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Silver Lake Watershed Assessment

Creating a Healthy Watershed through Cooperative Watershed Management

Silver Lake Watershed Assessment

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Introduction

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Creating a Healthy Watershed Through Cooperative Watershed Management

On August 18, 1998, a group of local landowners and managers met at the Silver Lake Fire Hall to discuss the formation of a local watershed-working group. The challenge is cooperative resource management over a particular land base while addressing state and federal standards and historic/community values. Of particular importance to the group are healthy, functioning watersheds – ones that capture, store, and safely release water to produce the desired beneficial uses – water quality/quantity, forage for livestock and wildlife, and fish and wildlife habitat. The mission is to build a foundation that will lead to ***cooperative watershed management*** across land ownership boundaries within the 167,462-acre watershed area (Silver, Bridge, and Buck Creek Watersheds). The first Silver Lake Community Watershed Council meeting; in attendance were Frank Shaw of the Buck Creek Ranch, Tim Hass of the Pitcher Ranch, Tom and Karmen O'Leary of the O'Leary Ranch, Lance and Carrie Brown of the Brown Ranch, Jeff and Linda Hunt of the Hunt Ranch, Gary Nolan of the ZX Ranch, Teresa Cliff of the Cliff Ranch, Brad Johnson of US Timberlands Inc., and Fremont National Forest Service employees. (Refer to Figure 1.1 – Silver Lake Watershed Location and Figure 1.2 – Silver Lake Watershed Land Ownership).

In order to gain a better understanding of the watershed's current condition, it became clear that the history of the watershed must be understood. Human activities, past and present, have impacted watershed functioning in various ways. Starting in the early 1800's, European trappers significantly reduced beaver populations in eastern Oregon streams, initiating drastic changes in stream processes. Beaver ponds had maintained wide floodplains, dissipated flood energy, and served as sediment collection areas. Once the beaver were trapped and removed, dams washed away restricting flood energy to a single channel, resulting in streambank erosion and downcutting (Elmore and Beschta 1987).

Attracted to water, forage, and wood, a steady flow of settlers and businessmen began to enter Lake County and the Silver Lake area in the 1870's (taken from Lake County Historical Society records). Large livestock operators moved their cattle, sheep, and horses throughout public domain and lands owned by local ranchers in the Northern Great Basin. Many areas were left barren of vegetation, causing soil to erode into streams and rivers. Likewise, timber companies were attracted to the vast timber resources of the area, bringing with them ideas of clear-cutting large tracts of land – not realizing the importance of replanting to prevent soil erosion. Gifford Pinchot, the first Chief of the US Forest Service (USFS) observed these actions on public domain and considered their effects on future generations when he stated, "Think of the wealth which people might have made permanent, simply by using the forests wisely" (Pinchot 1907). Keeping future generations in mind, Congress passed a series of laws, including the Organic Act of 1897, which culminated in the National Forest system in 1907. Within National Forests, timber harvest, grazing, and other activities were encouraged but regulated in a manner so as to maintain watershed conditions by promoting the safe capture, storage, and release of water (Pinchot 1907). For the next 90 years, management on both National Forest and private lands in the Silver, Bridge, and Buck Creek Watersheds has been continually refined to meet this goal. For example, the number of livestock permitted to graze Fremont National Forest lands has been gradually decreased in an effort to match the carrying capacity of the land. In 1909, the livestock permitted to graze Fremont National Forest lands included 110,000 sheep and 26,000 cattle and horses. Although these numbers dropped to 78,000 sheep and 10,996 cattle and horses by 1929, numerous allotments were still considered to be in a "deplorable condition" (Bach 1981). Vegetation was drastically reduced along many stream channels within the assessment area resulting in severe bank erosion and downcutting. By 1959, forest officials and permittees agreed to a further reduction of animal numbers to 31,210 sheep and 12,392 cattle (Bach 1981). In the 1960's, sheep were essentially removed from National Forest Allotments in the watershed because of a drop in market value and demand as well as the division of large allotments into many smaller ones – the additional fencing was not conducive to sheep management. Cattle numbers remain the same to this day at approximately 12,500. Current grazing practices throughout much of the assessment area are guided by standards used to ensure maintenance and/or improvement of late-seral plant species such as sedge and willow, which promote bank stability and water quality while also enhancing the forage base for livestock. In an effort to determine better management techniques of the allotment system, the Silver Lake Ranger District continues to conduct surveys and analyses of the Forest. Private land owners within the council are constructing riparian pasture fences, altering the timing of grazing, thinning juniper stands, and exploring the opportunity and possibility of implementing controlled burns to enhance upland and riparian conditions.

In 1922, mainly in response to grazing problems that had been exacerbated by extended drought and lightning fires and to meet increasing irrigation needs, a dam was constructed on Silver Creek. Built in cooperation with the Silver Lake Irrigation District, the dam collects water from about 52% of the Silver Creek Watershed and allows downstream users to better time their allocation of water and to extend their irrigation season. The resultant reservoir (Thompson Reservoir) flooded some 1,523 acres of land, most of Thompson Valley, and provided over 17,000 acre-feet of water. In 1946, the dam height was increased to provide about 19,000 acre-feet of water (as of 1991, the average retention in the reservoir was 15,500 acre-feet). In years with average precipitation, downstream users utilize over 85% of the water in the reservoir for irrigation, while in drought years the reservoir can be essentially drained. Thompson reservoir has subsequently become a major recreational site with large numbers of people taking advantage of seasonal activities, and continues to serve irrigation needs for the Silver Lake basin area.

Prior to 1945, timber harvest was sporadic and widely spread throughout the watershed with the products being primarily used for local community and ranch construction. As livestock numbers decreased in the watershed, however, timber harvest increased, marking a transition from a livestock to a livestock/timber-based economy. Of interest to note is that large white fir were harvested and used in the local market, a practice uncommon today. Since this time period, large ponderosa pine have been the high value product, with extensive timber harvesting, including old-growth timber, and associated road construction occurring throughout the Silver, Bridge and Buck Creek Watersheds. This occurred not only on National Forest lands, but also on large tracts of private lands including lands owned by the Weyerhaeuser Corporation, which were clear-cut in the late 1970's and early 1980's. The result was increased soil erosion and a change in runoff characteristics. The harvest of old-growth virgin pine came to a sudden halt in 1993 when public opinion and Forest Service policy shifted toward the maintenance of old-growth stands and subsequent reductions in road construction. Presently, the Inland Native Fish Strategy and other guidelines that ensure the maintenance or improvement of streamside areas and old-growth forests guide all timber sales on National Forest Lands.

Starting in 1971, the state of Oregon provided management guidelines for forest management by enacting the Forest Practices Act, the nations first, setting new forestry standards for private and state lands across the state. The act covers numerous forest operations including road construction, protects soils from erosion, protects waters of the state, and encourages improvement of fish and wildlife habitat through stream buffers. Further, in 1987, the Oregon Watershed Enhancement Board (OWEB) – formerly the Governor's Watershed Enhancement Board – was created to provide a source of seed money to local community groups and others interested in implementing watershed enhancement projects. In addition, OWEB is instrumental in encouraging the formation of watershed councils throughout the state, such as the Silver Lake Community Watershed Council formed in 1998. Finally, in order to help restore Oregon's wild trout and salmon, the Oregon Plan was endorsed and funded by the Oregon Legislature in 1997. This plan encourages cooperative efforts between state, local, federal, tribal, and private organizations and individuals to achieve its goals.

On private forestlands owned by US Timberlands Services (UST), the Oregon Forest Practices Act guides timber sales, and a grazing management program has been implemented to enhance riparian conditions across property boundaries. Additionally, UST views the watershed council as an important avenue to manage all aspects of the forest environment in a socially responsible manner.

From the historical perspective, the Silver Lake Community Watershed Council has learned that "Today's decisions become tomorrow's consequences..."(Maser 1996). They have experienced first-hand many of these historic changes-- and are dealing with the consequences of an altered landscape from European trappers, past grazing practices, timber harvest, and road construction. Chris Maser (1996), recognized for his work in sustainable community development, wrote that a community is within the carrying capacity of the land when the number of individuals living within a particular landscape does not impair its ability to function in an ecologically specific way. By forming the Silver Lake Community Watershed Council, members took an additional step in bringing management actions closer to the carrying capacity of the land.

Initially, it appeared that the consequences of erosion and downcutting within the watershed would concern only local landowners and managers. Soon after the Council's formation, however, the watershed's condition garnered national significance. Stream temperatures throughout the watersheds indicated poor water quality, placing the streams out of compliance with the Federal Clean Water Act. Following suit, redband trout, a species sensitive to water quality, was considered for listing under the Federal Endangered Species Act.

