish in Thompson Reservoir and ensure the lake as a fisheries recreation site.

I. Best Management Practices (BMP's)

Apply site-specific BMP's to activities with the potential to affect soil productivity and water quality and quantity. Emphasis should be given to the following Pacific N.W. Region BMP's: (Timber Management) T-11, T-13, T-14, T-16, T-18; (Road Systems) R-7, R-9; (Fire Suppression) F-3, F-4; (Range Management) RM-2, RM-3, and (Watershed Management) W-1, W-3, and W-5.

Reason: BMP's will help to meet water quality objectives for the watershed.

J. Restoration and Improvement Projects.

(Carried forward from 517 East Environmental Assessment.)

1) Add large woody debris to Silver Creek from the National Forest Boundary to the confluence with Auger Creek.

2) Install checkdams, plant willows and shave banks on Benny Creek just above Thompson Reservoir.

3) Repair the road drainage problem at Graham Creek culvert/2800505.

4) Repair the road drainage problem at Graham Creek culvert/2800066.

5) Provide bank armoring and check dams on Squaw Creek in alluvial depositional areas.

6) Repair road drainage problem at Graham Creek culvert/2916.

7) Armor bank below culvert on the tributary of Graham Creek.

8) Repair road drainage problem on the un-numbered road near Puddle Spring. Repair fence at the spring.

9) Add large woody debris to Squaw Creek from National Forest Boundary to the National Forest Boundary (approximately 3 1/2 miles).

10) Change the road gradient of (015) so that the low point is not directly above Squaw Creek and add surfacing to control the erosion.

11) Fence the riparian areas and add large woody debris to Squaw Creek.

12) Fence Aspen Spring.

13) Change road gradient (3012) so that the low point is not directly above Benny Creek.

14) Add large woody debris (in some cases add structures) to Benny Creek and its tributaries within National Forest Boundaries (approximately 5 miles total).

15) Armor the banks on the tributary of Benny Creek below Road 2901.

Specific Projects carried forward from identified in the Watershed Improvement Needs Inventory (WIN)

16) Obliterate portions of Indian Creek Road where the road is within the stream channel or flood plain.

17) Fence Toolbox Spring.

18) Construct vortex rock weir and log structures on West Fork Silver Creek.

19) Fence Horsetrack Spring.

(Specific projects carried forward from project level Environmental Assessments and/or Allotment Management Plans at the Lakeview Bureau of Land Management (BLM).

20) Implement a road closure of the stream crossing at West Fork Silver Creek near the underdeveloped recreation site. The project includes blocking the road and rehabilitating the closed road. The road would be closed from West Fork Silver Creek to the diversion dam reservoir on Silver Creek. This would include some miscellaneous fencing work to better manage livestock.

Reason: This existing road is causing accelerated erosion in the vicinity of West Fork Silver Creek and Silver Creek. Obliteration of the road will shift traffic to other and more stable roads that will continue to allow access to the diversion dam reservoir. This work will decrease erosion and sedimentation within the watershed.

21) Partial removal and new construction of fence on the West Fork Silver Creek rim to achieve livestock control and create riparian pasture.

Reason: This will benefit riparian areas along West Fork Silver Creek by managing livestock to control season of use.

22) Drill a well for livestock and wildlife.

Reason: This would be performed in conjunction with the fencing project to provide distribution of livestock.

Vegetation

A. Upland Forest Vegetation Recommendations

1. Reduce current densities to the levels that are within the ranges identified below in stands that are identified in the Appendix of this document.

SDI Management Zones by Plant Association Type

Ponderosa Pine Type

Plant Association	UMZ	LMZ
CPS314, CPS212	161	108
CPH311, CPS215	153	103
CPG211, CPS211, CPS121, CPS311, CPS213	146	98
CPS211, CPS217 **	150	100
CPS217 **	128	86
CPS111	106	71
CPS214	168	113
CPS311	164	110

White Fir Types

Plant Association	UMZ	LMZ
CWS313 (PP), CWS114 (PP)***	161	108
CWS313 (WF), CWS114 (WF)***	370	281
CWC411 (PP)***	128	86
CWC411 (WF)***	281	188
CWC311 (LPP)***	170	114
CWC311 (WF)***	281	188
CWH211 (PP)	285	191
CWS117 (PP), CWS112 (PP)	161	108
CWS115 (PP)	172	115
CWH111 (PP)	179	120

Lodgepole Pine types

CLG315, CLS211, CLG415 CLS215, CLG313, CLM311 CLG314, CLH111, CLS211 CLG313, CLM311, CLG311, CLM211, CLS911, CLS311, CLS214, CLS213, CLM111 CLG411, CLG413, CLS311 CLS212	170	114

** These are from different plant association guides, the Fremont Plant Association Guide and the Pumice Zone Plant Association Guide. Both had different site indicies. Each is potentially present in the watershed.

*** These are SDI management zones for white fir and ponderosa pine, therefore they have different SDI maximums.

Reason: These calculations are based on Cochran (1994) which combines both GBA and SDI assumptions to calculate upper and lower density managment regimes within stands to minimize the impacts of insect and disease. It will also increase the vigor of residual stands. Presently, approximately 24,000 acres are at high risk for significant mortality from insect and disease (see list of stands in Appendix). This high risk is to both the overstory large diameter trees as well as the understory. The range of densities will allow the flexibility to the silviculturist to meet the objectives identified by the various resources and maintain overall stand vigor.

2. Stand treatments should emphasize reducing the number of stands of multisized structure where the inherent disturbance regime minimizes the potential for sustainability of these stands. Utilize both mechanical and prescribed fires treatments to reduce this understory density. Remove trees up to 21 inches in diameter where there is a concern over loss of adequate numbers of replacement trees for the future stand in the understory.

3. Treatments should strive to maintain the late/old characteristic that is characteristic of stands developed within the inherant disturbance regime for a given site. Utilize unevenaged prescriptions where appropriate as per Forest Plan direction (p. 147).

Reason: Currently the analysis area is short of stands that meet these criteria.

4. Treatments within the pine and pine associated plant associations should favor the maintenance of large diameter ponderosa pine and potential replacement trees in the understory in areas where maintenance of LOS is below direction identified in the screens.

Reason: Past overstory removals has created a shortage of large diameter ponderosa pine within the analysis area. Increases are needed to maintain LOS and wildlife values.

5. Timber sale planning efforts should consider the economic viability of potential products with the overall sale objectives to assure that money will be available to meet desired goals.

Reason: Current budgets are decreasing. Material being sold is, in many cases, of marginal economic value and not capable of supporting additional improvements following removal.

6. Utilize thinning from below, sanitation salvage, and clearcutting treatments to minimize the potential for significant impacts from dwarf mistletoe in both ponderosa pine and lodgepole pine. Two specific stand conditions that were identified within the Assessment of forest health on the Fremont guide (Eglitis et.al., 1993) and should be given high priority within the analysis area are:

a) Plantations or regeneration units with mistletoe infected overstory with trees of the same species as a plantation. If the overstory is not removed or girdled, tree growth and wood fiber production may be greatly reduced. There maybe potential losses of initial planting investments also within these stands. It will also severely minimize the potential for these trees to reach sizes that will meet the needs as large diameter trees.

b) Young or intermediate sized stands should be identified and thinned to maintain vigorous growth. Lack of treatment will result in growth loss and mortality and will limit the ability of these trees to reach large diameters.

Reason: A general reconaissance of the watershed identified a number of stands within the watershed as having moderate to heavy dwarf mistletoe infections (Hawksworth rating of 4 to 6). Spread and damage is typically greatest in single species stands with a multilayered canopy. Overall rating of these stands should be reduced to a rating of 1 or 2 to increase vigor on residual stand and minimize the impacts from dwarf mistletoe.

7. Utilize underburning within juniper stands to reduce juniper and increase diversity of range species.

Reason: Underburning will be used to remove juniper and allow for the grass and herb species to reinvade the site improving overall productivity and range condition on these sites.

8. Evaluate all burned areas after 10 years for reburning. Identify significant stands of bitterbrush and/or mountain mahogany and identify reburning options within these significant shrub stands at that time.

Reason: By bringing these stands closer to the inherent disturbance regime for the analysis area, there will be a lower cost for maintenance of vegetation within the analysis area and a reduced fire hazard. In addition bitterbrush that occurs on the site will be more vigorous, will develop a more diverse age class distribution and be more palatible to wildlife. It will also reduce significantly the amount of bitterbrush in the area for a short time. Evaluating these sites after 10 years will allow managers to evaluate areas where bitterbrush regeneration is highly successful and allow future treatments to work at the development of these areas for bitterbrush as it is needed to meet wildlife values. This will allow for maximize bitterbrush levels based on needed values for the area. Maintaining a longer return interval will allow for species such as bitterbrush to maximize their development.

9. Utilize prescribed fire alone and mechanical methods in combination with presribed fire to meet the objectives of reducing density and structure from within stands. Consider demonstration burns within stands to demonstrate the ability of fire to meet density and structure reduction objectives in addition to fuels reduction.

Reason: There appears to be real potential for fire to be used as a tool to reduce density but a concern over the risk to lose current investments in standing inventory of trees.

10. All prescriptions should be approved by a certified silviculturist.

Reason: Regional direction says that vegetation management treatments will be approved by a certified siviculturist.

11. Continue to monitor noxious weed populations and work together with the BLM in controlling noxious weeds to minimize future spread.

Reason: Both the BLM and the FS have concerns over increasing noxious weed populations. There should be a coordinated effort to control these boundaries so that efficiency in control is achieved.

12. Review/develop a logging and transportation plan for the analysis area to minimize impacts from soil disturbance created from roads and skid trails.

B. Riparian

1. Continue to conduct inventories to define the current condition of aspen clones within the watershed.

Reason: The district wildlife resource has been conducting aspen surveys over the past year or so. These should continue to occur to get a good understanding of the overall condition of aspen.

2. Where aspen stands are presently declining due to various conifer encroachment, lack of regeneration, or with overstories that have significant dead branches or with a number of aspen trees that are dead with little regeneration in the understory:

a) Stimulate vegetative reproduction through disturbance that induces coppice sprouting (i.e. severing roots, cutting of standing live aspen). Utilize both mechanical methods such as felling or prescribed fire or a combination of both.

b) Introduce low-moderate intensity burns to induce coppice sprouting in aspen stands of low vigor. Utilize fencing where necessary to ensure establishment where grazing by livestock or wildlife prevents the establishment of young sprouts. In general, good management of livestock grazing programs should provide adequate protection. Implementation of control strategies is recommended for 4-5 years after the sprouting has occurred or until the aspen sprouts reach a minimum of 6 feet for domestic livestock and 12 feet for deer and elk (Personnal communication from Wayne Shepperd, 1996).

c) Generally maintain aspen stands to provide a variety of seral conditions from early to late over the analysis area. Where aspen stands are being encroached upon by conifer species, thin to remove or fell conifer species both within the clone and within a 25 foot buffer around the clone. This is expected to stimulate sprouting both within the clone and along the edges. Utilize underburning or felling of aspen of low vigor to further stimulate sprouting. Where aspen clones are no longer able to regenerate vegetatively, plan silvicultural treatments to establish site conditions for planting and then plant area.

Reason: Recent inventories have shown that some of the aspen stands are in a declining condition. Reasons for these declines are various but three areas of concern are conifer encroachment, grazing impacts, and lack of fire.

3. Coordinate with hydrologists and silviculturists to develop strategies to raise watertables along riparian systems for developing floodplains and vegetation conditions that meet fishery and hydrologic needs. Vegetation plans should look at development of sedge species along with willow, alder, and aspen. Methods to establish vegetation should be performed in conjunction with improvement projects.

Reason: To reestablish historic floodplains and riparian vegetation.

4. All vegetative prescriptions should be approved by a certified silviculturist.

Reason: Regional direction states that vegetation management treatments will be approved by a certified sivicuIturist.

C. TES Plants

1. Follow the standard and guidelines set forth in the Forest Plan for management of TES species (pages 108-109).

2. Conduct inventories to identify the location of TES species, their current population size, current condition, threats to the population, and their location.

Hydrology/Stream Channel

A. Large Woody Debris (LWD)

Large woody debris (LWD) should be restored to > 60 pieces per mile on A and B channel types and >20 pieces per mile on C channel types. These standards should apply to all perennial, intermittent and ephemeral channels. Work with Silviculture to develop unevenaged stands within RHCA's in all streams where historic cutting has occurred, or where forest health is of concern.

Reason: Large wood has been identified as lacking in streams in the watershed. Also, sediment in stream substrate has been identified at high levels that are detrimental to salmonid species. Studies have shown that large wood in the channel helps to retain sediments (>6.3 mm). Providing large wood to the channel will enhance the sediment retention of the tributary streams and will help to improve water quality in the fish bearing streams. Spawning gravel will be enhanced by lowering sediment and pool habitat will be improved by increasing pool depth. See (pg 37, Synthesis) and pg 8 Reference) for discussion of importance and quantities of large wood.

B. Channel Morphology

a) Restore streams to the desired channel morphology. Rosgen Stream Channel types G and F should be moved toward channel types C and E, as appropriate, for the natural morphology of the stream. Rosgen parameters of width to depth ratios and sinuosity should be used as target objectives for these streams.

b) Reduce bank erosion levels to less than 20% on all C, E, and F channels and less than 10% on all A and B channels.

c) Improve site conditions for meadow riparian vegetation by raising water table levels through stream channel restoration. Raise water tables in alluvial depositional areas.

Reason: Degraded G and F type channels are typical in the alluvial depositional areas of Benny, Squaw, Thompson and Indian Creek subsheds. Restoration of these channels back to C and E type channels will decrease erosion of unstable banks. Also, raised water tables will maintain vigorous riparian vegetation and will help to maintain stable stream banks. This restoration will also provide decreased sediment input to Thompson Reservoir and will maintain the depth of the reservoir by preventing siltation.

C. Pool Habitat

a) Increase pools per mile to meet Infish Standards on perennial streams.

b) Use current habitat restoration methods to increase residual pool depth to achieve reference depths that were recommended in the watershed analysis.

Reason: Level II Stream Surveys show that all perennial streams, except Guyer Creek, have fewer pools than recommended in the Native Inland Fish Strategy. The number of pools per mile can be increased by lowering sediment input to the stream channel, and by physically constructing pools through habitat improvement projects. All streams showed lack of residual pool depth within the stream systems. Improving pools per mile and improving pool depth will result in improved fisheries habitat. Habitat enhancement work should be conducted in conjunction with a reduction of sediment input and with vegetation management.

D. Canopy Cover

Because Forest Plan watershed impact limits have been met or exceeded in all of the subsheds in the analysis area, creation of new clearcuts is discouraged. To obtain hydrologic maturity of the watershed, canopy cover should be increased to minimum recommended levels in this watershed analysis. Timber management projects should identify canopy cover on a contiguous landbase, preferably isolating a drainage within each subshed. Emphasis should be placed on meeting minimum canopy closure within the drainage.

Reason: Watershed analysis shows that Forest Plan watershed limits have been met or exceeded in all subsheds. The watershed impact limits are based on the canopy cover that is needed to provide hydrologic maturity of the watershed. By managing within the range of the natural canopy closure (shown in the Watershed Analysis), peak flows and timing of runoff would be closer to reference conditions. This will help to stabilize degraded stream conditions and will provide natural timing of runoff.

Species and Habitats

A. Terrestrial

1. Threatened and Endangered Species

a) Northern Bald Eagle

Treatment recommendations include precommercial and commercial thinnings as well as prescribed underburning to reduce stand densities, fuel loads, mistletoe infection, and white fir competing with the establishment and growth of preferred ponderosa pine nest/roost stand and tree characteristics.

Reason: Such treatments would reduce the risk of loss of nest/roost trees and stands to natural disturbance events and accelerate development of preferred nest/roost tree and stand characteristics described below.

In general, preferred nest stand characteristics include: density > 100 trees/ha greater than 27cm, basal area of 20 sq.m/ha, mean DBH of 49 cm and a crown closure of 30%. Roost stand characteristics include: trees >200 years old; density <50 trees/ha; DBH >50 cm; height >25m; 10% spikes and snags. Preferred nest tree characteristics include height > 30m and DBH > 100cm. Preferred roost tree characteristics include: trees >200 years old; DBH >70cm; height >25m. Proportion of trees by height class for nest stands for the preferred basal area follows.

Tree Height	%
7.6-14.9m	35
15.0-22.6m	25
22.7-30.2m	20
30.3-37.8m	15
38.0-45.5m	5

Limit disturbance within 800m of occupied winter roost sites from 11/1 through 4/31 and around occupied nest sites from 1/10 through 9/10, or known time of occupancy determined from field observations.

Effectively close road 624 beyond the dispersed camp site. Close the 501, 502, 503, 504 and 626 roads.