The watershed council reviewed the 1997 U.S. Forest Service Silver Creek Watershed Analysis for guidance however; it did not include the Buck and Bridge Creek watersheds as part of the analysis area. Therefore, in order to make the necessary decisions guiding future management, the Council realized it needed a clearer understanding of the current ecological processes of the landscape as well as a more detailed assessment of the watershed. Therefore, the Council applied for and received an OWEB grant to conduct a watershed analysis across private and public lands. As a result, surveys were conducted during the 2000 field season, and the data collected was used in the following assessment.

The goal of this document is to provide information concerning basic processes and desired conditions of a healthy watershed and to present a clear picture of the current functioning condition of the watershed as well as recommendations for improvements. This document is meant to be dynamic and may change or be added to as more information is collected within the watershed, or new science is incorporated into the data and recommendations presented in this assessment. We recognize that this document may not cover all of the issues or include all of the possible data or recommendations that exist with the watershed.

Chapter Two will provide a short characterization of the assessment area and will discuss basic watershed processes as they relate to the Silver Lake Watershed – including the discussion of relevant issues and the formation of desired conditions and the four key questions that would address the hydrologic functioning of the watershed. Chapters Three, Four and Five will answer the first three key questions – the first concentrating on the uplands, the second on riparian vegetation and stream channels, and the third on habitat for aquatic species. Within each of these chapters is a description of both the current and desired conditions within the watershed, a comparison between these conditions (synthesis), and viable recommendations for improvements. Chapter Six brings together all of this information and analysis by summarizing how conditions within the watershed are affecting the viability of native redband trout populations, the fourth key question. The last chapter, Chapter Seven, serves primarily as an action plan for the Council by prioritizing recommendations and describing the necessary-monitoring needed across the watershed. Finally, this document will allow current council members – Buck Creek Ranch, Pitcher Ranch, O'Leary Ranch, Brown Ranch, Hunt Ranch, Bridge Creek Ranch, US Timberlands Inc., Bureau of Land Management and Fremont National Forest – to, through cooperative watershed management, meet their goal of creating a healthy and sustainable watershed.

On July 12, 2002 a lightning storm ignited 67 fires on the Fremont National Forest. On the Silver Lake Ranger District, which encompasses the Silver Lake Watershed, two of these fires, the Toolbox fire, which started near Toolbox Springs, and the Silver Fire, which started near Silver Creek Marsh Campground, became the primary fires within the Toolbox Complex. In total, the Toolbox Complex included approximately 85,000 acres, including approximately 49,500 acres of National Forest lands, 8,000 acres of Bureau of Land Management administered lands, and 27,500 acres of private land. These fires occurred after this watershed assessment was prepared and therefore the effects to the watershed are not addressed within this document. However, and addendum to this assessment may be prepared at a latter date which addresses the impacts of the fires to the watershed and any potential project work that may occur in the future.

Figure 1.1 - Silver Lake Watershed Location

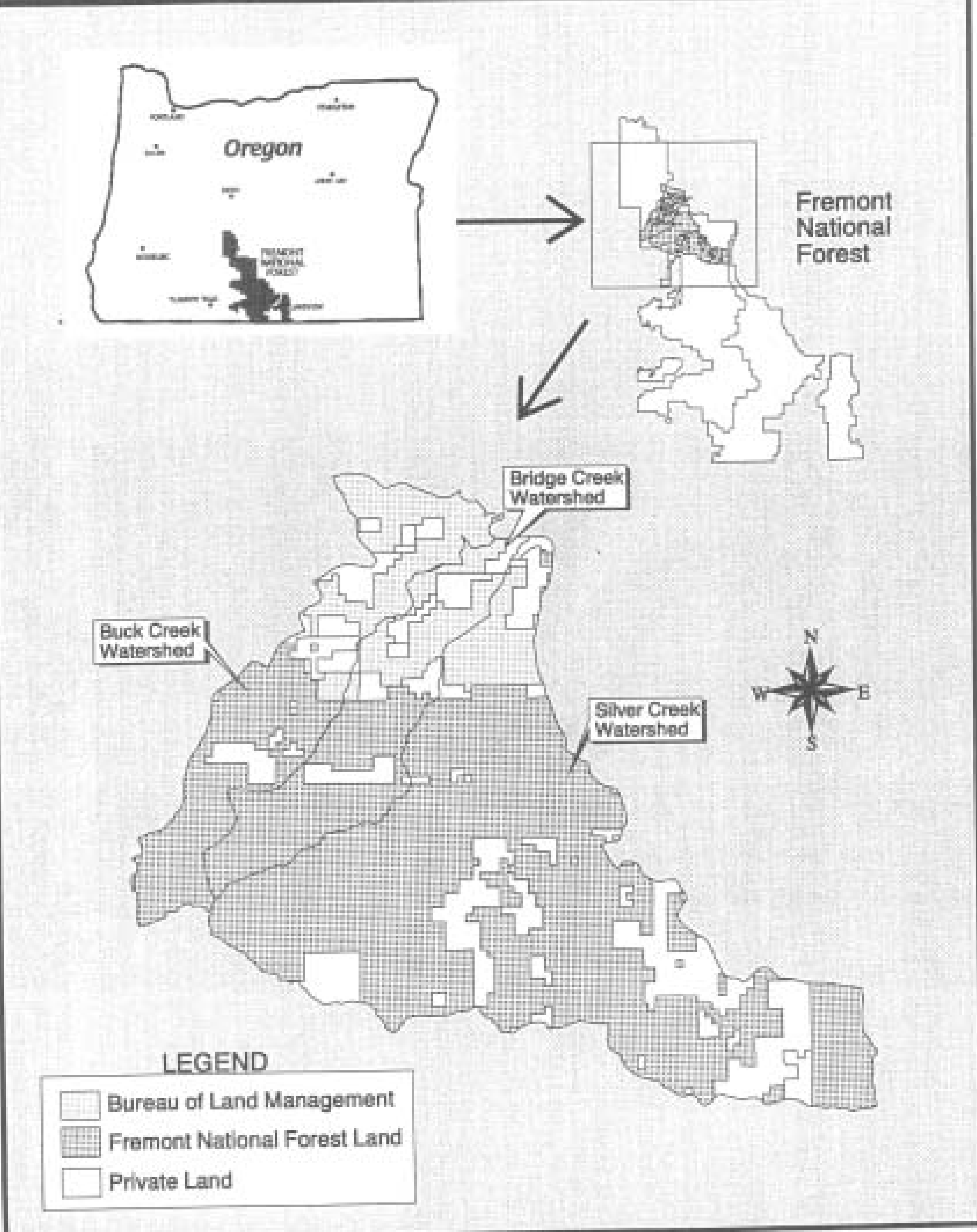
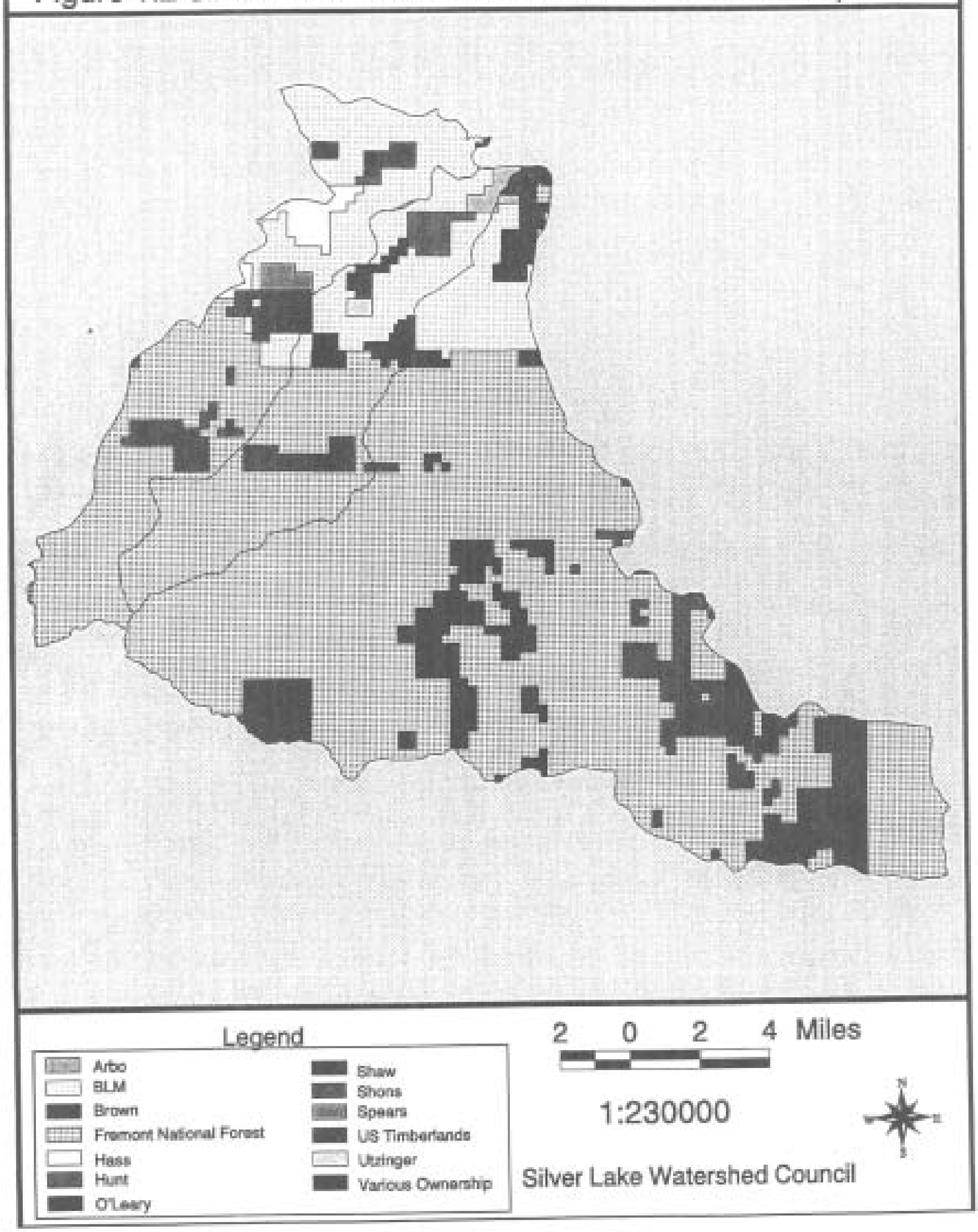


Figure 1.2 Silver Lake Watershed Council Land Ownership



Chapter 2

Characterization, Issues, and Key Questions

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Characterization

Introduction

The Silver Lake Community Watershed Council's Watershed Assessment Area is located in the northwestern corner of the Great Basin in south-central Oregon. This area encompasses a significant portion of the Silver Lake Ranger District in the northern portion of the Fremont National Forest, and includes three watersheds: Silver Creek, Bridge Creek and Buck Creek, all of which drain into and are a significant contributor of Paulina Marsh – a large wetland that drains into Silver Lake (the outlet of this closed basin). For this and other reasons, such as wanting to find a shorter name that describes the assessment area and illustrates the involvement of the Silver Lake Community, the area will be further referred to as the Silver Lake Watershed Assessment Area. Paulina Marsh/Silver Lake, and the streams flowing into them, are the life-blood of the local community and ranchers, as well as breeding bird and mammal populations within the area, due to their highly productive lands and the fact that they are the major late summer water source (primarily Paulina Marsh) within the Silver Lake Basin. The entire analysis area totals approximately 167,462 acres with about 112,946 acres (67%) being managed by the USDA Forest Service, roughly 21,107 acres (13%) being managed by the Bureau of Land Management, around 16,255 (10%) acres being managed by U.S. Timberlands Services, and the remaining 17,120 acres (10%) being privately owned.

Uplands

During the first few Silver Lake Community Watershed Council meetings, basic watershed processes were discussed and explained using the words of Gifford Pinchot. In 1907, he described the ways in which a watershed functions:

> "What they (watersheds) do, and this no one of experience disputes, is to nurse and conserve the rain and snow after they have fallen. Water runs down a barren, hard surface with a rush, all at once. It runs down a spongy, soft surface much more slowly, little by little. A very large part of rain and snow of the arid regions falls upon the great mountain ranges. If these were bare of soil and vegetation, the waters would rush down to the valleys below in floods. But the forest cover – the trees, brush, grass, weeds, and vegetable litter – acts like a big sponge. It soaks up the water, checks it from rushing down all at once, and brings about an even flow during the whole season."

Most current documents and texts that describe watersheds restate Pinchot's observations, some using the same generalities, others providing detailed specifics on capture, storage, and safe release of water (Anderson et al. 1976, Black 1996, Brooks et al. 1997, Dzurik 1990). Quite simply, a watershed is the area that collects and discharges runoff through a given point on a stream (Satterlund and Adams 1992). Furthermore, it has been viewed as a catchment area separated from the next watershed by topographic features like ridgetops (Bedell 1991).

As in other regions, watershed hydrology in the Silver Lake Watershed begins with climate. Local weather is largely influenced by the Cascade Mountains. The higher peaks of the watershed lie east of the Cascade Mountain Range within view of Crater Lake National Park and Mount McLoughlin. This mountain range lifts and blocks the maritime air masses that move eastward from the Pacific Ocean, inducing rain and snow to blanket its slopes. The watershed stands in the shadow of the Cascades, receiving leftover rain and snow, about 15-40 inches each year depending on elevation. The majority of precipitation falls as snow from October through March, with the highest elevations receiving the greatest depths and winter temperatures dropping below 0°F. Even during the summer, frost and snow may occur at these elevations. Convective thunderstorms provide rain in spring and summer, although the summer months are relatively dry. Higher elevation areas have a progressively shorter growing season, being significantly shorter above 6,500 feet elevation where ponderosa pine becomes less common. Rain and snow are captured by juniper and sagebrush along the lower scabland plateaus, by ponderosa pine in the lower to middle elevations, and by white fir, Shasta red fir, mountain hemlock and lodgepole forests in the upper elevations. Some of this intercepted water evaporates, while the remainder soaks into the soil. The best infiltration occurs when needles and leaves cover the soil, slowing surface runoff and allowing the water to enter the ground.

The Silver Lake Watershed, from Paulina Marsh to the north, Yamsay Mountain to the west, Brattain Ridge and Sycan Butte to the south, and Winter Ridge to the east, is characterized by gentle topography. The slope on 154,894 acres (92% of the area) is between 0 and 20%, while only 12,568 acres (8% of the area) have slopes over 20%. The few areas with steeper slopes occur along the canyons of Silver, West Fork Silver, Bridge and Buck Creeks, and along peaks and ridges such as Sycan Butte, Foster Butte and Hagar Mountain. Elevation ranges from approximately 4,400 to 7,840 feet with the majority of the watershed oriented either northeast or northwest.

The geomorphology of the Silver Lake Watershed is characterized by large volcanic eruptive centers – Yamsay Mountain shield volcano and northwest trending fault blocks (Winter Ridge) interspersed with conical or irregularly shaped volcanic piles (Sycan Butte, Hagar Mountain, Foster Butte). Most of the soil lying beneath the forest and shrub litter is derived from igneous rocks, which were ejected from small volcanoes and solidified from a molten state. The kinds of soils found in the watershed are the result of several factors, namely parent material, topography, climate, organisms, and time, which have interacted to produce five basic groups. These groups are different in their physical and chemical properties, and therefore, different in their susceptibility to erosion and compaction and their capacity for water infiltration.

The first group of soils is derived of alluvial materials; those materials transported and deposited by water, and occur along major streams, valleys, bottomlands and old lakebeds. Thompson Valley and the meadows along Silver Creek, West Fork Silver Creek, Guyer Creek, Bridge Creek, and Buck Creek possess these types of soil. Because they occur adjacent to moving water, they are highly susceptible to gully erosion and eventual downcutting.

The second group of soils is derived from basalt, andesite, and tuff parent materials, which are found on lava tablelands, volcanic eruptive centers, and block faults such as Winter Ridge. These soils are highly susceptible to compaction from management activities, which reduce infiltration and increase overland flow and erosion. They are one of the two dominant soil and rock type in the assessment area.

The third group of soils consists of rhyolite, a fine-grained and light-colored volcanic material, associated with dome-shaped volcanoes, such as Hagar Mountain along the northeastern portion of the watershed. These soils are susceptible to surface and gully erosion because of their loose, coarse texture and the steep landforms on which they occur.

The fourth group of soils is derived from rhyolite and consists of those formed in wind-carried Mazama ash and pumice deposits. They are primarily found in the southwestern portion of the watershed around Partin Butte. These areas have an ash or pumice layer over the buried rhyolite derived soils. Erosion risks from management activities vary from low to high, but gully erosion and displacement risks are moderate to severe depending on slopes.