Reason: Road closures and activity restrictions would improve habitat security for nesting and roosting eagles within the proposed BECA and increase the proability of successful fledgling production.

b) American Peregrine Falcon

Consider peregrine habitat needs in any future recreational developments around Thompson Reservior if any cliff sites along Silver Creek become occupied.

Reason: Maintain solitude within 1.0 miles of active nest sites during the courtship, nesting and fledgling period from February 1 thru August 15.

c) Sage Grouse

The following desired conditions should be managed for within potentially suitable habitat within 1.5 miles of the lek site if birds have re-occupied the lek.

Reason: The conditions described below will provide the habitat conditions necessary for successful nesting and brood rearing within the vicinity of the lek site typically used by female grouse. Maintain or increase the status of populations and habitats of sensitive species.

Maintain at least 50% of the annual herbaceous vegetation (by weight) prior to mid-September.

Manage sagebrush for an average composition of 20-30% or for 5000 - 10,000 plants/acre.

Manage some sagebrush stands with 20 to 40% canopy cover for nesting and brood-rearing.

Fence springs and reserviors and pipe water for livestock to an outside trough to stimulate production of forbs and grasses around the wet areas.

Maintain an herbacaous stubble height of 4" and manage some stands of tall grass cover at a height greater than 18 cm.

2. Keystone Species

a) Big Game

Forage, cover, and road densities on mule deer ranges will be managed to provide the habitat conditions necessary to meet the ODFW herd management objectives over the long term. Short term declines in the population may be experienced as habitat is treated to increase forage quantity, quality and species diversity. These treatments may temporarily reduce densities of bitterbrush over the short term, but will improve age class diversity, density, productivity and vigor over the long term. A reduction in hiding cover below current conditions also can be expected as forest stands are treated to reduce overstocked understories, improve site conditions for establishment and growth of bitterbrush and other forage species, and move the forested landscape back toward the historic range of conditions existing earlier in the century. Such habitat conditions can be characterized as having less forest hiding cover but more robust understory and non-forest herb and shrub plant communities.

Road densities and special elk habitats will be managed in accordance with the standards and guidelines in the Forest Plan to provide habitat conditions conducive to a rapidly increasing elk population.

Reason: A combination of treatments and protection of existing habitat features will provide the forage from early seral and open forest understory plant communities, hiding and thermal cover and habitat security necessary to improve habitat conditions and population performance (reproduction and survival) for both deer and elk.

i. Security Habitat

Design forest thinning treatments with non-uniform (variable) spacing and unthinned clumps to maintain an interspersion of cover and forage patches, and variable densities of cover. Patches **intended to provide thermal and/or hiding cover should be 2 to 26 acres.**

Road density on all big game seasonal ranges should be managed toward 1.0 mile/square mile.

Transition and Winter Ranges (Ponderosa pine/bitterbrush and ponderosa pine-juniper/mountain mahogany plant communities)

Manage for pine basal area of 40-80 square feet with non-uniform spacing and scattered patches of pine in excess of 125 square feet of basal area for thermal and hiding cover. Some reduction in hiding cover from current conditions is inherent with this recommended treatment. An increase in herbaceous and shrub understory vegetation should be expected with the more open forest condition. Around mahogany patches, manage pine basal area at the lowest end of the range, and experiment with small openings of 0.50 to 2 acres around patches.

Manage that portion of the Alder Ridge wildfire on this seasonal range type for an open early seral forest structure to help maintain more abundant forage resources during development of forest cover. Consider wider spacing during tree planting to help achieve this open condition and reduce the cost of follow-up thinning treatments to culture the stand.

Implement prescribed fire, mechanical treatments and seedings/plantings to reduce juniper and big sage densities, create a mosaic of diverse shrub age classes, and increase herbaceous plant production and nutrient quality.

Prescribe burn an area of the Silver Lake Exclosure Research Natural Area to monitor the establishment, productivity, and survival of ungulate browse species in the absence of grazing by big game and livestock, and for comparison to existing shrub communities both inside and outside the exclosure.

ii. Edge Habitat

Maintain the quality and quantity of edge habitat. Increase the quantity and quality of forage in the ecotone formed along edges. In existing small burns and regeneration harvest units (<80 acres), maintain 1 to 25 acre forage patches on sites near the edges of units. In extensive burn areas such as Coyote and Tool Box maintain 1 to 40 acre forage patches in a mosaic. Priority areas for treatment would include those sites where forage species are decadent, forage productivity has declined because of an increase in forest cover, and/or preferred forage species occur. These openings will help maintain early seral foraging habitat for a longer period of time during forest stand development.

iii. Foraging Habitat

Bitterbrush

Conduct prescribed burning during plant dormancy, preferably over frozen ground or when soil moisture exceeds 50%.

Burn in a mosaic pattern to leave unburned islands of scattered live plants as a seed source.

Fall is the best time to burn for seed production since seeds must be cold treated and scarified for germination.

Understory/overstory thinning prior to burning will increase seedling establishment.

Soil disturbance from logging activities prior to burning will increase seedling establishment.

As a general rule, a fire return interval no shorter than 30 years on deer winter/transition range, and no shorter than 20 years on deer summer range on the most productive/vigorous bitterbrush stands, unless monitoring indicates a need for shorter intervals. The most thrifty stands are characterized by plants generally less than 45 years old, multiple age classes, predominately unbrowsed to moderately hedged plant form classes, and moderate to high plant density. These stands should be identified prior to prescribed fire treatments for either protection or scheduled treatment at the intervals suggested above. As a minimum, effective distribution of these stands should occur at a level which represents the mean of deer winter home range areas. All bitterbrush stands (irregardless of productivity and vigor) that are prescribed burned should be evaluated at 10 years post burn to determine if and when reburning of the stands would be in the best interest of bitterbrush survival, density, productivity and establishment, and fuel treatment and big game forage needs. Diligent monitoring and evaluation of representative treated and untreated stands will help establish an acceptable fire return interval for different biophysical environments to restore, maintain and/or improve the health of bitterbrush and their associated plant communities, and manage fuel within acceptable risk levels.

Livestock grazing on deer winter/transition ranges will improve/maintain bitterbrush production/survival under an early season use strategy. Livestock should generally be removed from winter range around July 1 and from transition around August 1.

Mountain Mahogany

Burn in a mosaic pattern to leave unburned islands of scattered live plants as a seed source.

Soil disturbance from logging activities prior to burning will increase seedling establishment.

Fire return intervals no shorter than 50 years where vigorous stands have become established.

Reduce thinning slash and stem density in previously treated harvest units where herbaceous and woody understory plant growth is surpressed or stagnated. Where broadcast reduction is not feasible because of the amount of residual slash and the presence of advanced fir regeneration or pole stands, implement spot reductions over 0.5 to 3 acre areas to stimulate understory plant growth. Place emphasis on hand piling or burning treatments but restrict mechanical methods in order to meet soil objectives.

iv. Fawning/Calving/Rearing Habitat

Restrict activities from at least 5/10 through 6/20 to minimize disturbances in deer and elk parturition areas.

b) Beaver

Maintain and restore beaver habitat, both deciduous and herbaceous forage species and water availability near active and historic dam sites where these factors may be limiting re-colonization or productivity. Raise the water table in riparian areas where downcutting has occurred.

Control livestock stocking rates, season-of-use and grazing systems to restore both deciduous and herbaceous forage species, and water availability near active and historic dam sites, and along stream reaches of potential habitat.

Implement a multi-year beaver transplant program in areas of potential and/or formerly occupied habitat where riparian vegetation recovery is adequate to provide at least marginal forage resources for survival. Multiple transplants over several years at a single site may be necessary until beaver successfully restore habitat conditions to suitable year round occupancy.

Reason: Restoration of beaver habitat will increase the area of wetland habitats and associated plant and animal diversity and productivity, improve water and sediment storage and transport, and nutrient cycling and decomposition.

3. Management Indicator (MI) Species Associated with Late/Old Forest Cover and Dead Wood Habitat

a) Late/Old Seral Forest Habitat

Manage for a matrix of LOS forest habitat closer to the natural range of historic variability at the subshed level. Manage forest habitat so that 33% of the forested landscape provides LOS habitat. LOS patch average size acreage, the minimum size of one or more patches, and the area of the largest LOS patch in relationship to the total landscape area should be determined. (refer to Data Gaps). Manage for a diversity of stand densities (basal area, trees/acre and dbh) both within and among stands to provide diverse habitat conditions for species richness.

Manage for an old-growth restoration zone (600-1,200 feet) surrounding presently designated and "other" old-growth where feasible to buffer and increase forest interior habitat to a level closer to the range of historic variability. Design and implement prescriptions to develop and maintain late/old seral forest characteristics within the zone. Manage forest habitat so that at least 25% of the total recommended LOS forest provides interior "core" habitat. Core area patch size should average at least 225 acres. The minimum size of one or more core area should be determined. (refer to Data Gaps).

Manage for larger additional or replacement designated old-growth stands within 1.5 miles of existing designated and "other" old-growth stands where the distance between these stands presently exceeds 1.5 miles. Select stands most resistant to natural disturbances over the long term, which have the most suitable habitat for the species of interest and are distributed throughout the subsheds. Some of the most stable and suitable stands occur around riparian areas, on north and east aspects, and at higher elevations.

Manage pine and pine associated forests on a three-tiered system to maintain a dynamic balance in LOS forest patch loss and development over time and space.

Manage forest stands adjacent to the Antler/Buck semiprimitive nonmotorized management area in upper West Fork and Guyer Creek drainages to develop and/or conserve LOS forest as connectivity corridors and to increase interior habitat. Implement non-uniform thinning and prescribed burn treatments where necessary to control understory stocking, reduce fuels, develop canopy gaps and multi-storied stands, restore open park-like ponderosa pine stands where appropriate and culture the development of large diameter live trees and future snags.

Establish Interim Riparian Habitat Conservation Areas and manage forest stands within these areas to conserve LOS forest as a network of corridor habitat. Implement non-uniform thinning and prescribed burn treatments where necessary to control understory stocking, reduce fuels, develop canopy gaps and multi-storied stands, restore open park-like ponderosa pine stands where appropriate and culture the development of large diameter live trees and future snags. When appropriate within this LOS forest corridor, implement small patch regeneration treatments to restore stands of shade intolerant deciduous species such as alder, aspen, dogwood and willow.

Manage all "other" late/old seral forest habitat mapped in the inventory completed in 1994 to conserve its character as interior and corridor habitat.

Design and implement forest management prescriptions featuring progressive or cluster treatments from existing scattered nuclei (particularly existing shelterwood, seed tree, overstory removal and partial cut units) to reduce risks to LOS forest cover associated with edges, gaps, fragmentation, and the amount of maintained roads. Cluster treatments are simply aggregations of similar treatments adjacent to areas already existing on the landscape to create larger patches more homogeneous in structure and to reduce fragmentation. Progressive treatments occur where a central patch(es) or strip(s) is progressively enlarged by contiguous cutting.

Maintain or restore connectivity between all remaining other LOS stands and designated stands. Specific desired conditions for connectivity are described in the "Forest Plan Amendment for Interim Standards" under "Interim Wildlife Standards" in the Forest Plan.

Maintain or restore the abundance and distribution of large diameter snags, relic, large diameter live LOS trees and large down logs in all forest stands. To accelerate the development of large diameter trees, mechanical and prescribed fire treatments should be implemented where appropriate to thin overstocked stands. Retention and recruitment of large trees should be a priority in stands dominated by younger age-classes.

Manage for a higher basal area of large diameter white fir (>15" dbh) in true mixed conifer plant associations above 5,500 feet elevation in general, and down to 5,100 feet elevation on some north and east aspects. Priority areas would be occupied and historic pileated woodpecker foraging and nesting sites, and occupied or suspected marten habitat. Canopy closures in forest stands where foraging is evident should be managed at >60%. Manage to maintain >5 trees per acre that are >20" dbh.

Maintain or restore open park-like stands of LOS ponderosa pine with average tree diameters greater than 20" (10 to 40 trees/acre) for white-headed and Lewis woodpecker and pygmy nuthatch. A desirable condition would be trees > 24" dbh comprising > 40% of the total basal area at a density of > 8 trees/acre. Implement mechanical and prescribed burn treatments to reduce stand densities. Thin overstocked understories, reduce accumulated duff, and culture patches of non-uniform multi-storied pine understories and large diameter live trees and future snags.

Reason: The goal is to develop a late/old seral forest network that protects and enhances the habitat effectiveness of the remaining LOS forest ecosystem. A linked network of patches will help to restore historic landscape scale habitat characteristics needed to sustain associated MI wildlife species. Conservation of late/old seral forest habitat representation rather than preservation of individual patches is the objective. A proposed LOS patch and linkage system map is provided at the beginning of this document. A review of stand conditions to determine their suitability as LOS patches and linkages should be conducted.

b. Goshawk

Manage to protect active and historic nest stands and treat replacment nest stands and PFA's to develop and/or restore preferred habitat coniditions for goshawk nesting and rearing, and to provide prey species habitat needs.

Maintain 30 acres of the most suitable nesting habitat surrounding all active and historical nest trees. Within a 0.5 mile radius of active or historic nest sites, maintain at least two-30 acre areas of the most suitable nesting habitat surrounding documented historic nest trees, and three-30 acre areas as potential replacement (alternate) nest sites. Defer active and historical nest areas from timber harvest. Replacement nest sites needing improvement should be treated with thinning from below (variable or non-uniform spacing) using either mechanical means or prescribed fire to promote faster tree growth and crown development, and reduce risk to insect, disease and fire. Lop and scatter slash that cannot be burned. On the Forest, every documented nest site is considered "historically active" whether or not it has been monitored for activity in the last 5 years. Suitable habitat as defined in the Forest Plan must still be present at the nest site.

Designate a 400 acre "Post fledgling family area" (PFA) of the most suitable habitat around every known active nest site. Manage to maintain and restore as possible the late/old seral structural characteristics of forest stands, with as least 60% of the PFA in late/old forest cover. Maintain a minimum canopy cover of 50% in ponderosa pine and 60% in pine associated and lodgepole pine. Create scattered openings 2 acres or less where necessary. Leave 3 to 6 large diameter reserve trees per acre in clumps in the openings. In stands with overstocked understories and high fuel loads, thin from below with non-uniform spacing using either mechanical and/or prescribed fire to promote large tree growth, crown development, understory herb and shrub development and more open stand conditions for hunting and prey availability. Lop and scatter slash that cannot be burned.

Maintain solitude in the active nest areas and PFAs during the breeding, nesting and fledgling period from March 1 thru September 30, or during period of occupancy as determined from field observations, to improve the probability of successful fledgling production.

Leave 5-7 and 10-15 tons/acre of woody debris, greater than 3" diameter in ponderosa pine and pine associated forest types, respectively, within territories to provide habitat for prey species.

4. Dead Wood Habitat Management Indicator Species

a) General

In all stands of ponderosa pine and pine associated forest design future timber harvest treatments to maintain or restore snags and green replacement trees greater than or equal to 15" dbh at 100% potential population levels of primary cavity excavators. For lodgepole pine stands, maintain snags and green replacement trees greater than or equal to 10" dbh at 100% potential population levels of cavity excavators. Proper management application and specific desired conditions for snags and down logs are described in the "Forest Plan Amendment for Interim Management Direction Establishing Wildlife Standards for Timber Sales" in the Forest Plan.

In addition, the desired condition for snag and green replacement tree densities and distributions to achieve 100% habitat potential for cavity excavators was interpreted by the Fremont Forest on 8/30/93 to be as follows:

> The following is the standard for "...snag and green replacement/roost trees of $\geq$ 15" DBH at 100% potential population levels for primary cavity excavators". One clarification is that this is not 100% of population potential as defined in the Forest Plan.

DBH	Height	Trees/Ac.
	PINE/PINE ASSOCIATED	
15"+ (20" preferred)	20'+	3 dead + 2 green
10"+ (12" preferred)	20'+	1 dead + 3 green
	LODGEPOLE PINE	
12"+	15'+	1 dead + 1 green
10"+	15'+	1 dead + 1 green

Manage snags and green replacement trees in dispersed clumps rather than individual trees uniformly scattered over the landscape. As a minimum, manage for 1 clump/5 acres consisting of both dead and green replacement trees. This is based on the smallest home range size of primary excavator species in the current literature. Manage snags and replacement trees in the same species composition as representative of the stand. Manage for a large proportion (>50%) of standing snags >33 feet in height. Retain spike-topped and lightning-scarred trees that provide alternate nesting substrates.

Overall, maintain/restore snag and green tree replacement habitat within the watershed to support all primary excavator populations at at least 60% of potential.

In snag deficient areas, where feasible and appropriate, create snags from live trees and/or manage adjacent forest stands for higher densities to partially compensate for the deficient areas. Implement top blasting, girdling and/or injection to create snags. Create bat slits/flanges, lightning strikes, sap wells and cavities in created snags and existing hard snags to enhance snag habitat features and increase wildlife use.