The fifth group of soils also consists of those formed in wind-carried Mazama ash and pumice deposits and are the other dominant soil and rock type in the watershed (most occur at the middle-to-higher elevations of the watershed). These areas have an ash or pumice layer over the buried basalt/andesite derived soils. Erosion risks from management activities are low, but gully erosion and displacement risks are moderate to severe depending on slopes.

Overall, the primary sources of sediment within the watershed are associated with roads, past logging activities, and stream bank erosion. Roads are a primary concern as they are the link between sediment source areas and stream channels.

Riparian Vegetation and Stream Channels

Riparian Vegetation

Water which escapes interception and use from trees, shrubs, and grasses becomes surface or subsurface flow, eventually making its way through the soil to narrow strips of land called riparian areas along creeks and rivers and other bodies of water. Riparian areas occupy a small percentage of the watershed, about 5%, but are an extremely vital component of the landscape, especially in arid eastern Oregon (Elmore and Beschta 1987). Riparian vegetation found in these areas buffers the fluvial system from potential impacts and disturbances caused by land management activities and natural events. Because of their close proximity to water, plant species within riparian zones differ significantly from those of adjacent uplands. Found in riparian areas within the watersheds are a variety of sedges (*Carex* spp.), shrubs such as thinleaf alder (*Alnus incana*) and willow (*Salix* spp.), and deciduous trees such as aspen (*Populus tremuloides*) and black cottonwood (*Populus trichocarpa*). These riparian plants play a significant role in retaining water received from the uplands. The stems of these plants provide roughness and resistance to dissipate floodwater energy and act as a filter to trap sediment transported by the stream and to the stream (the sediment that is captured provides microsites for the germination and establishment of new plants within riparian areas). The strong root systems of these plants also provide resistance to a stream's erosive power, holding the soil mantle together, which minimizes stream bank erosion. By collecting sediment and stabilizing stream banks, riparian plant species act to maintain the integrity of riparian areas and elevate or maintain water tables. The increased subsurface flow, resulting from water storage in the riparian area, may be greater than the amount of water used by willow, cottonwood, alder, sedge, and rush (Elmore and Beschta 1987). In addition, low-gradient areas with willow attract beaver, resulting in impoundments that expand riparian zones and hold water, further ensuring stream flow during summer months (Olson and Hubert 1994). Conifer species such as ponderosa pine, white fir, and lodgepole pine also occur along the edges of the riparian areas and within active floodplains.

The major influencing factors affecting riparian conditions within the analysis area are associated with grazing, beaver trapping, fire suppression, and timber harvesting activities. Historical livestock grazing and beaver trapping has resulted in some degraded riparian areas. The widespread beaver trapping initiated changes in the hydrologic functioning of streams and riparian areas. Beaver dams, which maintain floodplains, dissipate stream energy, and deposit sediment, were not maintained and eventually failed. This caused stream energy to be confined to discrete channels, leading to channel erosion and downcutting. In addition, livestock were allowed to graze season long and with concentrated use in riparian areas. Improper livestock grazing, in itself, can change species composition and reduce or eliminate riparian vegetation and can degrade riparian areas through channel widening, channel aggrading, or lowering of the water table (Platts 1991). In 1915, Reginald Bradley, the Fremont National Forest Deputy Supervisor, described intense grazing which had downcut a once productive meadow in Lake County, Oregon:

> "Before this area was grazed, the whole of the flat, approximately 200 acres, was a fine 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." (Reginald 1915).

Although historical livestock grazing has resulted in riparian and stream channel degradation, current livestock numbers are considerably lower and most stream channels are steadily improving under present management. Additionally, fire suppression has affected the vegetative component of riparian areas by allowing encroachment of shade tolerant conifers into meadow, aspen, and willow communities. This, combined with livestock use, has reduced the ability of deciduous communities to compete for site resources and to regenerate in the low light conditions caused by conifer encroachment. There has also been extensive timber harvesting and associated activities within the assessment area, although harvesting along riparian areas has had a limited effect on the amount of shading and the number and type of large woody material in streams. All of these activities together have cumulatively influenced riparian areas within the watershed.

Stream Channels

Subsurface and overland flows make their way to the riparian area forming an intricate drainage network that eventually culminates into three main streams – Silver, Bridge and Buck Creeks. These channels can be classified into four basic stream types (Rosgen A, B, C and E) that vary in their size, shape, pattern and position in the landscape (see Rosgen stream type discussion in the Desired Conditions section) and are distributed amongst the three watersheds as follows: Silver Creek, 269 miles; Bridge Creek, 66 miles; and Buck Creek, 80 miles. Approximately 89 miles of these streams are perennial, thus flowing continuously throughout the year. Intermittent stream channels, ones that flow immediately after a storm event and replenish water tables or seeps, account for 234 miles. Finally, ephemeral channels are similar to intermittent types; however, the streambed dries up rapidly due to porous soils and a disconnection to saturated water tables (Black 1996). They account for the remaining 92 miles.

Since 1905, flow measurements have been recorded in Silver Creek with other instantaneous measurements taken for other streams within the assessment area. The highest mean flows for the major streams within the area occurs in May, produced by a mixture of rain and snowmelt within the watershed – estimated mean monthly flows during May for Silver, Bridge, and Buck Creeks (near the outlet of each watershed), are 125, 26, and 48 cfs, respectively. Conversely, the estimated mean monthly flow at these same locations in September, a low-flow month, are 23, 2, and 5 cfs, respectively. Streams originating on the western side of the assessment area, West Fork Silver, Bridge and Buck Creeks, have higher low-flows than those originating on the eastern portion, Benny and Squaw Creeks.

The level of stability in stream channels and riparian areas is defined as the balance between sediment deposition along banks (aggradation) and erosion/downcutting (degradation), influencing the integrity of riparian zones in the event of a major disturbance (DeBano et al. 1998). A healthy riparian area will buffer against disturbance, capturing sediments that may inundate streams, but even the most productive riparian areas have limitations and cannot withstand severe forms of disturbance. Under present conditions, intense upland erosion resulting from a catastrophic fire would be the most likely disturbance event in the Silver Lake Watershed Assessment Area.

Habitat for Aquatic Species

The watershed provides water that supports many beneficial uses, including: irrigation, livestock and wildlife watering and forage, road watering for dust abatement, wildlife habitat, hunting, fishing, water contact recreation, aesthetic quality, salmonid fish spawning and rearing, and resident fish and aquatic life. Of those listed, the primary uses include irrigation and those associated with habitat for aquatic species. Silver Creek, West Fork Silver Creek, North Fork Silver Creek, Guyer Creek, Bridge Creek, and Buck Creek are the primary perennial fish-bearing streams, with native redband trout (*Oncorhynchus mykiss*) and stocked brook trout (*Salvelinus fontinalis*) present. Brook trout were introduced into the system in the 1930's, and are now widespread. These streams are providing adequate habitat for aquatic species – the noted exceptions being those reaches with high stream temperatures and/or livestock impacts that are causing stream channel/riparian areas or habitat variables to be less than desirable. The majority of reaches surveyed have ample numbers of large woody debris and pools, which are both important habitat features needed for viable populations of fish. On the other hand, sediments exceeding the recommended threshold of fines in spawning gravels were found at several locations, indicating some possible negative effects on aquatic macroinvertebrates and embryo survival within the watershed. Also, stream temperatures were found to exceed state standards at numerous locations, mainly the lower ends of Silver, West Fork Silver, Bridge and Buck Creeks. Currently only two of these streams are listed, due to high stream temperature, on the State's "303(d)" list of water quality limited streams. Because stream temperature affects fish habitat, and is an important factor regulating aquatic life within these streams, it is considered to be a limiting factor that may be affecting fish populations. Increased width-to-depth ratios (larger surface area being heated) in stream channels are considered to be the primary cause of elevated temperatures, the extent of which is unknown. It is also unknown if State stream temperature standards can be achieved even under natural or desired riparian and stream channel conditions. Fish passage concerns are widespread throughout the watershed, and need to be addressed immediately to ensure habitat connectivity and genetic exchange. Overall, temperature, low flows, fish passage and sediment appear to be the dominant limiting factors for aquatic species.

Issues and Key Questions

Issues

A variety of issues arose during discussions surrounding the previously mentioned watershed processes. These include: concerns over the quantity of water used by increasing numbers of juniper and other overstocked conifer stands crowding the landscape, water which could be available for forage production and maintenance of stream flow; concerns with conifer encroachment into meadows and Aspen stands; concerns with roads and culverts and their effects on sediment delivery to streams and fish passage, respectively; concerns with riparian and stream channel conditions and whether these conditions provide suitable habitat for aquatic species; and concern over the ability to manage for viable populations of native trout, which can be used to indicate whether or not land management activities are ecologically sound.

Key Questions

The primary question arising from the discussion of these processes and issues is: *how can the watershed be managed to improve the capture, storage, and slow release of water, and improve water quality and fish habitat?* To answer this, four key questions were formulated which reflect the connection between uplands, riparian areas, stream channels, and native trout. These four questions will provide the basis of discussion and analysis of watershed and aquatic resources for the remainder of this document.

1) Is the upland portion of the watershed producing hydrological conditions (water and sediment outputs) which contribute to properly functioning riparian areas?

2) Is vegetation in riparian areas contributing to the appropriate channel types and hydrologic regime?

3) Are the channels providing adequate fish habitat?

4) How are the above watershed conditions influencing native trout viability?

Development of Desired Conditions

To address the four key questions, numerous individuals and representatives from natural resource agencies and institutions were contacted for advice and technical expertise about the most desirable watershed conditions. These included: Oregon State University, Oregon Department of Forestry, Oregon Department of Agriculture, Oregon Department of Environmental Quality, Izaak Walton League, USDA Natural Resources Conservation Service, USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, the National Riparian Team (NRT), and others. Council members used this information to give them a better understanding about the aspects of a healthy, functioning watershed. Desired conditions provide a target for private and public land managers to aim for as they conduct resource management activities across the landscape.

One of the first tasks was to inform and educate council members on the aspects of a healthy, properly functioning watershed. The most intensive learning experience for many of the Council members occurred when the National Riparian Team visited the watershed on September 16, 1999. Led by Wayne Elmore and Steve Leonard, the NRT is composed of individuals from the Bureau of Land Management and Forest Service who are dedicated to helping landowners across the western United States learn to identify proper functioning riparian areas. This visit was timely, as many of the Council members had just completed the riparian training, sponsored by the NRT, in Lakeview. During the first part of their visit, the NRT showed Council members slides of healthy riparian areas – narrow and deep streams channels that were lined with sedge and willow. They explained how these important riparian plants sink their roots deep into the banks, protecting them from the erosive power of high stream flows. In contrast, the team then showed examples of unstable stream/riparian areas – wide and shallow channels lined with Kentucky bluegrass and sagebrush with unstable stream banks that were susceptible to erosion even during the lower flow periods. By the end of the presentation, it became clear to all which stream/riparian area they desired to have on their land.

Following the presentation, Council members and the NRT traveled to several sites, such as Silver Creek on the Brown's Ranch and Buck Creek on the Pitcher Ranch, to utilize what they had just learned. This diverse group of individuals – composed of ranchers, hydrologists, range conservationists and biologists – walked along the stream banks at these sites discussing components of healthy stream channels and riparian plant communities. After examining each segment of stream, the group was asked to discuss and complete a checklist provided by the NRT to assess the functionality of stream/riparian conditions. Questions included such things as: was there an active floodplain? Were stream banks lined with a variety of species and age classes of riparian plants, enough to dissipate flood energies? Were gravel bars revegetating? Was the stream stable or downcutting? For each item, the group checked yes or no. From these responses, the group could determine the functioning condition of each segment of stream.

From then on, most of the discussion was focused on the terminology used to describe the ecological status of riparian areas, such as PFC (Proper Functioning Condition) and PNC (Potential Natural Community). Proper Functioning Condition, as described by the NRT and defined in Riparian Area Management: Process for Assessing Proper

Functioning Condition (USDI 1995, PFC manual), is described as meeting the minimum conditions for a riparian area to function properly. "Riparian areas are functioning properly when adequate vegetation, landform, or large woody debris is present to dissipate stream energy associated with high water flows, thereby reducing erosion and improving water quality; filter sediment, capture bedload, and aid floodplain development; improve flood-water retention and groundwater recharge; develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and support greater biodiversity." The NRT and PFC manual also discussed Potential Natural Community (PNC) – "the highest ecological status an area can attain given no political, social, or economical constraints" (USDI 1995). Realizing that PFC is not the end point in stream evolution, but near the mid-point along the continuum towards PNC, the Council members agreed that their desire is to have all streams and riparian areas meet minimum proper functioning conditions, then strive to get as close to PNC as is attainable under multiple-use management (desired or target condition). This concept would involve managing the watershed in a manner which is in harmony with the ecological processes of the area, thus resulting in enhanced water quality, fish habitat, and forage for livestock and wildlife.

In order to prevent confusion and provide consistency when describing other elements within the watershed, the Council chose to use terminology that was cooperatively designed by the US Forest Service and the US Fish and Wildlife Service. This terminology relates to PFC and PNC in the following ways. When a parameter is in its desired (target) condition, it is considered to be **functioning appropriately**. When a parameter is in a functional condition, but has an existing attribute that makes it susceptible to degradation, it is determined to be **functioning appropriately but-at-risk**; PFC lies somewhere on the continuum at/or between the Functioning Appropriately but-at-Risk rating and the Functioning Appropriately (desired or target condition) rating. A **functioning inappropriately** rating is given when a parameter is considerably less than its desired state or does not exhibit conditions of sustainability. The Council's overall goal is to manage for conditions that are **functioning appropriately**, meaning they are at their desired (target) condition, as close to PNC as is attainable under multiple-use management.

Based on these numerous discussions, the Council has developed desired conditions for the following parameters as they relate to the four key questions:

Uplands

Question 1 - a. Desired upland plant communities
b. Desired road density and soil conditions

Riparian Vegetation and Stream Channels

Question 2 - a. Desired riparian vegetation and bank stability
b. Desired stream characteristics (stream types)

Habitat for Aquatic Species

Question 3 - a. Desired amount of large woody debris
b. Desired pool numbers
c. Desired percentage of fines in spawning gravel
d. Desired stream temperature
e. Desired fish passage--culverts

Question 4 - a. Desired native trout viability

Chapter 3

Uplands

Chapter 3
Uplands

Key Question #1: Is the upland portion of the watershed producing hydrologic conditions (water and sediment outputs) that contribute to properly functioning riparian areas and stream channels?

A) Upland plant communities and their effect on the amount of water and sediment reaching riparian areas

In order to address this part of Question 1, survey crews and resource professionals collected current condition information across the three watersheds (Silver, Bridge and Buck Creek) so that an assessment of upland plant communities could be performed. The following methods were used to assess current conditions:

Forested stands with high canopy closure were located using satellite imagery available on the Fremont National Forest's Geographical Information System (GIS); due to data availability, canopy closure is used instead of leaf area index to quantify recovery. This information is provided because an increase in conifer densities may result in a loss of water available for stream flow during the dry summer months. As shown in the Desired Conditions section below, Fremont National Forest silviculturists described a range of presettlement canopy closures, the Historic Range of Variability (HRV) for various forest types, under which streams within the assessment area evolved. These include the following canopy closure values: 11-40% for ponderosa pine, 26-55% for mixed conifer (ponderosa pine and white fir), 41-70% for lodgepole pine, and 41-70% for white fir. This satellite imagery data was combined with the 1947 Timber Type Map to determine the amount of forested lands that currently have canopy closure exceeding the HRV values described above. Forested stands are considered hydrologically recovered, in terms of their water use and yield, when canopy closure reaches these reference condition ranges. Early-seral conditions, those forested lands in openings, mainly as seedling/sapling stands, were determined from the ISAT layer as well as the condition class and harvest layers available in GIS. This information was compared with aerial photographs to verify accuracy. The best information providing a baseline for seral stages comes from the 1947 Timber Type Map for Lake County, Oregon. This information has been digitized into a GIS coverage, and by reselecting those types listed as containing a large tree component, used to estimate the acreage of the original old growth pine stands that predominated on the landscape. By comparing this information with the current GIS old growth coverage, which has been field verified (1994-1999), a picture of the changes that have occurred during the past 50 years emerges.

Aspen locations were mapped based on past field reconnaissance by Forest personnel and private landowners. It is likely that this mapping does not identify all aspen within the assessment area, thus additional sites will need to be mapped and assessed for treatment. Current mapping does identify aspen stands as being either a high or low priority for treatment. It should be noted, however, that these priority ratings are based on anecdotal information and past field reconnaissance. Many of the areas identified for treatment as high priority include those stands that are in an over-mature or decadent condition with little regeneration present, or those clones that have been overtopped and out-competed by conifers.