Culture green replacement trees in early and mid seral stands to develop future large diameter snags at the desired species composition and densities for the full forest rotation.

Protect down logs and snags with fuel breaks and/or burn prescriptions where necessary to maintain the desired densities and size classes when implementing prescribed burn treatments. Where case hardened logs are created from burn treatments or wild fires, mechanically cut slits in logs and cut logs in half to improve habitat for wildlife use. This especially critical for pileated woodpecker foraging areas, goshawk PFA's and along riparian areas for marten habitat.

Stands identified for snag retention will be entered into a GIS database to develop a permanent record of size, density, species composition and location.

b) Red-naped sapsucker

Manage for more acres of aspen habitat than presently exist on the landscape to help move the diversity and distribution of plant communities toward the conditions that existed during reference and historic periods.

Manage pure aspen stands to maintain the dominance of aspen stems in both the mature and early seral stages. At least one-third of the existing mature stands will be converted to a younger age class and managed as replacement stands. Mature stands in poor condition will receive priority treatment. Converted stands will be protected from grazing by ungulates.

Manage mixed aspen stands to maintain the present basal area ratio of aspen in the stand. Mixed stands of aspen in the poorest condition will have the highest priority for treatment.

Implement mechanical and/or prescribed burn treatments to promote suckering in mature aspen clones that are without adequate replacement stems and still support a root system capable of responding to treatment.

Plant aspen where relic mature/decadent trees indicate site conditions are favorable for establishment and growth.

Livestock grazing of aspen suckers will be controlled, where necessary, until regeneration is a minimum of 4-6 feet tall to insure suckers sprout and replace the stand within five years after treatment.

Reason: Additional aspen will help meet the habitat needs and possibly improve the population performance of associated wildlife species. Aspen stands are generally our most diverse plant communities in terms of both plant and animal species composition and productivity.

B. Aquatic

1. Floodplain Restoration

Improve beaver habitat along both perennial and intermittent streams in order to enhance floodplain restoration. This should be accomplished by reducing lodgepole pine and encouraging willow and aspen development within the floodplain. Methods employed may include constructing grade control structures to raise the water table, thus reducing lodgepole pine by flooding of the area. Rapid habitat enhancement would include raising the water table with a grade control structure, cutting or girdling lodgepole pine trees, and planting willow in the edges of the flooded areas. This work should be done in areas of historic beaver ponds.

Reason: Enhancement of beaver habitat will allow beaver to establish in marginal habitat areas and help in floodplain restoration. Benefits of beaver ponds include raised water table, increased summer flow, sediment trapping behind beaver dams, refugia for native fish, and improved wildlife habitat.

2. Fisheries Genetic Study

Perform a genetic study of redband trout in the tributary streams of Silver Creek. The study should be conducted to determine the level of introgresion that has occurred within the watershed. Also, perform genetic studies of redband trout in Bridge Creek and Buck Creek (outside analysis area).

Reason: Stocked rainbow trout in Thompson Reservoir have potentially introgressed with native redband trout. Loss of genetic purity of fish in the watershed would be contrary to the requirements in the National Forest Management Act (NFMA) for maintaining genetic diversity of aquatic species.

Human Uses

Recommendations focus on: 1) Providing commodity resources within the scope of ecosystem management. 2) Enhancing recreation experiences, environmental education, and providing increased opportunities for Klamath Indian Tribes expression.

A. A major focus for recreation activities within the watershed is the various bodies of water; streams, ponds and a reservoir. Of these, Thompson Reservoir, and its associated campgrounds, is the primary destination of recreation enthusiasts. If a minimum pool level could be agreed upon this would be a much more popular and viable recreation site.

Reason: A minimal and increased pool level would enhance fisheries and aquatic habitats thereby improving water focused recreation experiences.

B. Any road closure opportunities, especially at the higher elevations, should be considered.

Reason: This would would enhance dispersed recreation opportunities, such as back country hiking, and give the users more of an isolation experience in the wooded environment.

C. Expand developed opportunities in the more heavily used areas and provide greater accessibility to the existing and future recreation developments.

Reason: Provide or enhance outdoor opportunities for those with more physical limitations and those less interested in backcountry opportunities.

D. Interpretive signs strategically placed throughout the watershed could be used to increase the public awareness of Forest Service land and resource management activities.

Reason: A long human history exists in the area, and strategic placement and wording of signs would relate this story in an informative and interesting manner.

E. There is an ongoing effort to improve and maintain good relationships with our neighbors and the Klamath Tribe.

Reason: The Forest should continue to work closely and openly with the appropriate Tribal representatives in the management of mutually significant forest resources to maintain a positive working relationship with the tribe.

Monitoring Needs

Continue monitoring bald eagle nest occupancy, success, and fledgling success, annually.

Monitor potential peregrine nesting cliffs at least every three years for occupancy. If occupied, monitor annually to determine nesting and fledgling success.

Monitor herbaceous and shrub responses (species composition, survival and productivity) on the Alder Ridge wildfire and prescribed burns.

Monitor occupied goshawk nesting territories for occupancy, nesting and fledgling success annually. Monitor historic unoccupied nest sites for occupancy every three years or whenever a project is proposed that would affect habitat conditions within a 400 acre area of the nest site.

Monitor the pileated woodpecker pair at Hagar Mountain to document nest and roost trees and stands being used by the birds.

Monitor levels of detrimental upland soil conditions during project planning for the purpose of assessing preexisting conditions in order to help determine project alternatives. Equate detrimental soil conditions from all activities, including system roads, to assess cumulative impacts.

Monitor vegetation trends (species composition, productivity, density, canopy cover, etc.) within and adjacent to the Silver Creek RNA Exclosure.

Develop a water quality/habitat monitoring plan for the watershed that considers parameters including:

-Residual Pool Depth
-Sedimentation (Macroinvertebrates & Physical Sampling)
-Stream Temperature
-Reservoir Temperature
-Large Woody Debris

On a representative basis, monitor the implementation and effectiveness of BMP's, mitigation measures, and constraints for management activities. Monitoring should emphasize meeting Forest plan standards for soil compaction and work in RHCA's.

Annually monitor 1/3 to 1/4 of completed watershed improvements projects under the Forest WIN inventory system.

Perform a genetic study of native fish species in the tributary streams of Silver Creek, Bridge Creek and Buck Creek (Bridge and Buck are outside analysis area).

Develop a systematic monitoring system for stream channels using Proper Functioning Condition (PFC). Alluvial depositional reaches (Rosgen Type C and E) should be emphasized.

Data Gaps

Complete the landscape ecosystem assessment module to determine maximum, average and range for LOS matrix and core patch sizes.

A site specific Bald Eagle Management Plan needs to be completed and implemented for the proposed Silver Creek Bald Eagle Consideration Area. The plan should include a monitoring program to determine the number of eagles using winter roost sites, season of use, stands/trees being used, and disturbance sources (especially from recreational boating and fishing activities in the vicinity of the nest stand). Flight paths and foraging areas should also be identified. Forest stands should be field reviewed by a journeyman wildlife biologist, silviculturist and fuels management specialist to identify habitat suitabiltiy, needed treatments and develop a priority schedule for future treatments.

Collect basic field data on the distribution, numbers, seasonal range use, and special habitats of the elk herds in the watershed.

Collect basic field data on the distribution, population (numbers and trend) and habitat use of MI species associated with LOS forest cover, particularly marten, pileated, white-headed, black-backed, northern three-toed and Lewis woodpeckers, and goshawks across the watershed.

Collect basic field data on the habitat suitability of LOS forest and replacement habitat in Management Areas 3, 14, 15 and "other mapped" old growth for all the MI wildlife species noted above.

Collect basic field data on the present location, acreage and condition of all bitterbrush and curlleaf mountain mahogany patches.

Collect basic field data on the habitat suitability of forest stands within goshawk nest and post family fledgling areas of occupied nest sites.

Collect basic field data on the seasonal diets of goshawks by forest types occupied in the watershed.

Collect basic field data on snag and down log conditions, densities, and sizes by forest types in the watershed.

Collect basic field data on the distribution and numbers of red-naped sapsuckers across the watershed.

Collect basic field data on the current distribution, acreage and condition of all aspen stands.

Reinitiate spring inventories of the sage grouse lek site to determine occupancy.

APPENDIX

REFERENCES

SUPPLEMENTAL MAPS AND DATA

CORE TEAM

KEY CONTACTS

REFERENCES

REFERENCE SECTION
LITERATURE CITED

Adams, T.A. and Sullivan K. 1990. The Physics of ForestStream Heating: A Simple Model. Washington Department of Natural Resources Timber/Fish/Wildlife Report TFW-WQ3-90-007.

Alexander, E.B., 1988. Strategies for Determining Soil-Loss Tolerance. 5p.

Baker, Malchus B. Jr. 1988. Selection of Silvicultural Systems for Water. pp. 209.

Behnke, R.J. 1981. Systematic and zoogeographic interpretation of Great Basin trouts. In: R.J. Naiman and D.L. Soltz (eds.), Fishes of North American Deserts. New York: John Wiley and Sons. pp 95-124.

Benke 1992. Native Trout of Western North America. American Fisheries Society Monograph 6.

Bilby Robert E., Sullivan, Duncan. 1989. The generation and Fate of Road-Surface Sediment in Forested Watershjeds in Southwestern Washington. p. 453 - 467.

Bilby, R.E., and G.E. J.W. Ward. 1989. Changes in characterization and function of woody devbris with increasing size of streams in Western Washington. Transactions of the American Fisheries Society. 118:368-378.

Burroughs Jr., E.R and King J.G., 1989, Reduction of Soil Erosion on Forest Roads, Intermountain Research Station, General Technical Report INT-264, p. 10.

Bjorn T.C. and Reiser D.W., 1991, Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, p. 99.

Carlston, C.W., 1963, Drainage Density and Streamflow, US Geological Survey Professional Paper 422-C, Physiographic and Hydraulic Studies of Rivers, pp. C1-C8.

Clary, W.P., and B.F Webster. 1989. Managing grazing in riparian areas in the Intermountain region. Gen Tech. Rep. INT-263. Ogden, UT: U.S.D.A., Forest Service, Intemountain Research Station. 11 p.

Cochran, P.H., Geist, J.M., Clemens, D.L., Clausnitzer, R.R., and Powell, D.C., 1994. Suggested Stocking Levels for Forest Stands in Northeastern Oregon, and Southeastern Washington. USDA-Forest Service, Pacific Northwest Research Station, Research Note PNW-RN-513. pgs 1-21.

Decker, L.M., and D.C. Erman. 1992. Short-term seasonal changes in composition and abundance of fish in Sagenhen Creek, Calififornia. Transactions of the American Fisheries Society 121: pp. 297-306.

Duncan S.H., Bilby, Ward, Heffner, 1987. Transport of Road-Surface Sediment through Ephemeral Stream Channels. 118 p.

Elliot, W.J., Luce, Foltz, Koler, 1996, Hydrologic Sedimentatin Effects of Open and Closed Roads, Natural Resource News, p. 7.

Eglitis, A., Maffei, H., and Schafer, M., 1993. Forest Health on the Fremont--- An assessment of the existing conditions and a plan for restoration. White paper developed in coorperation with Forest Pest Managment and the Fremont National Forest. 48 pages plus appendices.

Furniss M.J., Roeloffs, Yee, Road Construction and Maintenance, Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, p. 298.

Harr, R.D., Fredriksen, Rothacher, 1979, Changes in Streamflow Following Timber Harvest in Southwestern Oregon, p. 13.

Hessburg, P.F., Mitchell, R.G., and Filip, G.M., 1994. Historical and Current Roles of Insects and Pathogens in Eastern Oregon and Washington Forested Landscapes. USDA-Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-327. 72 pages.

FEMAT, Interagency Document, 1993, Forest Ecosystem Management: An Ecological, Economic, and Social Assessment, p. V-29.

Kovalchik, B.L. and Elmore W., 1991, Effects of Cattle Grazing Systems on Willow-dominated Plant Associations in Central Oregon, Paper presented at the Symposium on Ecology and Management of Riparian Shrub Communities, p. 114.

Leopold L.B., Wolman, M.G. and Miller, J.P. 1964. Fluvial Process in Geomorphology. W.H. Freeman and Co. San Franciso. p. 504.

Leitritz, E. and R.C. Lewis. 1980. Trout and Salmon Culture. Sacramento: California Department of Fish and Game. Bulletin 164.

Leopold, Luna B., A view of the River, p. 90.

LRMP, Land and Resource Management Plan. 1989. Fremont National Forest. USDA Forest Service, Pacific Northwest Region.

McIntosh Bruce A, Sedell, Thurow, Clarke, Chandler. 1995. Historical Changes in Pool Habitats in the Columbia River Basin. 1 p.

Meghahan, W.F., 1972, Subsurface Flow Interception by a Logging Road in Mountains of Central Idaho, AWRA, National Symposium on Watersheds in Transition, pp. 350-356.

Nichols, B., District Biologist - Bly Ranger District. Personnel Communication.

Olson, R. and Hubert W.A., 1994, Beaver: Water resources and riparian habitat manager, pp. 15,19.

Platts, W.W., 1991, Livestock Grazing, Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, pp. 399, 405.

Platts W.S., 1981, Effects of Sheep Grazing on Riparian-strean Environment, Intermountain Forest and Range Experiment Station, Research Note INT-307, p. 6.

Reiser D.W., and Bjornn T.C., 1979. Influence of Forest and Rangeland Management on Anadromous Fish Habitat in Western North America, Habitat Requirements of Anadromous Salmonids, p. 22.

Reiser Dudley W., Ramey, Bechtel Group, Lambert. 1985. Review of Flushing Flow Requirements in Regulated Streams. 7 p.

Rosgen, D., 1991, An empirical Prediction Methodology of Potential Sediment Yield from Forest Roads Utilizing a Road Impact Index, p. F24.

Rosgen, D.L., 1994, A Classification of Natural Rivers, Catena an Interdisciplinary journal of Soil Science-Hydrology-Geomorphology, Vol. 22, No.3, p. C19.

Schumm, S.A. and Harvey, M.D., Natural Erosion in the USA. 1982. Determinants of Soil Loss Tolerance, ASA Publication Number 45, Soil Science Society of America. 153 p.

Sedell, J.R., P.A. Bisson, F J. Swanson, and S.V. Gregory. 1988. What We Know About Large Trees That Fall Into Streams and Rivers. USDA Forest Service General Technical Report PNW-229: pp. 47-81.

Sedell, J.R., F.H. Everest, and D.R. Gibbons. 1989. Streamside Vegetation Management for Aquatic Habitat. In Proceedings, National Silviculture Workshop- Silviculture for all Resources. U.S. Forest Service, Timber Management, Washington, D.C.

Sigler, W.S., and J.W. Sigler. 1987. Fishes of the Great Basin, A Natural History. University of Nevada Press. 425 pp.

Troendle, C.A. and C.F. Leaf. 1981. Effects of timber harvest in the snow zone on volume and timing of water yield. In: Interior West Watershed Management. Cooperative Extension, Washington State University, Pullman, WA (Symposium, Spokane, WA, April 8-10, 1980), pp. 231-243.

Troendle, C.A. 1982. The effects of small clearcuts on water yield from the Deadhorse Watershed, Fraser, Colorado. In: Proceedings 50th Annual Western Snow Conference (Conference in Reno, NV, April 19- 23, 1982). Colorado State University, Fort Collins, CO.

Troendle, C.A., 1983, The Potential for Water Yield Augmentation from Forest Management in the Rockey Mountain Region, pp. 359-373.

Troendle, C.A. and W.K. Olsen. 1991. Potential Effects of Timber Harvest and Water Management on Streamflow Dynamics and Sediment Transport. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Weaver T.M. and R.G. White. 1985. Coal Creek fisheries monitoring study III. Final Report to USDA Forest Service, Flathead National Forest. Cooperative Fishes Unit, Montana State University.

Young, M.K. 1989. Effect of substrate composition on the survival of emergence of Colorado River cutthroat trout and brown trout. PhD Dissertation, University of Wyoming.

SUPPLEMENTAL MAPS AND DATA

Stand Density Management Guides
Silver Creek Analysis

These upper and lower management SDI zone calcualtions are based on Cochran et al (1994). The Upper Management zoned can be defined as the density level at which a suppressed class of trees begins to develop. The Upper Management Zones (UMZ) for Ponderosa Pine used the formula UMZ = 365(-.36 + .01(SI for PP). For White fir the assumption was that the Upper Management Zone would be calculated by Adjusting the UMZ as identified in Cochran (1994) based on the maximum basal area identified in the plant association guide for each plant association. For Lodgepole Pine a UMZ based on 170 was used as literature identifies this as the critical threshold for Mountain Pine beetle with not enough observations to determine if site index effects it. Lower Management Zones (LMZ) were in all cases .67 of the UMZ. The lower management zone is that point at which most of the site resources are still going towards tree growth. It is essentially that point at which there is a minimum level of intertree competition and just above maximum individual tree growth on a site.

FOR PONDEROSA PINE PA TYPES	UMZ(SDI)	LMZ(SDI)
CPH311 (Ponderosa Pine-Quaking Aspen/ Bluegrass) PP Site Index= 78	153	103
CPC211 (Ponderosa Pine-Juniper/Mountain Mahogony-Bitterbrush) PP Site Index= 76	146	98
CPS217 (Ponderosa Pine/Bitterbrush-Manzanita/ Fescue)(Fremont Plant Associations) PP Site Index=77	150	100
CPS217 (Ponderosa Pine/Bitterbrush-Manzanita/ Fescue) (Pumice Zone Associations PP Site Index= 71	128	86
CPS215 (Ponderosa Pine/Bitterbrush/Sedge) PP Site Index= 83	153	103
CPS213 (Ponderosa Pine/Bitterbrush-Manzanita/ Needlegrass) PP Site Index= 76	146	98
CPS314 (Ponderosa Pine/Bitterbrush-Snowbrush/ Fescue) PP Site Index= 80	161	108
CPS211 (Ponderosa Pine/Bitterbrush/Fescue) PP Site Index= 77 (Fremont PA Guide)	150	100
CPS211 (Ponderosa Pine/Bitterbrush/Fescue) PP Site Index = 76 (Pumice Zone PA Guide)	146	98

CPS121 (Ponderosa Pine/Mountain Big Sagebrush/ Bluegrass		
PP Site Index= 76	146	98
PS111 (Ponderosa Pine/Bitterbrush/Bunchgrass)		
PP Site Index= 65	106	71
CPS212 (Ponderosa Pine/Bitterbrush/Needlegrass)		
PP Site Index=80	161	108
CPS311 (Ponderosa Pine/Bitterbrush-Snowbrush/ Needlegrass)		
PP Site Index= 76	146	98

<u>FOR WHITE FIR PA TYPES</u>

	UMZ	LMZ
CWH212 (CAN'T FIND IN THE GUIDE)		
CWH213 (CAN'T FIND IN THE GUIDE)		
CWS313 (White Fir-Ponderosa Pine/Snowberry/ Starwort)		
PP Site Index = 80	161	108
WF Site Index = 88	370	248
CWS114 (Mixed Conifer/Snowbrush)		
PP Site Index = 80	161	108
WF Site Index = 90	370	248
CWC411 (White Fir-Ponderosa Pine-Western White Pine/Sticky Current)		
PP Site Index = 71	128	86
WF Site Index = 80	281	188
CWC311 (White Fir-Lodgepole Pine/Long Stolon Sedge-Needlegrass)		
LPP Site Index = 67	170	114
WF Site Index = 77	281	188
CWH211 (White Fir-Ponderosa Pine-Quaking Aspen Long Stolon Sedge		
PP Site Index = 78	285	191
CWS117 (White fir- Ponderosa Pine/Manzanita/ Oregon Grape		
PP Site Index= 80	161	108
CWS112 (Mixed conifer/snowbrush/manzanita)		
PP Site Index= 79	161	108

CWS115 (Mixed conifer/snowbrush/sedge) PP Site INdex = 83	172	115
CLG314 (Lodgepole Pine/Needlegrass/Lupine) Site Index LPP=70	170	114
CLM111 (Lodgepole Pine/Quaking Aspen/Strawberry) LPP Site Index = 79	170	114

FOR LODGEPOLE PINE PA TYPES

CLG315 (Lodgepole Pine/Strawberry-Fescue) LPP Site Index = 73	170	114
CLS211 (Lodgepole Pine/Bittervrush/Needlegrass) LPP Site Index = 76	170	114
CLS215 (Lodgepole Pine/Currant-Bitterbrush/ Needlegrass) LPP Site Index = 67	170	114
CLG415 (Lodgepole Pine/Squirreltail-Long Stolon Sedge) LPP Site Index = 66	170	114
CLG313 (Lodgepole Pine/Needlegrass-Lupine-Linanthastrum) LPP Site Index = 75	170	114
CLM311 (Lodgepole Pine/Blueberry/Forb Wetland) Site Index = 75	170	114

Priority stands for treatment in the Silver Creek Watershed

Stand #	Plant Ass.	Acres	PP SDI	LP SDI	WF SDI	Total SDI
Alder 950	CPS211	72	151	148	9	308
Alder 951	CPS212	99	182	182	29	315
Alder 952	CPS212	84	280	27	5	312
Alder 955	CPS217	17	219	78	15	312
Banker 098	CPS212	136	188	14		202
Banker 099	CPS212	31	193	14		213
Beggar 134	CPS211	48	170	64		234
Beggar 138	CPS211	81	161		2	163
Beggar 142	CPS217	46	158		48	206
Beggar 144	CPS211	38	176		21	197
Beggar 147	CPS211	54	209		80	289
Beggar 148	CPS211	81	205		13	218
Beggar 149	CPS217	129	211			211
Beggar 150	CPS217	51	203		6	209
Beggar 151	CPS217	45	211			211
Beggar 152	CPS211	190	287		13	300
Blue Antler 760	CWS112	24	158	67	96	322
Border 431	CPS213	171	190	68		258
Border 445	CPS213	68	172	5		177
Bungle 559	CPS211	143	291	19		311
Bungle 566	CPC211	109	148			148
Bungle 567	CPS211	123	204			204
Bungle 650	CPC211	108	285			285
Bungle 652	CPS211	101	235			235
Bungle 653	CPS211	127	213			213
Bungle 660	CPS211	22	216			216
Bungle 661	CPC211	89	162			162
Bungle 663	CPS211	46	172			172
Bungle 664	CPS211	46	156			156
Bungle 666	CPS211	33	173			173
Bungle 667	CPS211	42	327	5		332
Bungle 668	CWS313	30	239	109		348
Bungle 670	CPC211	69	233	57		290
Bungle 671	CPS211	159	170			170
Bungle 672	CPS211	106	243			243
Bungle 673	CPC211	204	218	30		248
Bungle 676	CPS211	266	187			187
Canyon 112	CPS211	70	180			180
Canyon 113	CPS211	17	194		4	198
Canyon 114	CPS211	18	197	7		204
Canyon 116	CPS211	58	267	12		278
Canyon 118	CPS211	46	258	47		305
Canyon 119	CPS211	44	279	8		287
Canyon 140	CPS213	17	215	27		241
Canyon 141	CPS213	34	150	124		274
Canyon 142	CLS911	25	194	126		320
Canyon 167	CPS211	19	151	85		235

Canyon 168	CPS211	37	186	102		288
Canyon 169	CPS211	37	204	19		224
Canyon 421	CPS213	107	285			285
Canyon 422	CPS211	51	228			228
Canyon 423	CPS111	55	160			160
Canyon 433	CPS211	42	324			324
Canyon 474	CPS211	24	294			294
Canyon 475	CPS111	10	178			178
Canyon 755	CPS211	124	154			154
Canyon 758	CPS213	74	170		76	247
Carty 413	CPS211	182	180			180
Carty 417	CPS211	60	251			251
Carty 419	CPS211	97	192			192
Carty 421	CPS211	127	163			163
Carty 424	CPS217	46	191			191
Carty 425	CPS211	202	171			171
Carty 427	CPS211	53	311			311
Carty 428	CPS211	114	188			188
Carty 429	CPS211	128	199			199
Carty 430	CPS211	48	173			173
Carty 431	CPS211	72	227			227
Carty 432	CPS211	46	170			170
Congo 410	CLS211	8	328	350		678
Cookie 540	CPS211	62	151	5	88	244
Cookie 542	CPS211	114	171		3	174
Cookie 543	CPS211	151	165			165
Cookie 545	CPS211	20	202	49		251
Cookie 546	CPS211	103	398			398
Cookie 549	CPS211	143	214			214
Cookie 551	CPS211	41	165		10	175
Cookie 552	CPS211	136	211		25	236
Cookie 553	CPS211	100	265			265
Cookie 554	CPS211	65	154			154
Cookie 559	CPS211	27	202	7	25	234
Cottman 251	CPS211	39	193			193
Cottman 252	CPS211	60	294			294
Cottman 253	CPS211	49	287			287
Cottman 254	CPS211	32	303			303
Cottman 255	CPS211	29	318			318
Cottman 256	CPS211	50	248			248
Cottman 257	CPC211	206	161			161
Cottman 258	CPS211	82	186			186
Cottman 260	CPS211	56	210			210
Cottman 261	CPS211	55	230			230
Cottman 262	CPS211	52	243			243
Cottman 263	CPS211	48	202			202
Cottman 266	CPS211	92	218			218
Cottman 268	CPS211	472	245			245
Dee 173	CPS121	19	250			250
Dee 174	CPS121	18	236			236
Dee 177	CWS313	41	168	45	348	562
Dee 181	CPH311	30	168		1	169
Dee 182	CPS221	50	200		123	323
Dee 183	CPS121	37	166		156	322

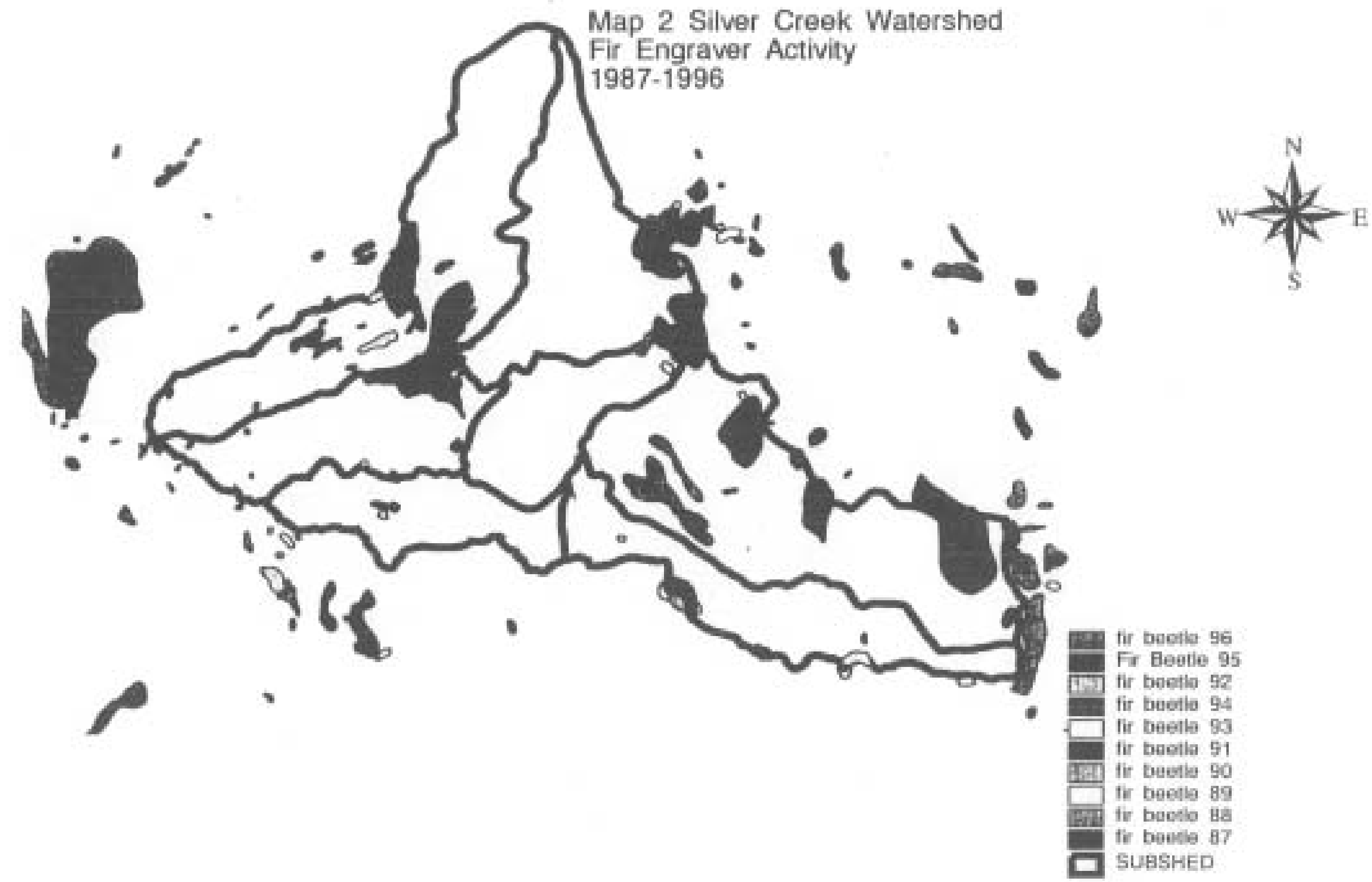
Dee 184	CPS121	90	150	1	30	181
Dee 185	CPS121	43	198		114	312
Dee 186	CPS121	74	150		84	234
Dee 193	CPS121	49	185		67	252
Dee 194	CPS121	28	162		11	173
Dee 196	CPS121	28	194		167	361
Dee 199	CPS121	202	154		11	165
Dee 413	CWS313	69	163		75	238
Dee 422	CPS121	104	216			216
Dee 423	CPS121	82	195	9		204
Deerhead 521	CPS217	38	295		41	335
Deerhead 522	CPS217	20	274		66	340
Deerhead 523	CPS217	40	235		5	240
Farm 352	CPS211	17	164			164
Farm 354	CPS211	14	217			217
Farm 356	CPS217	34	153		89	242
Farm 357	CWS217	23	189		202	391
Farm 358	CPS211	27	152			152
Farm 360	CPS211	32	192			192
Farm 362	CPS217	17	362		16	378
Farm 364	CPS217	80	236		3	239
Farm 367	CPA211	10	343			343
Gnat 504	CWS114	87	285	57	107	449
Gnat 505	CWS114	62	185	5	68	259
Gnat 506	CWS114	40	175		121	296
Gnat 510	CPS217	87	267	42	12	321
Gnat 512	CPS217	71	255	4	5	264
Hager 443	CPS217	108	212		70	282
Hager 444	CPS217	148	293		145	438
Hager 445	CPS217	48	406	8	5	496
Hager 446	CWS114	53	496			496
Hager 447	CPS217	160	173			173
Hager 448	CPS217	146	304		9	313
Hager 449	CPS217	241	157			157
Hager 451	CPS215	70	216			216
Hager 452	CPS217	70	207			207
Hager 453	CPS217	58	166			166
Hager 456	CWS117	79	420		60	480
Hager 457	CPS217	69	419		5	424
Hager 458	CPS211	40	355			355
Hager 459	CWS114	77	323			323
Hager 460	CWS117	155	182		115	297
Hager 461	CPS217	27	264			264
Hager 462	CWS117	44	165		117	283
Hager 463	CWS117	88	245	1	60	307
Hager 464	CPS217	80	222		36	258
Hager 465	CPS217	27	195		11	206
Hager 467	CPS217	122	168			168
Hager 468	CPS217	54	188		67	255
Hager 469	CPS217	86	243		1	244
Hager 470	CPS217	94	166			166
Hager 471	CPS217	60	243			243
Hager 472	CPS217	37	246			246
Hager 473	CPS217	38	237			237

Hager 474	CPS217	48	244		3	247
Hager 478	CPC211	111	164			164
Hager 480	CPS217	53	246			246
Hager 481	CPS211	111	186			186
Hager 482	CPS211	36	205			205
Hager 483	CPS211	167	155			155
Hager 484	CPS211	91	194			194
Hager 485	CPS211	66	260			260
Hager 488	CPS217	70	201			201
Hager 489	CPS217	132	380			380
Hager 490	CPS217	39	172			172
Hager 491	CPS217	58	244			244
Hager 492	CPS217	147	156			156
Hager 493	CPS217	36	147			147
Hager 494	CPS217	23	171			171
Hager 496	CPS217	63	202		10	212
Hager 497	CPS217	190	130**			130
Hager 498	CPS217	68	213	11		223
Hager 499	CPS211	54	162			162
Knothole 151	CPS217	29	303		8	311
Knothole 152	CPS211	28	159		3	162
Knothole 153	CPS217	59	156		46	203
Knothole 157	CPS217	174	196		82	278
Mcvat 257	CWS313	157	354		7	361
Mcvat 258	CPS211	115	240	46		286
Pond 140	CPS211	105	196			196
Pond 141	CPS211	106	213			213
Pond 142	CPS211	38	153			153
Pond 144	CPS211	114	191			191
Pond 146	CPS211	81	207			207
Pond 147	CPS211	17	179			179
Pond 148	CPS211	188	207			207
Pond 149	CPS211	313	242			242
Pond 151	CPS211	182	168			168
Pond 152	CPS211	79	202			202
Pond 154	CPS211	58	196			196
Pond 155	CPS211	43	192			192
Pond 158	CPS211	48	238			238
Pond 159	CPS211	60	188			188
Pond 162	CPS211	16	156			156
Pond 164	CPS211	78	220			220
Pond 165	CPS211	58	252			252
Pond 166	CPS211	81	228			228
Pond 177	CPS211	29	179			179
Pond 179	CPS211	29	283			283
Pond 335	CPS211	13	292			292
Pond 336	CPS211	17	226	34		260
Pond 342	CPS211	23	158			158
Pond 346	CPS211	72	153			153
Pond 347	CPS211	15	155			155
Pond 348	CPS211	43	152			152
Pond 349	CPS211	18	177			177
Pond 350	CPS211	24	193			193
Pond 351	CPS213	36	151			151