Juniper plant communities were also mapped within the assessment area. On both private and BLM lands, areas of juniper were mapped utilizing orthophotos and aerial photos, while on Forest Service lands these areas were mapped based primarily on the ecoclass layer in the Forest's GIS system. The two juniper plant associations used to map areas of juniper are the juniper/bitterbrush/bunchgrass plant community and the ponderosa pine-juniper/mountain mahogany-bitterbrush-big sagebrush/fescue plant community (Hopkins 1979). The juniper/low sagebrush/fescue plant community was not included since it incorporates numerous acres of low sagebrush scabrock flats with few juniper trees present. It should be noted, however, that the juniper/low sagebrush areas with deeper soils do have an increased number of juniper trees, with continued expansion likely in the absence of fire. Using this information, juniper communities across the assessment area were classified as either high-density or low-density areas. The areas identified as high density are primarily those areas where juniper trees are crowding out shrubs and grasses and soil cover has been reduced (mid-to-late-seral stands). The areas identified as low density are primarily the early to mid-seral stands.

Current Conditions

Silver Creek Watershed: Within the 108,278 acre watershed, forested lands cover 83,842 acres or approximately 77% of the area. Conifers have encroached into many of the dry and moist meadows and aspen stands within the watershed. Aspen stands or scattered aspen occupy about 3,420 acres, while there are an estimated 6,834 acres of juniper/bitterbrush/bunchgrass or ponderosa pine-juniper/mountain mahogany-bitterbrush-big sagebrush/fescue plant communities, with encroachment of juniper occurring in the drier, deeper-soil pine sites.

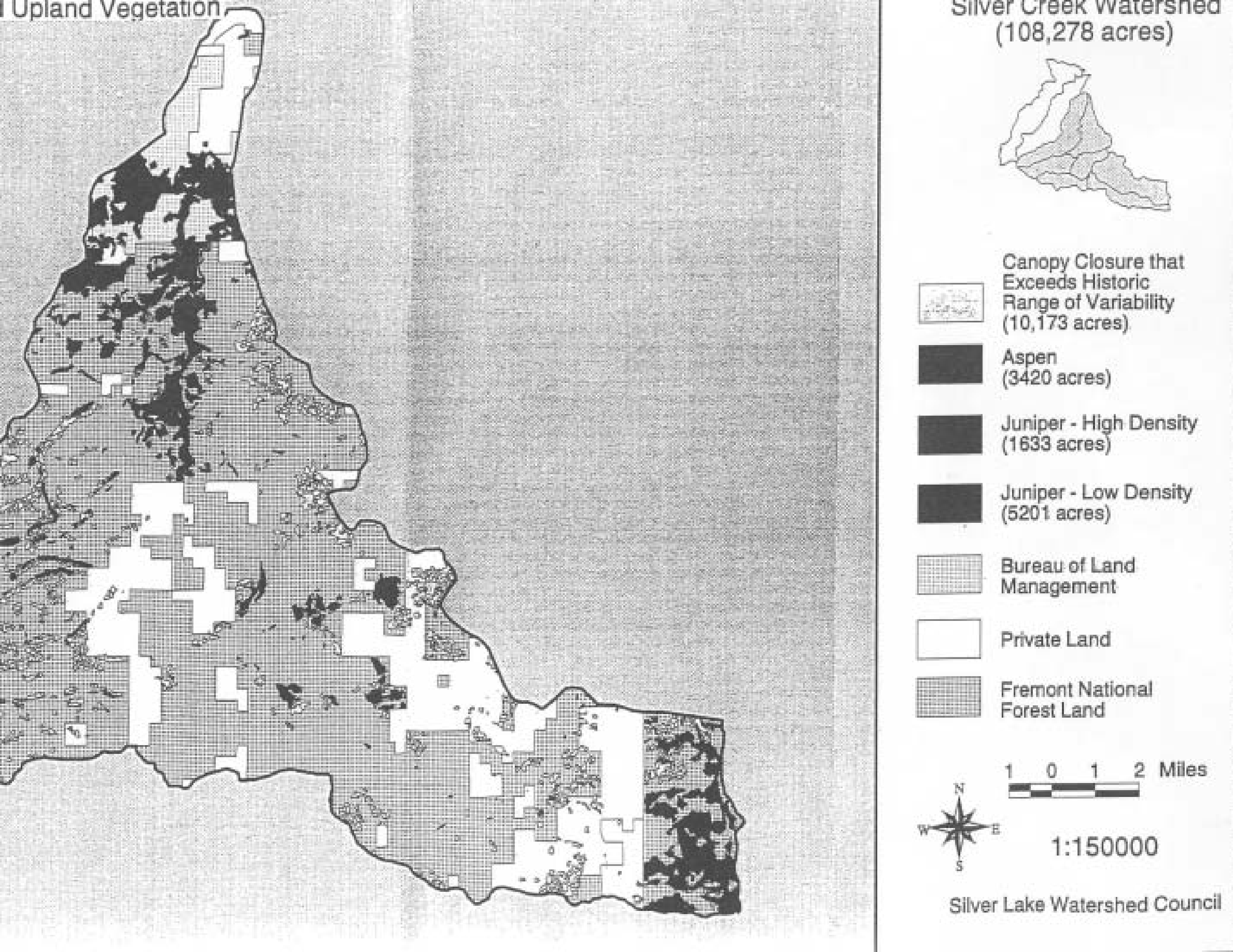
Of the forested acres, 13% or 10,744 acres have been determined to have canopy cover that exceeds HRV (refer to Figure 3.1 – Silver Creek Watershed Upland Vegetation). Conversely, about 5% (4,500 acres) of the forested lands, or 4% of the watershed, consists of forest openings, primarily as seedling/sapling sites. The private land, owned by US Timberlands Services, was harvested mostly in the 1970's and 1980's and is comprised of ponderosa pine and lodgepole pine plantations as well as other mixed conifer stands. Some of these plantations and/or stands, however, do have forest canopy closures that are within HRV. These forest sites are considered hydrologically recovered, in terms of their water use and yield, because the leaf area is sufficient to return transpiration rates to reference or historic conditions and canopy closure is sufficient to prevent rapid snowmelt.

Bridge Creek Watershed: Within the 25,940 acre watershed, forested lands cover 14,980 acres, approximately 58% of the area. Conifers have encroached into many of the dry and moist meadows and aspen groves within the watershed. Aspen stands and scattered aspen (< 20% aspen) are found throughout the watershed, occupying about 244 acres. There are an estimated 4,435 acres of juniper/bitterbrush/bunchgrass or ponderosa pine-juniper/mountain mahogany-bitterbrush-big sagebrush/fescue plant communities, with encroachment of juniper occurring in the drier, deeper-soil pine sites.

Nineteen percent, or 2,817 acres of the forested areas, have canopy closure that exceeds HRV (refer to Figure 3.2 – Bridge Creek Watershed Upland Vegetation). Much of the private land owned by US Timberlands Services was harvested in the late 1970's and early 1980's and is comprised primarily of ponderosa pine plantations that are in early-to-mid seral (sapling-pole) condition, but are still considered to have forest canopy closures outside the HRV values. A few of the areas, on both private and Forest Service lands where much of the overstory has been removed, are considered hydrologically recovered in terms of their water use and yield because the leaf area is sufficient to return transpiration rates to reference or historic conditions and canopy closure is sufficient to prevent rapid snowmelt. About 17% (2,600 acres) of the forested lands, or 10% of the watershed, consists of forest openings, mainly seedling/sapling sites.

Buck Creek Watershed: Within the 33,244 acre subwatershed, forested lands cover 18,239 acres or approximately 55% of the watershed. As in the other two watersheds, conifers have encroached into many of the dry and moist meadows and aspen stands throughout the watershed. Aspen or cottonwood stands are found occupying about 135 acres of the watershed, while there are an estimated 10,688 acres of juniper/bitterbrush/bunchgrass or ponderosa pine-juniper/mountain mahogany-bitterbrush-big sagebrush/fescue plant communities, with encroachment of juniper occurring in the drier, deeper-soil pine sites.

Of the forested acres, 15%, or 2,795 acres, have been determined to have canopy closure that exceeds HRV (refer to Figure 3.3 – Buck Creek Watershed Upland Vegetation). Approximately 6% (1,050 acres) of the forested lands, or 3% of the watershed, are in openings, primarily as seedling/sapling sites.