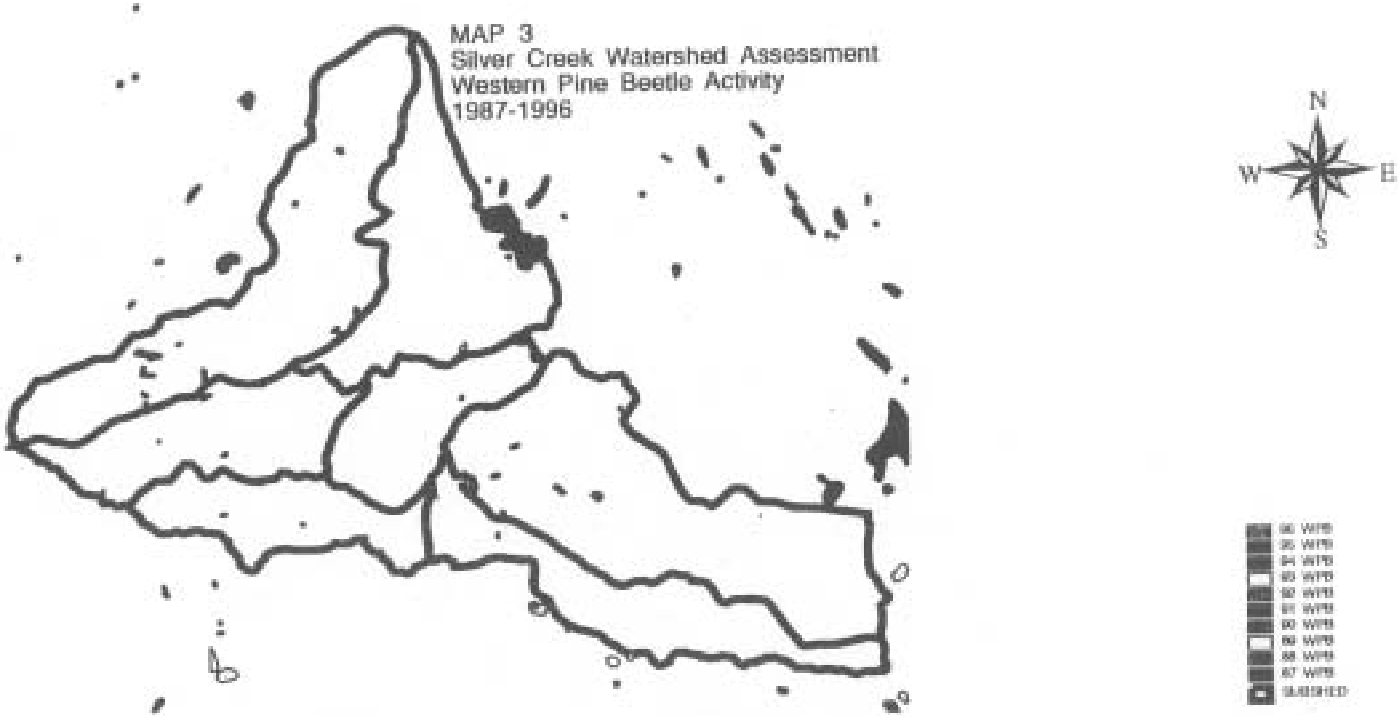
Pond 352	CPS213	123	176			176
Rocpic 111	CWS313	8	233		19	252
Rocpic 121	CWS313	31	221		74	295
Rocpic 123	CWS313	13	183	1	34	219
Rocpic 126	CWS313	104	308	17	165	489
Rocpic 127	CPS121	50	164		227	391
Rocpic 128	CWS313	15	233		19	251
Rocpic 129	CPS121	20	151			151
Rocpic 131	CPS211	60	207			207
Rocpie 676	CPS121	48	157	18	43	218
Scild 850	CPS217	150	166	17	68	251
Scild 851	CPS217	40	143		16	159
Scild 853	CPS217	48	216		17	233
Scild 856	CPS217	58	285		25	310
Scild 857	CPS217	32	142	234		376
Scild 858	CPS217	16	159	103	91	353
Scild 859	CPS217	86	137**	2	7	145
Scild 860	CPS217	76	194			194
Scild 862	CPS217	28	173	109		282
Scild 863	CPS211	161	282	24		306
Scild 864	CPS211	87	241	38		279
Scild 865	CPS217	32	430	31		460
Scild 866	CPS217	66	155		4	159
Scild 869	CPS217	76	145		27	172
Scild 873	CPS217	38	246		12	258
Scild 878	CPS217	39	265			265
Scild 880	CPS217	22	210		37	247
Scild 881	CPS217	127	223		40	263
Scild 882	CPS217	43	178			178
Scild 883	CPS211	10	286			286
Scild 887	CPS211	53	298	43		341
Scild 888	CPS211	40	152	145		297
Scild 890	CPS211	179	159	81		240
Scild 891	CPS211	146	218	106		324
Scild 892	CPS217	105	150	17	6	173
Scild 895	CPS217	23	234	160		394
Scild 896	CPS211	46	275	44		319
Scildian 374	CWS112	120	170	5	19	194
Scildian 375	CWS112	169	178		4	182
Scildian 377	CWS112	21	233	10	14	256
Scildian 378	CWS112	175	187			187
Scildian 379	CPS213	30	175			175
Scildian 380	CPS314	42	185			185
Scildian 382	CPS311	21	193		33	226
Scildian 383	CPS212	105	180			180
Scildian 384	CPS212	58	241	35		276
Scildian 385	CPS213	168	220			220
Scildian 386	CLS211	86	181	110		291
Scildian 387	CPS217	72	201	11		212
Scildian 390	CWS112	34	185		114	299
Scildian 391	CPS217	134	200	18	79	297
Scildian 392	CPS217	163	156	9	105	272
Scildian 394	CPS211	82	189	42	2	234
Scildian 395	CPS211	163	282	3		285

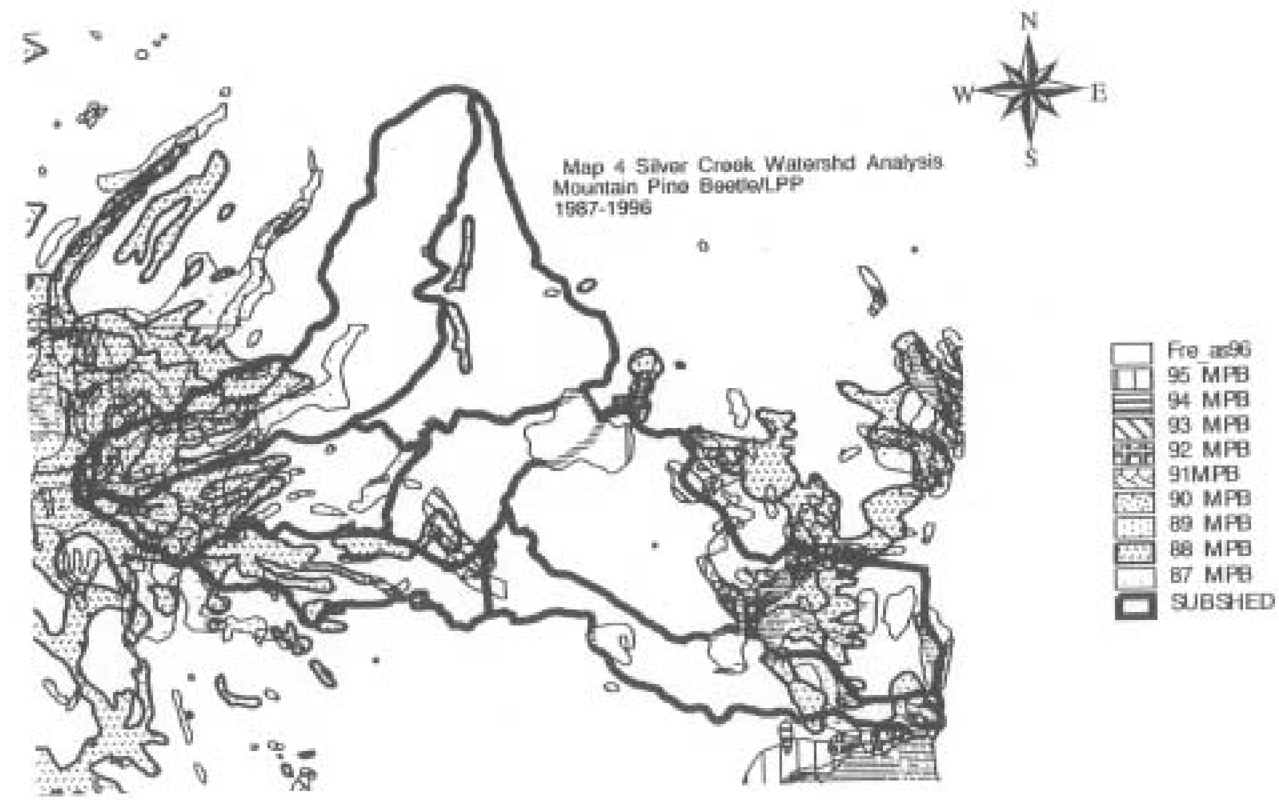
Scildian 396	CLS213	20	238	129		367
Scildian 397	CPS212	143	396		28	425
Scildian 399	CPS211	82	204			204
Shoeboy 077	CPS314	100	169		67	236
Shoeboy 094	CPS211	40	190	1	16	207
Shoeboy 095	CPS314	108	162		39	201
Shoeboy 096	CPS111	25	209			209
Shoeboy 097	CPS212	32	228		17	245
Shoeboy 098	CPS211	37	225		6	231
Shoeboy 100	CPS211	110	200		6	206
Shoeboy 101	CPS215	38	189	44	19	252
Shoeboy 136	CPS217	119	250			250
Shoeboy 137	CPS217	44	168		78	246
Shoeboy 139	CPS217	115	156	8	35	199
Shoehorn 002	CWS112	43	264			264
Shoehorn 003	CWS112	56	269		15	283
Shoehorn 004	CWS112	141	244	18		262
Shoehorn 005	CWS112	233	225	17	4	245
Shoehorn 007	CWS112	50	237	8		244
Shoehorn 009	CWS112	100	162	124	1	287
Shortshirt 204	CPS217	100	189	8	15	212
Shortshirt 205	CWS114	207	232	4	60	296
Shortshirt 206	CWS114	149	182		104	286
Shortshirt 214	CWS114	53	192	70	71	333
Shortshirt 217	CWS112	139	177	48	36	261
Shortshirt 218	CPS311	34	212	6	14	232
Shortshirt 219	CPS311	58	161	16	6	183
Shortshirt 221	CPS311	50	160	11	78	249
Shortshirt 223	CPS311	44	170		16	186
Shortshirt 236	CPS311	62	186		154	340
Spoon 308	CWS112	238	167	24	106	298
Spoon 314	CWS112	46	254			254
Spoon 315	CWS112	166	236		56	292
Spoon 317	CWS114	80	184	5	117	307
Spoon 319	CWS114	33	282	4	88	375
Spoon 327	CPS311	24	172	52	128	353
Stone 451	CPS311	29	191			191
Stone 452	CPS311	11	148			148
Sycan 301	CPC211	17	190			190
Sycan 302	CPC211	87	226			226
Sycan 304	CPC211	82	179			179
Wikerif 535	CPS311	75	161	48		214
Wikerif 537	CPS311	267	158	12		170
Wikerif 540	CPS311	213	194	10		204
Wikerif 545	CPS311	268	183	71		254
Wikerif 689	CPS212	25	164	22		186


MAP 1
Silver Creek Watershed Assessment
Mountain Pine Beetle Activity/
Ponderosa pine
1987-1995
N
W
E
S
95 MPB
94 MPB
93 MPB
92 MPB
91MPB
90 MPB
89 MPB
88 MPB
87 MPB
SUBSHED


Map 2 Silver Creek Watershed
Fir Engraver Activity
1987-1996
N
W
E
S
fir beetle 96
Fir Beetle 95
fir beetle 92
fir beetle 94
fir beetle 93
fir beetle 91
fir beetle 90
fir beetle 89
fir beetle 88
fir beetle 87
SUBSHED

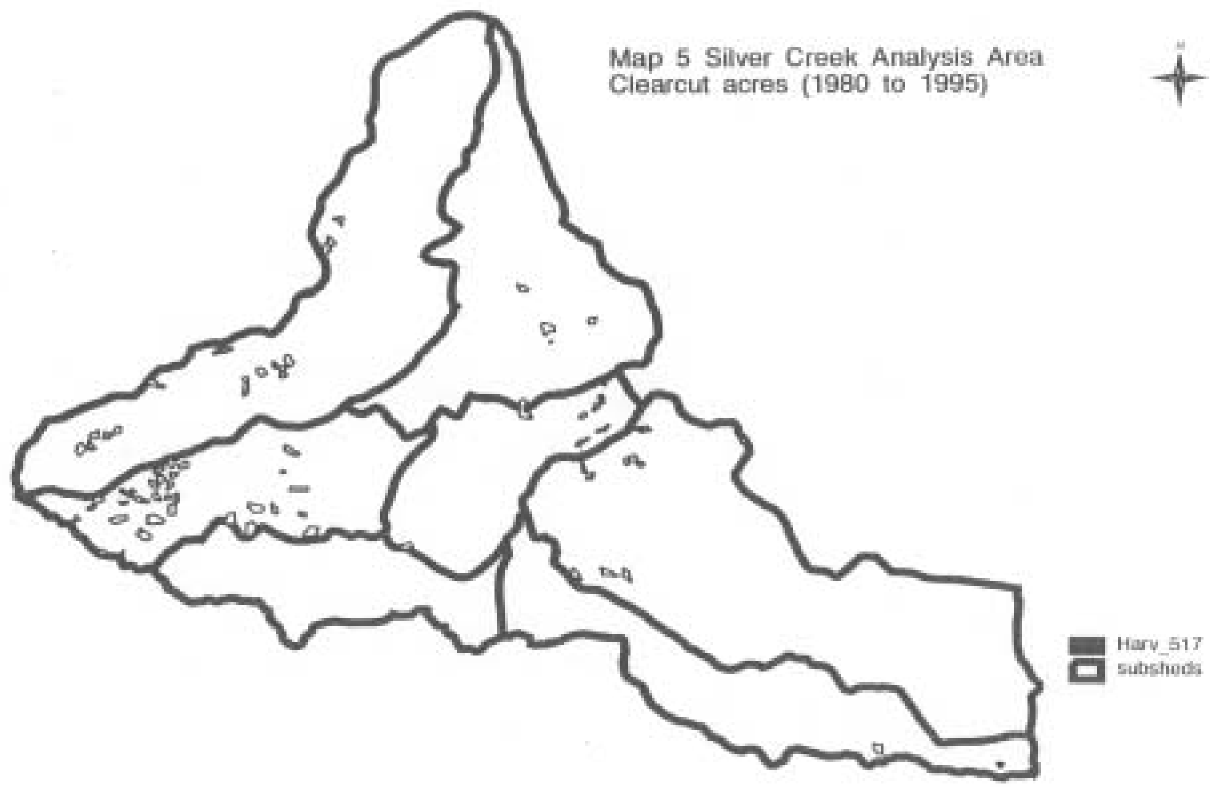
MAP 3
Silver Creek Watershed Assessment
Western Pine Beetle Activity
1987-1996