Upland Vegetation
Silver Creek Watershed
(108,278 acres)
Canopy Closure that Exceeds Historic Range of Variability (10,173 acres)
Aspen (3420 acres)
Juniper - High Density (1633 acres)
Juniper - Low Density (5201 acres)
Bureau of Land Management
Private Land
Fremont National Forest Land
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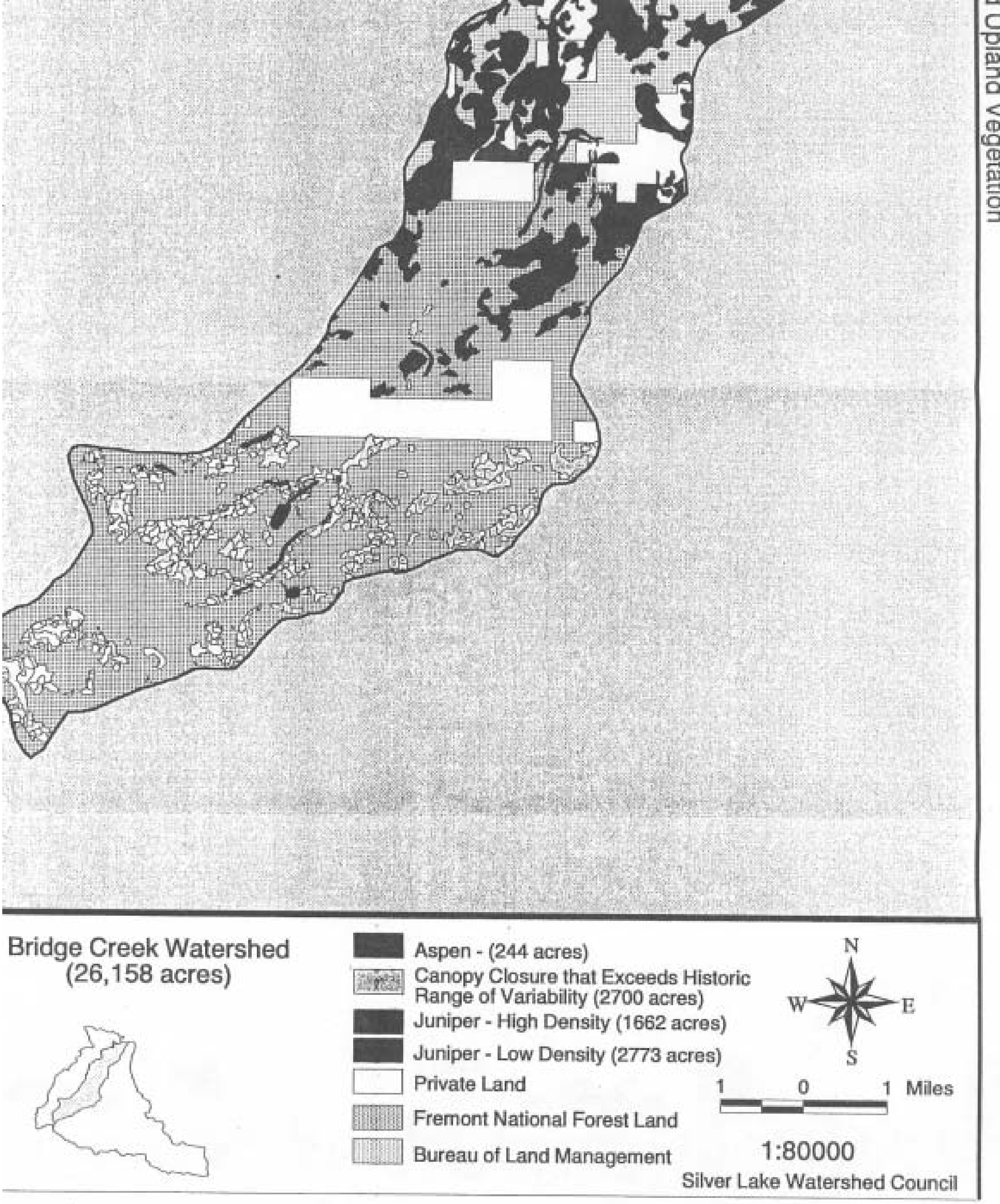
Silver Lake Watershed Council


d Upland Vegetation
Bridge Creek Watershed
(26,158 acres)
Aspen - (244 acres)
Canopy Closure that Exceeds Historic Range of Variability (2700 acres)
Juniper - High Density (1662 acres)
Juniper - Low Density (2773 acres)
Private Land
Fremont National Forest Land
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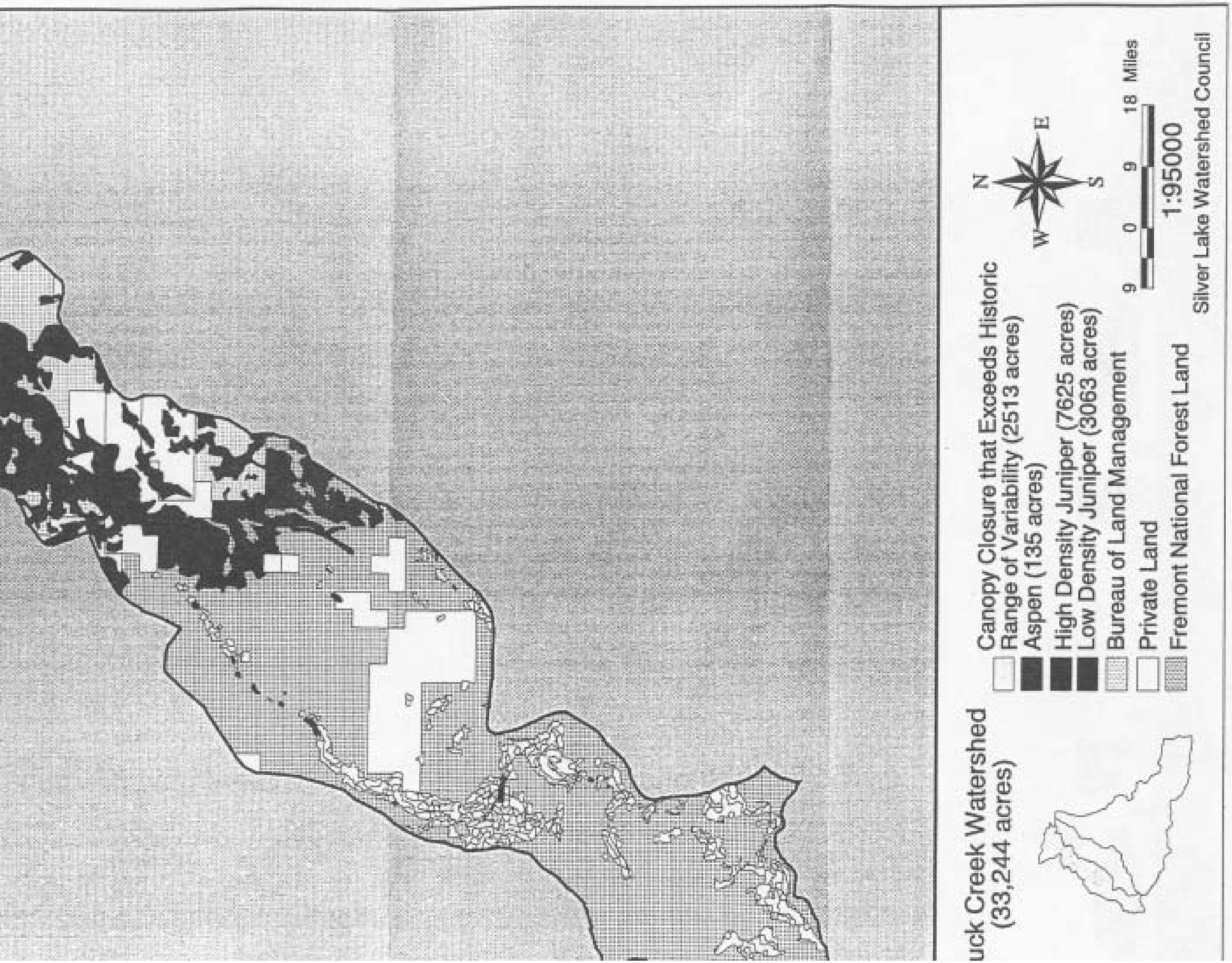
uck Creek Watershed
(33,244 acres)
Canopy Closure that Exceeds Historic Range of Variability (2513 acres)
Aspen (135 acres)
High Density Juniper (7625 acres)
Low Density Juniper (3063 acres)
Bureau of Land Management
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Silver Lake Watershed Council

Desired Conditions

Of the upland plant communities, the primary focus is conifers as they influence the amount of precipitation available for subsurface flow into riparian areas, particularly during the summer months – the period of low flows. In such an arid environment, water becomes scarce during the summer so low flows become important for maintaining riparian and aquatic habitat, and water for irrigation, wildlife, and livestock. Low precipitation, reduced drainage from soil and bedrock, and sustained high evapotranspiration are factors affecting the amount of available water.