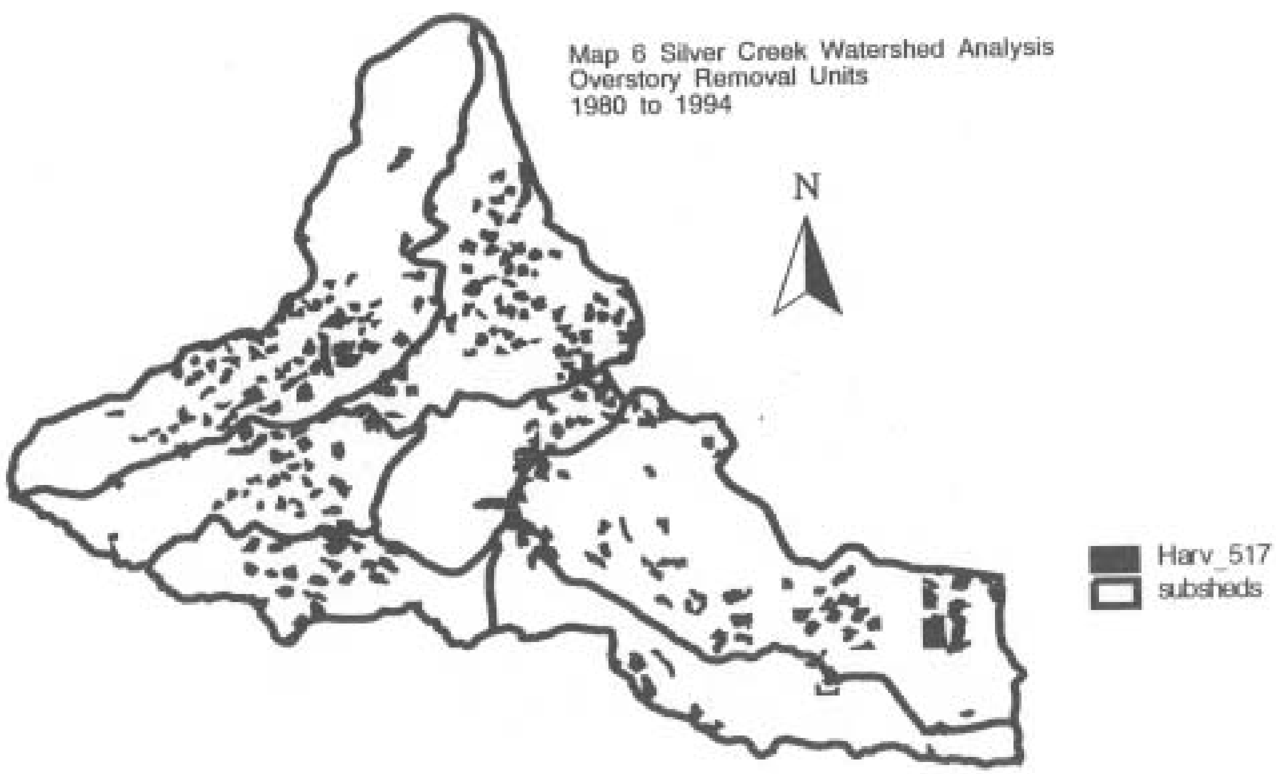


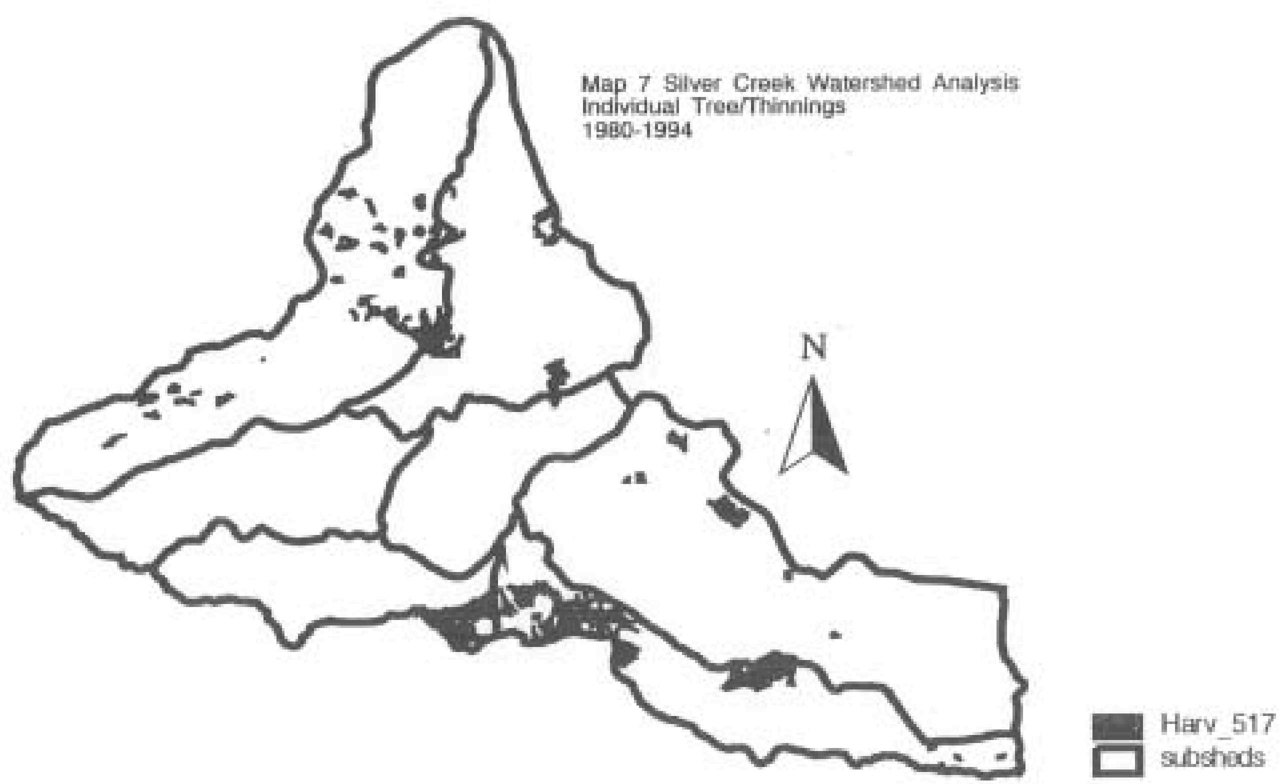
Map 4 Silver Creek Watershd Analysis
Mountain Pine Beetle/LPP
1987-1996
N
W
E
S
Fre_as96
95 MPB
94 MPB
93 MPB
92 MPB
91MPB
90 MPB
89 MPB
88 MPB
87 MPB
SUBSHED

Map 5 Silver Creek Analysis Area
Clearcut acres (1980 to 1995)

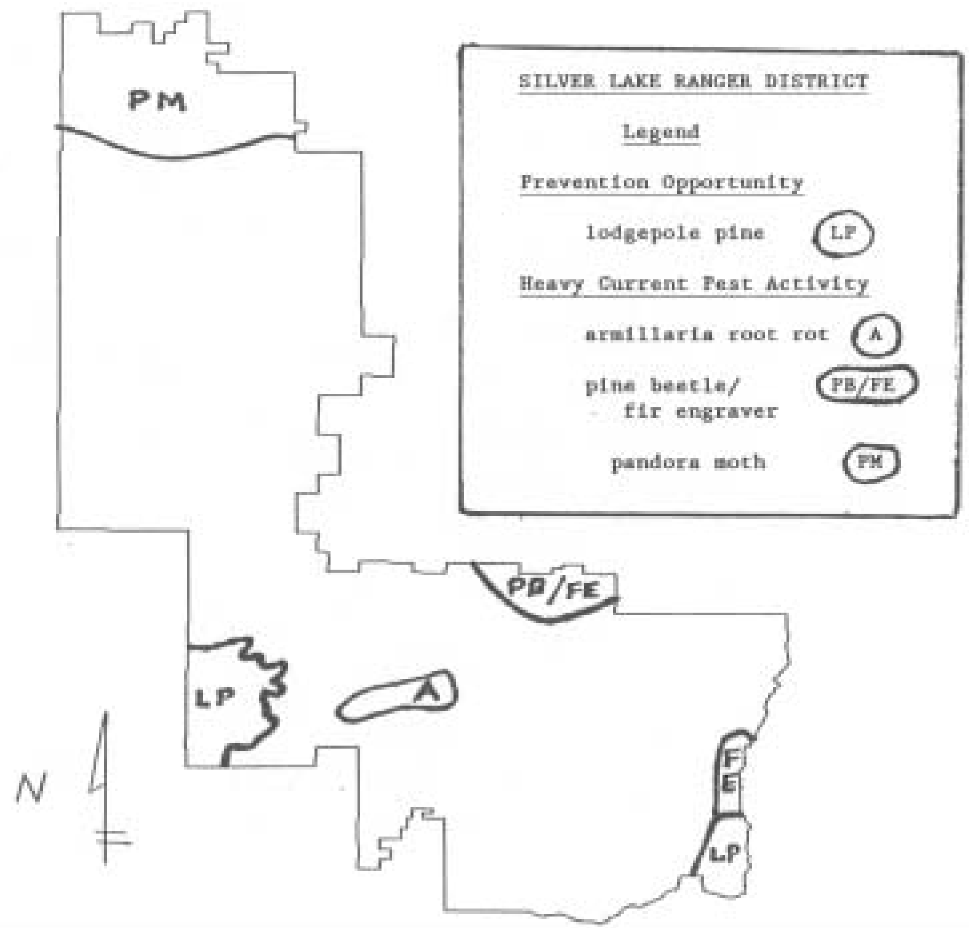


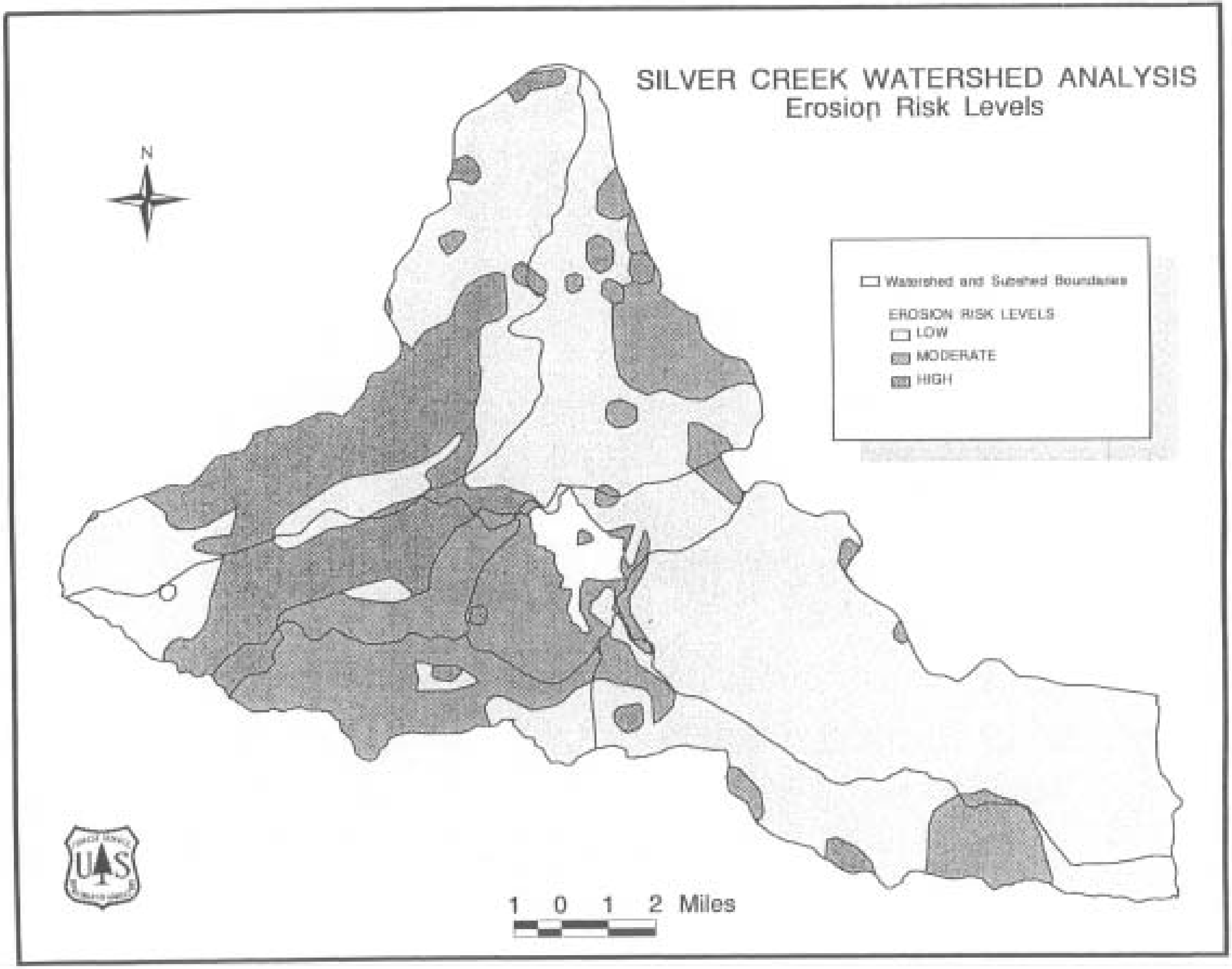
Map 6 Silver Creek Watershed Analysis
Overstory Removal Units
1980 to 1994



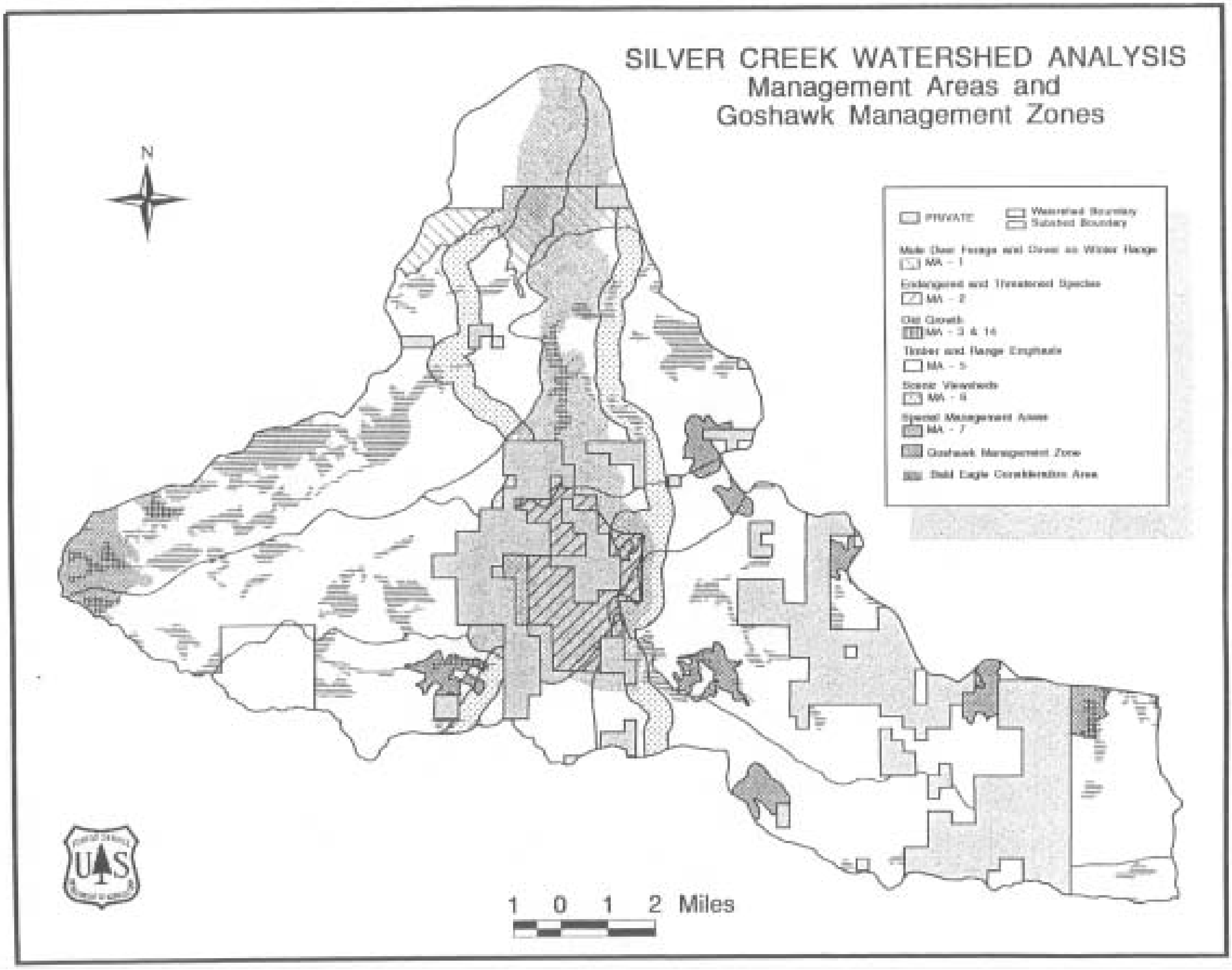

Map 7 Silver Creek Watershed Analysis
Individual Tree/Thinnings
1980-1994
N
Harv_517
subsheds

MAP 8

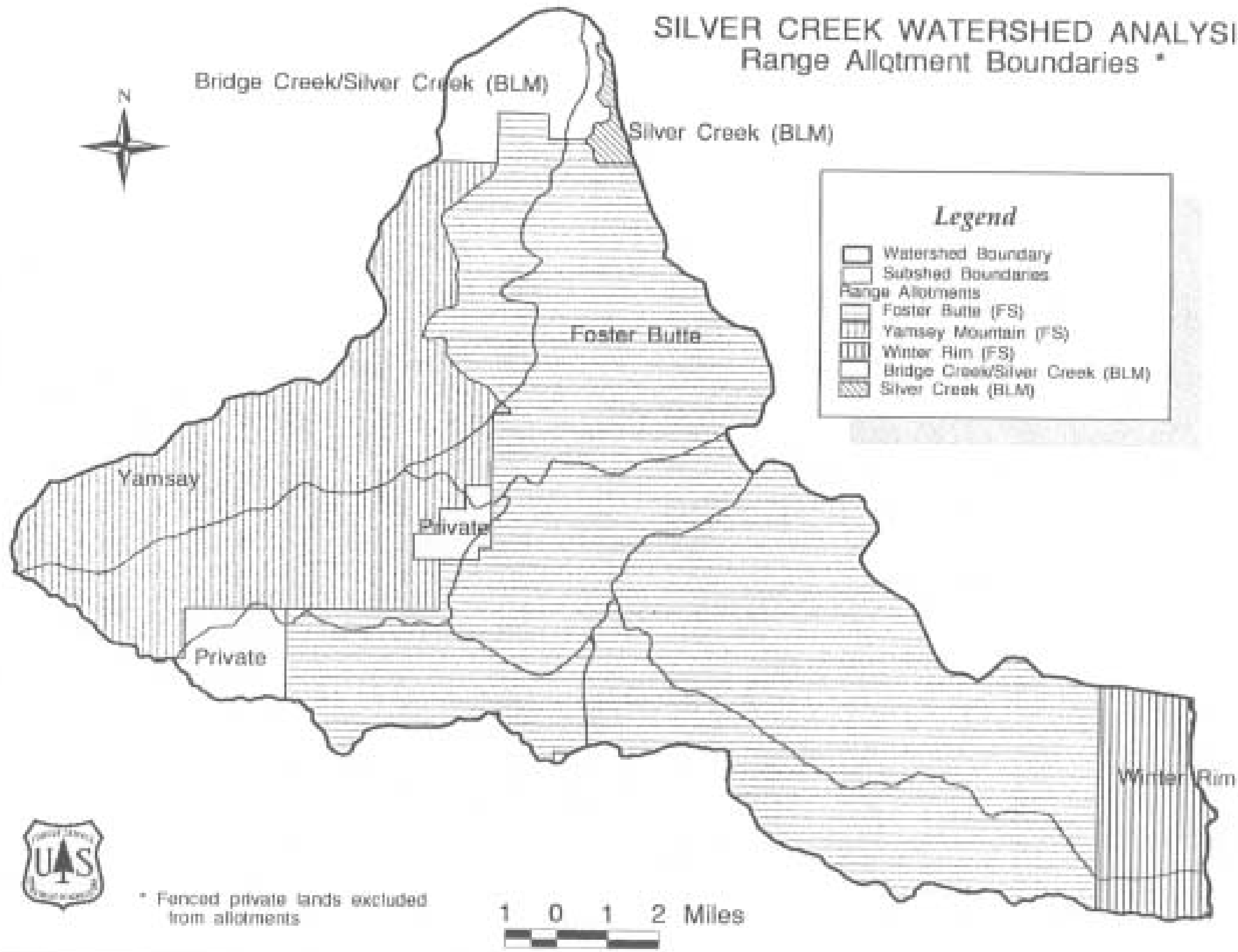

SILVER LAKE RANGER DISTRICT
Legend
Prevention Opportunity
lodgepole pine LP
Heavy Current Pest Activity
armillaria root rot A
pine beetle/ fir engraver PB/FE
pandora moth PM
PM
PB/FE
LP
A
FE
LP
N



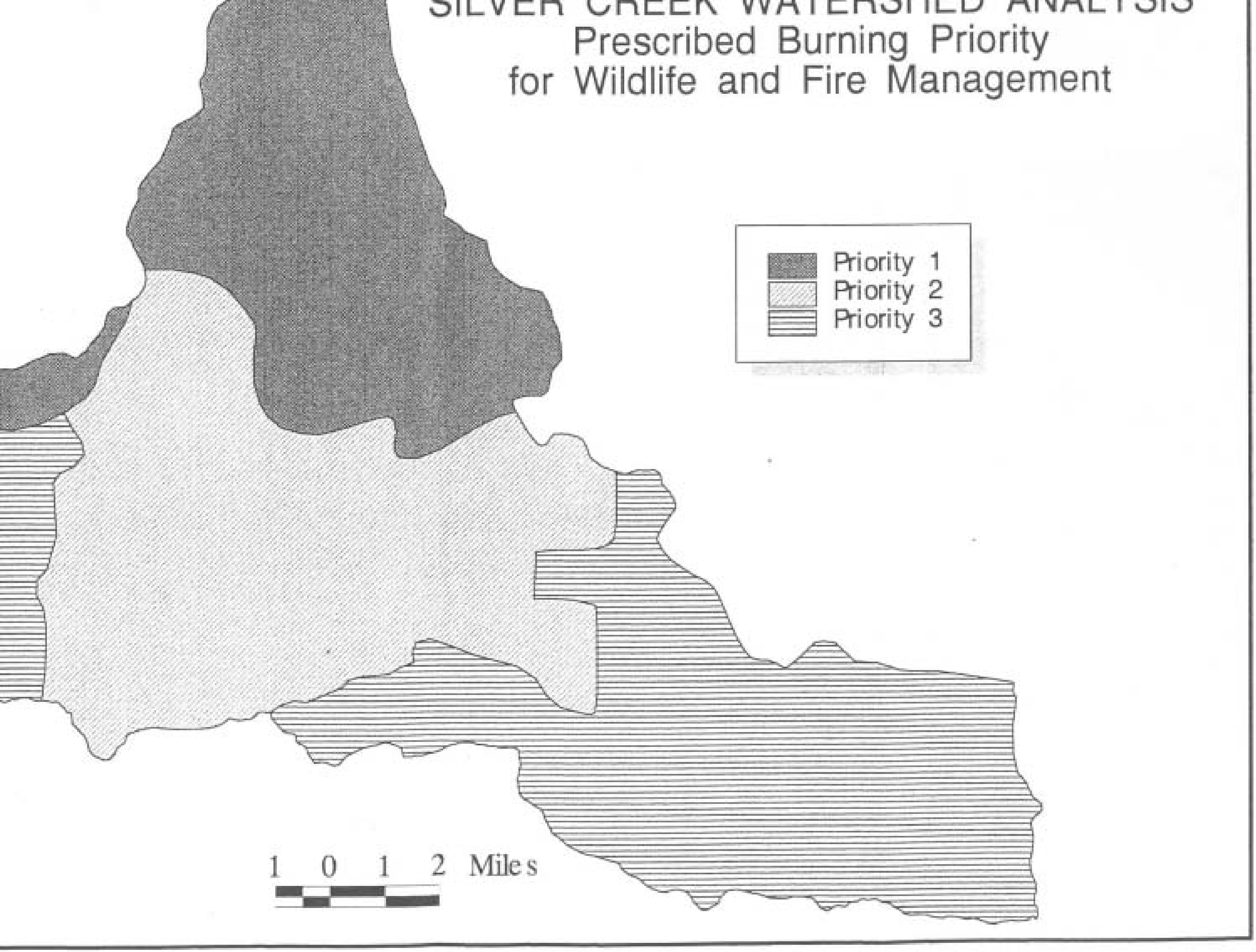
SILVER CREEK WATERSHED ANALYSIS
Erosion Risk Levels
N
Watershed and Subshed Boundaries
EROSION RISK LEVELS
LOW
MODERATE
HIGH
1 0 1 2 Miles

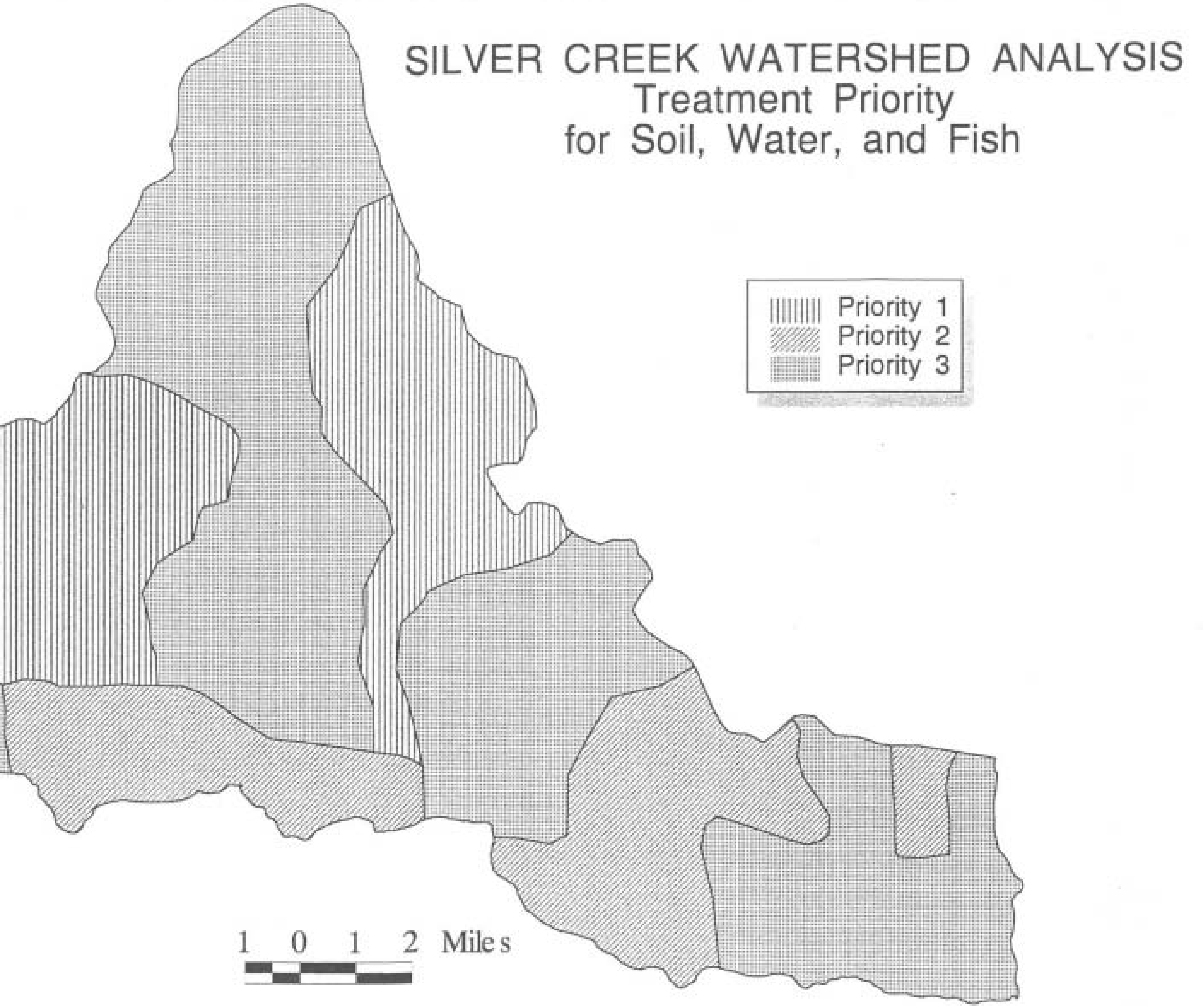

SILVER CREEK WATERSHED ANALYSIS
Management Areas and
Goshawk Management Zones
N
PRIVATE
Watershed Boundary
Subshed Boundary
Mule Deer Forage and Cover on Winter Range
MA - 1
Endangered and Threatened Species
MA - 2
Old Growth
MA - 3 & 14
Timber and Range Emphasis
MA - 5
Scenic Viewsheds
MA - 6
Special Management Areas
MA - 7
Goshawk Management Zone
Bald Eagle Consideration Area
1 0 1 2 Miles

SILVER CREEK WATERSHED ANALYSIS
Range Allotment Boundaries *

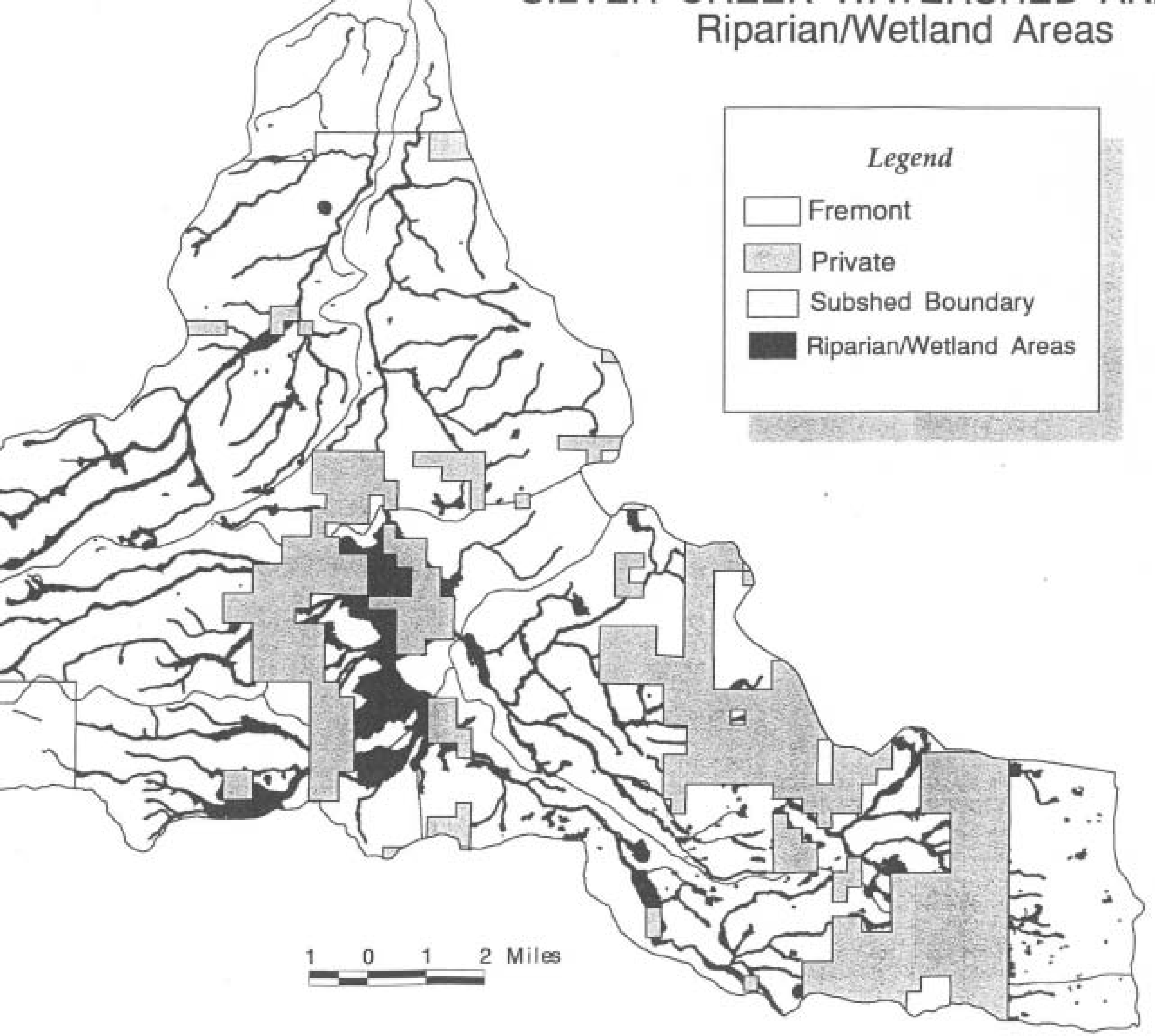


* Fenced private lands excluded from allotments

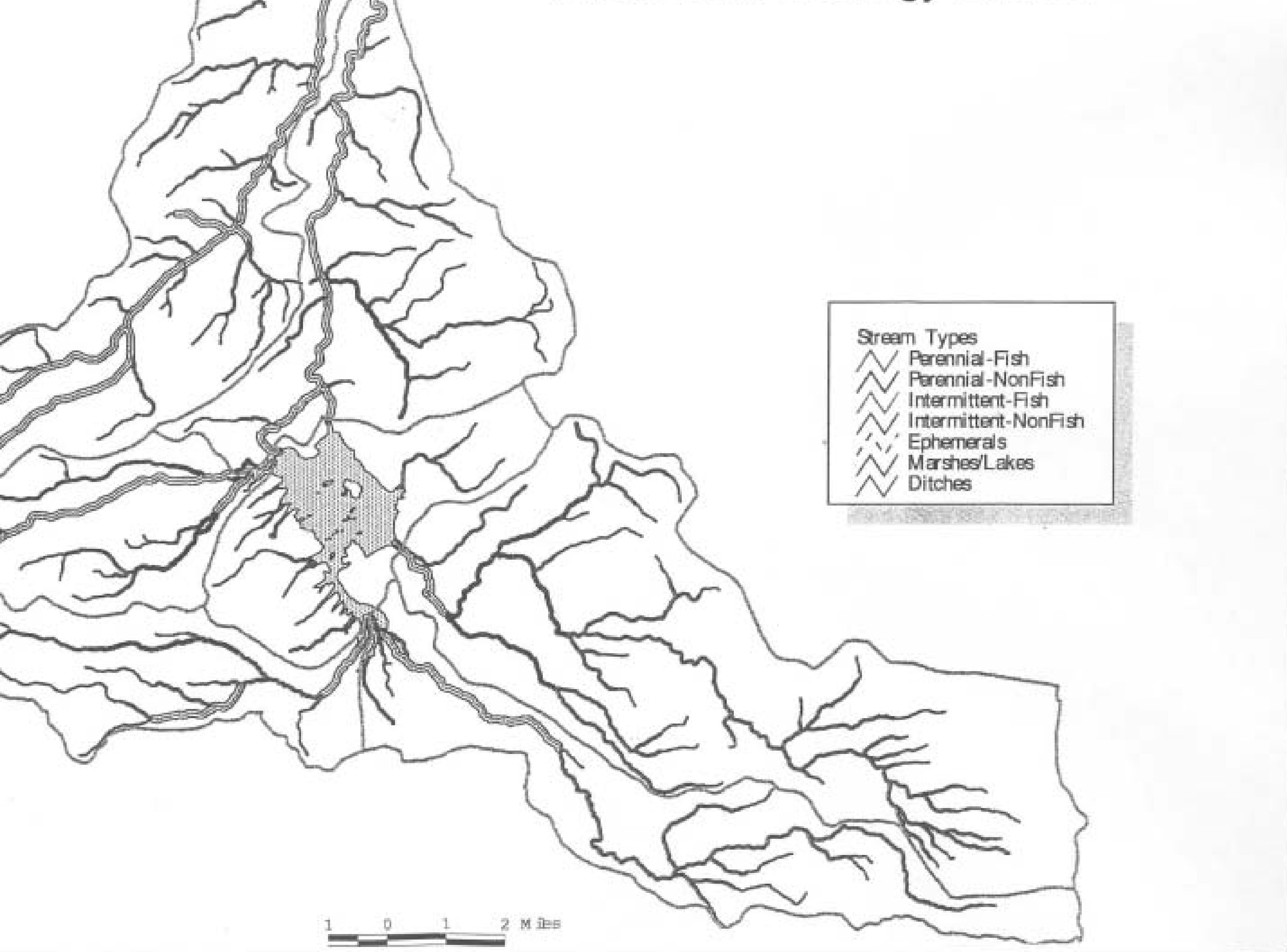

SILVER CREEK WATERSHED ANALYSIS
Prescribed Burning Priority
for Wildlife and Fire Management
Priority 1
Priority 2
Priority 3
1 0 1 2 Miles


SILVER CREEK WATERSHED ANALYSIS
Treatment Priority
for Soil, Water, and Fish
Priority 1
Priority 2
Priority 3
1 0 1 2 Miles

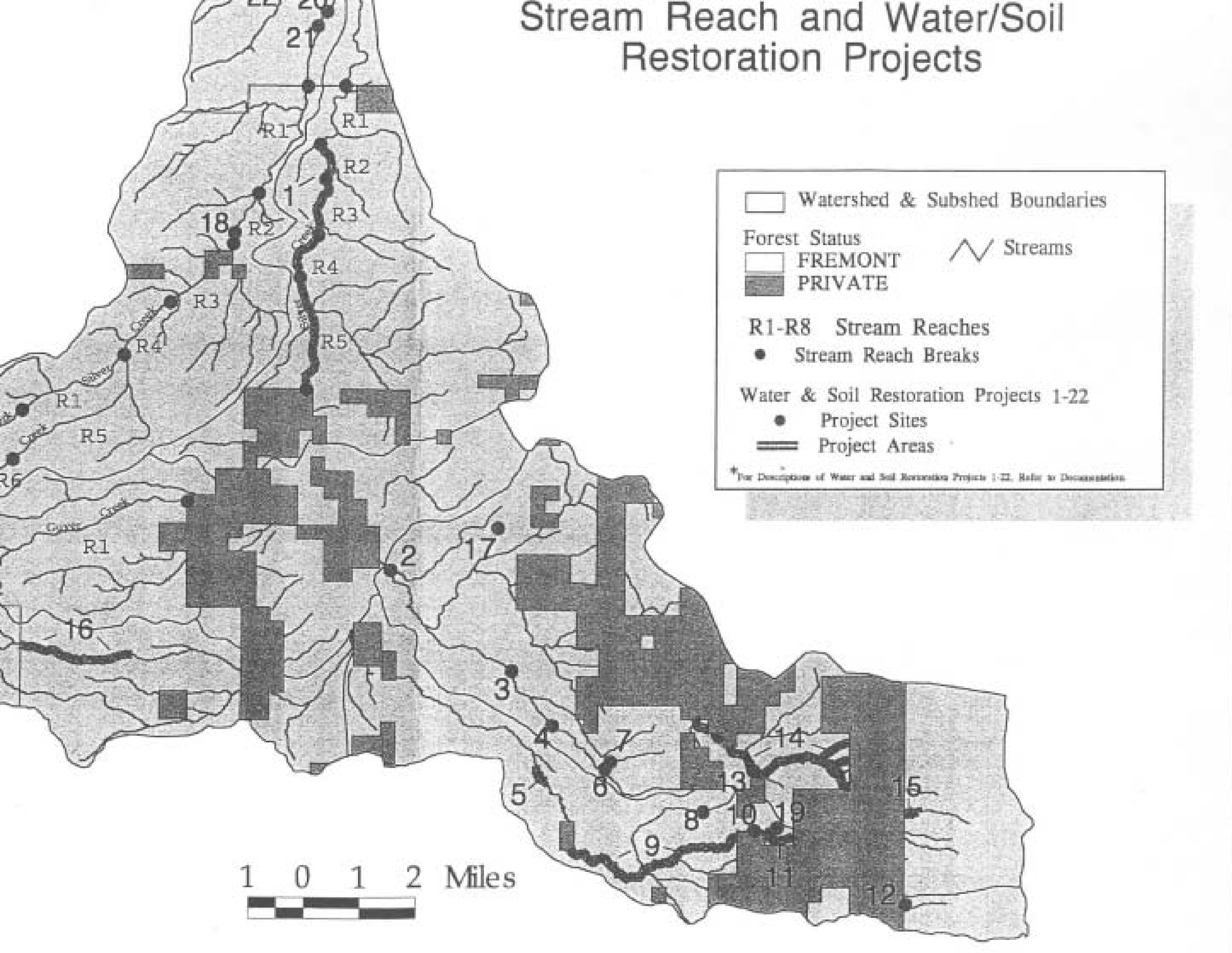
Riparian/Wetland Areas



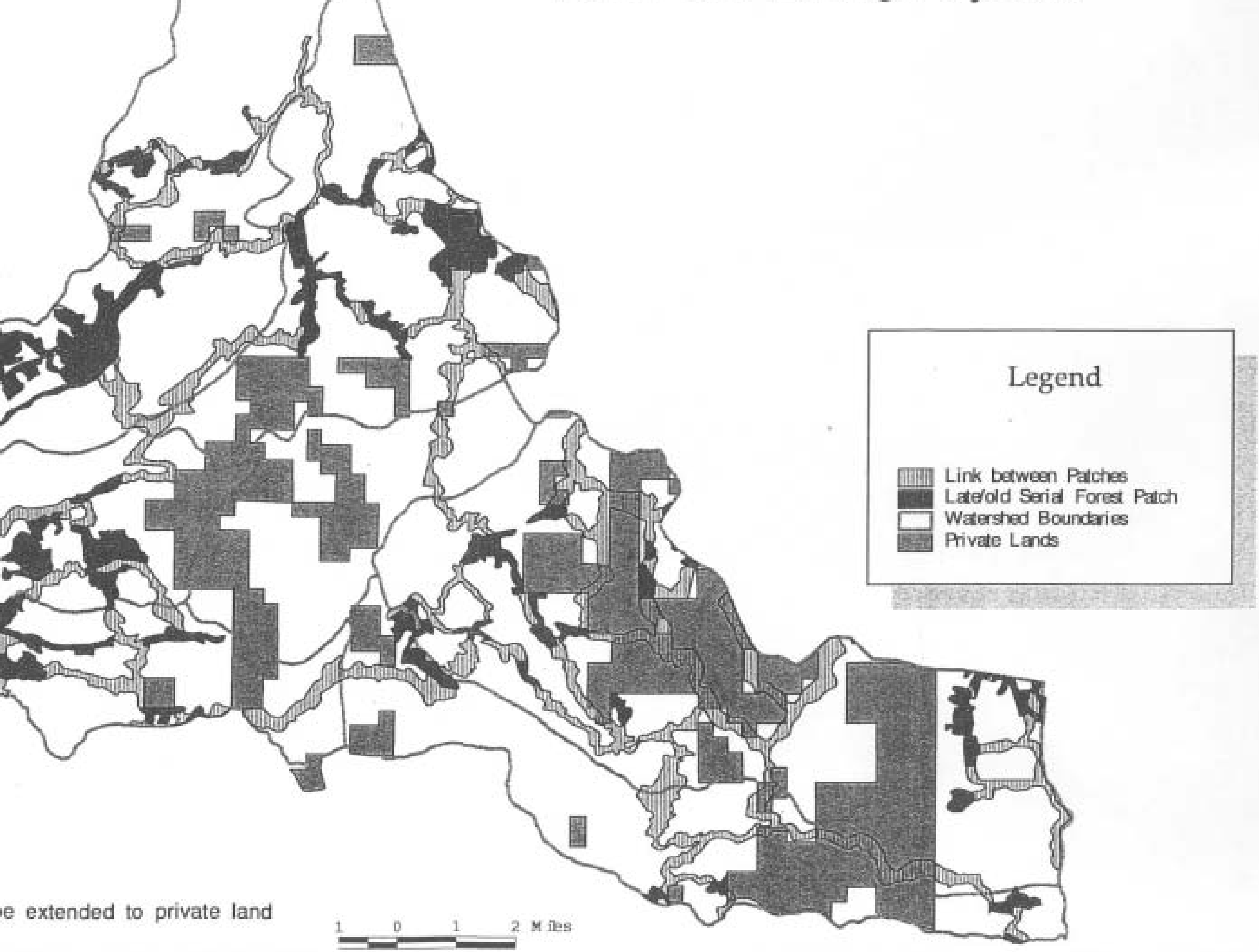
Inland Fish Strategy Buffers



Stream Reach and Water/Soil Restoration Projects

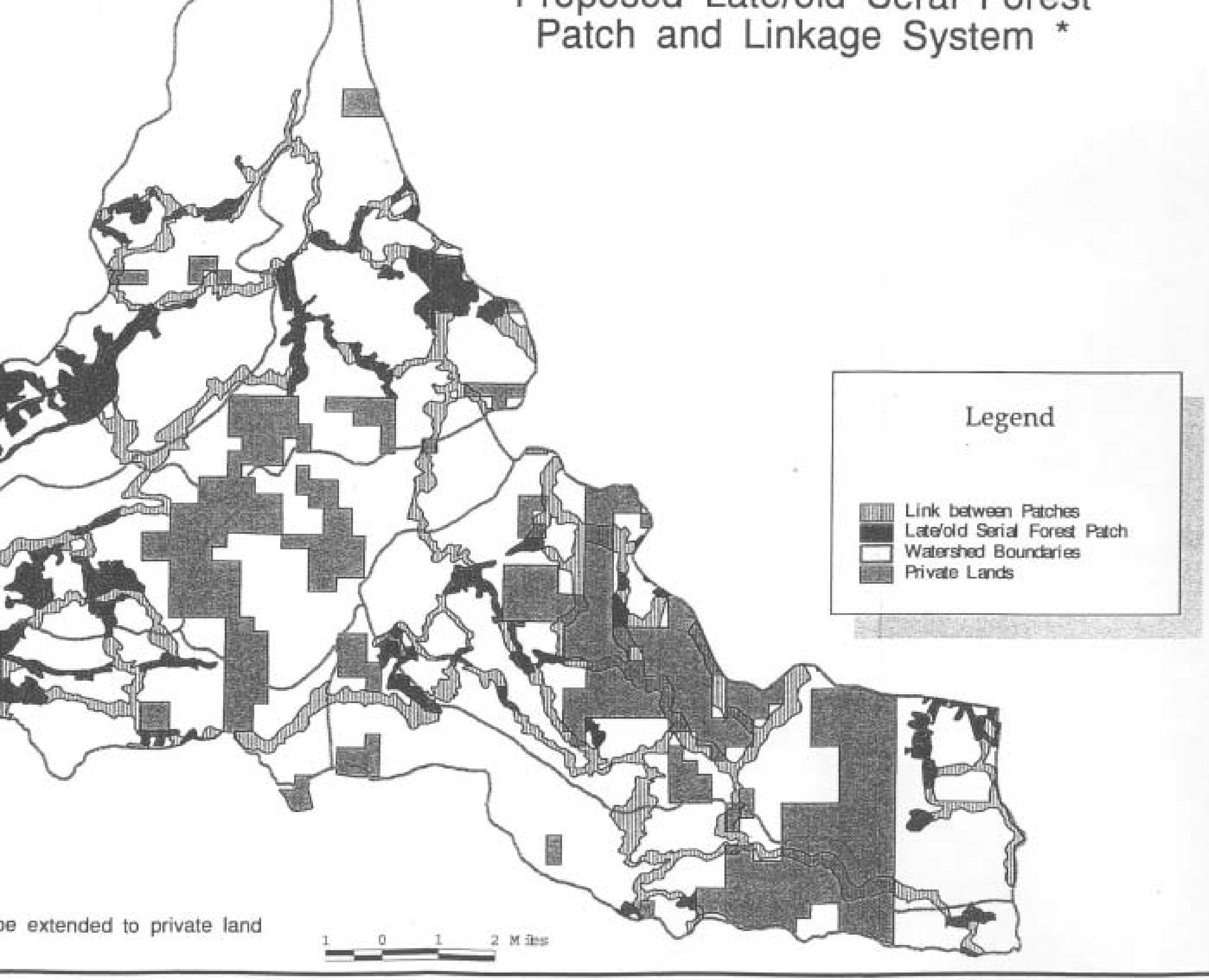


Proposed Late/old Seral Forest Patch and Linkage System *



...e extended to private land

Proposed Late/old Serial Forest
Patch and Linkage System *



be extended to private land

CORE TEAM

CORE TEAM MEMBERS

Dave Wenzel - Watershed Program Manager/Forest Soil Scientist/Team Leader
BS-Soils Science, 30 Years Experience

Mike Montgomery - Forest Hydrologist
BS-Civil Engineer, 14 Years Experience

Terry Hershey - Forest Wildlife Biologist
BS-Wildlife Biology, MS-Wildlife Management, 19 Years Experience

Rod Hoibakk - Forest Assistant Fire Officer
AA-Forest Management, 23 Years Experience

John Kaiser - Forest Archaelogist
BA-Anthropology, 18 Years Experience

Bob Obedzinski - Forest Silviculturist
BS-Forest Management, R-6 Certified Silviculturist, 19 Years Experience

Steve Ruda - Hydrologist Technician
3 Years Experience

Bob Wooley - District Representative
8 Years Experience

Jim Rosetti - Forester-Writer/Editor
BS-Forest Management, 26 Years Experience

KEY CONTACTS

Key Contacts

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Max Corning, Natural Resources Conservation District

Curtis Edwards, Oregon Department of Fish and Wildlife

Dennis Glender, Lake County Watermaster, Lake County Courthouse

Morris Jiminez, Chairman-Klamath Tribes

A. K. Majors, Oregon Division of State Lands

Robert Pardue, Chairman-Lake County Commissioners, Lake County Courthouse

Willie Riggs, Lake County Extension Service, Lake County Courthouse

Roger Smith, Oregon Department of Fish and Wildlife

Roy Woo, Oregon Department of Forestry, Klamath Falls

Rollie White, Fish and Wildlife Service, Oregon State Office, Portland, Oregon

Bureau of Land Management, Lakeview Office

Fish and Wildlife Service, Lakeview, Oregon