Upland conifers intercept and evapotranspirate incoming rain and snowfall – that is, they evaporate the precipitation that is intercepted on stems and leaves and transpire water that is absorbed through the roots. Precipitation that is not evapotranspired becomes water yield available to ground water reserves, streams, and lakes. Bassman (1985 and 1988) provided information on the water use of ponderosa pine, mixed conifer, and lodgepole pine, the major forest types in the Silver Lake Watershed. Data referring to juniper was acquired from Bedell et al. (1993). These are listed below along with water yields – the water left over which is absorbed into the soil and available for grasses, shrubs, and subsurface flow. Refer to Table 3.1.

Table 3.1 - Conifer Species and Associated Water Yield

Conifer Species	Annual Precipitation	Evapotranspiration Rate	Estimated Water Yield	% of Annual Precip. Resulting in water yield
Juniper	11-18" (14.5" ave.)	12"	2.5"	17%
Ponderosa Pine	18-30" (24" ave.)	16"	8"	33%
Mixed Conifer	20-35" (27.5" ave.)	17"	10.5"	38%
Lodgepole Pine	25-35" (30" ave.)	17"	13"	43%

The expansion of juniper within the watershed has become a major concern, as these trees were historically restricted to rocky hillsides, ridges and outcrops due to periodic fire. The primary concern with their expansion, from a watershed perspective, is that juniper trees are able to use water in the early spring before other plants begin to grow, and throughout the summer they will continue to draw water when ponderosa pine shut their stomata and discontinue water use. A juniper tree 18 inches in diameter at its base can transpire 30 to 40 gallons per day if adequate soil moisture is available during the summer. Because juniper has the ability to use such large amounts of water, it reduces available water for nearby plants. This lowers shrub and grass density, soil cover, and infiltration rates. It also increases nutrient loss, overland flow, and soil erosion, often resulting in a reduction of site productivity (Bedell et al. 1993). For all of the above reasons, an increase in conifer densities results in a loss of water available for stream flow during the dry summer months. To determine the conifer densities under which the Silver Lake Watershed streams evolved, Fremont National Forest silviculturists described a range of presettlement canopy closures – or the Historic Range of Variability (HRV) for various forest types. These include the following range of canopy closures: 11-40% for ponderosa pine, 26-55% for mixed conifer (ponderosa pine and white fir), and 41-70% for lodgepole pine and white fir. Where feasible, returning canopy closures to HRV is desired, as is lessening the impacts of juniper in the watershed.

The non-forest plant communities described in the uplands include the following: Bluegrass-Dry Meadow, Hairgrass-Sedge-Moist Meadow, Sedge-Wet Meadow, Big Sagebrush/Bunchgrass, Juniper/Low Sagebrush/Fescue, Low Sagebrush/Fescue-Squirreltail, Low Sagebrush/Bluegrass-Onespike Oatgrass, Ponderosa Pine/Bitterbrush/Fescue, Ponderosa Pine-Juniper/Mountain Mahogany-Bitterbrush-Big Sagebrush/Fescue, Ponderosa Pine-Quaking Aspen/Bluegrass, and Ponderosa Pine/Mountain Big Sagebrush/Bluegrass (Hopkins 1979). Of particular interest are the three meadow types because they are primary water storage sites, tucked away in the bottom of almost every small basin throughout the watershed and the sources of many headwater streams. Tree densities in the surrounding catchment area influence the amount of water collected and stored in these meadows. Conifer encroachment within these meadows is a concern and does not aid in moving these areas towards their desired condition.

Fire in the uplands is essential in maintaining desired upland vegetation. The integrity of the above vegetation types (HRV forest types) and associated flow regimes are dependent on low intensity fires. These low intensity fires promote ecosystem stability because fuel levels are kept at a minimum, reducing the possibility of a catastrophic fire (Agee 1990). For pure ponderosa pine sites in a nearby watershed, the Upper Chewaucan Watershed, a fire return interval of 11 years was documented (Miller 1997). Mixed conifer sites, characterized by ponderosa pine and white fir, had fire intervals up to 30 years (Agee 1990). These frequent and low intensity ground fires maintained vast stands of open ponderosa pine forests, leaving a fuel gap between the overstory and ground. In the Silver Lake Watershed, it is estimated that these historical fire intervals maintained about 70-95% of the forested stands in a late-seral condition (mature and old), with roughly 5-15% being in a mid-seral condition (young and mid-aged), and the remaining 5-15% in openings and early-seral condition. Thinning stands to enable the reintroduction of prescribed fire would help return the watershed to more historic stand conditions.

When natural fire regimes are excluded and canopy cover increases, forested communities become susceptible to catastrophic fire. The removal of large areas of conifer by wildfire or timber harvesting has the potential to increase the amount of runoff and change the stream flow regime. Research has shown detectable changes in stream flow when 20 to 30% of a watershed is in a cutover (early-seral) condition (Troendle 1982; Troendle and Leaf 1981). For this analysis, forested lands in a cutover condition are those areas in openings, mainly as seedling/sapling stands. Further, when high intensity fires consume vegetation and forest ground cover, erosion increases (McNabb and Swanson 1990). Mass erosion into streams after a wildfire can overwhelm the channel with more sediment than local stream flows are able to transport and deposit onto floodplains, resulting in high levels of sediment in spawning gravels (Swanston 1991).

Desired Upland Vegetation:

Functioning Appropriately - Forested communities are within recommended canopy closures, and/or openings (early seral condition) account for approximately 5-20% of the subwatershed; meadow and other upland communities have little or no conifer encroachment. ***This is the desired (target) condition.***

Functioning Appropriately but-at-Risk - Less than 50% of forest communities are outside recommended canopy closure ranges, and/or openings (early seral condition) account for approximately 20-30% of the watershed; meadows and other upland communities have experienced conifer encroachment.

Functioning Inappropriately - Over 50% of forested communities are outside recommended canopy ranges and/or openings (early seral condition) account for more than 30% of the watershed; the majority of meadow and other upland communities have a high level of conifer encroachment.

Summary and Synthesis for the entire Silver Lake Watershed Assessment Area

Within the 167,462-acre watershed assessment area, forested land covers 117,061 acres, approximately 70% of the watershed. The frequent and low intensity ground fires that maintained vast stands of open ponderosa pine forests have been suppressed since the early 1900's. This has created conditions that allow conifers to grow in greater densities than occurred historically in both forested and meadow sites. Of the forested acres, 14% or 16,356 acres have canopy densities exceeding the Historical Range of Variability (HRV) (Refer to Figures 3.1, 3.2, and 3.3). As mentioned in the desired conditions section, when less than 50% of forested communities are outside recommended canopy closures, the forest stands are either functioning appropriately or functioning appropriately but-at-risk. All three watersheds are below 20% (Silver Creek 13%, Bridge Creek 19%, and Buck Creek 15%).

In addition, past silvicultural treatments emphasized either clear-cutting of lodgepole and ponderosa pine or selective removal of individual large ponderosa pine. Because these treatments were not based on maintaining forested stands within their HRV, they are a contributing factor to current conditions. The seedling/sapling stands are a result of forested areas that were harvested through clear-cutting, shelterwood, and seed-tree silvicultural prescriptions. Approximately 7% (8,150 acres) of the forested lands within the watershed are in openings – mainly as seedling/sapling sites – which is below the 20% recommendation for the Silver Lake Watershed and the 20-30% figure noted by Troendle (1982), the point where a significant change in flow can be detected. As mentioned in the desired conditions section, when less than 20% of forested lands are in openings (early seral condition), the forest stands are considered to be functioning appropriately. All three of the watersheds forested lands meet this condition – Silver Creek 5%, Bridge Creek 17%, and Buck Creek 6% – and are thus functioning appropriately.

As mentioned earlier in this chapter, the best information providing a baseline for seral stages comes from the 1947 Timber Type Maps. This information can be compared with the current old growth coverage in order to determine the magnitude of change that has occurred in the past 50 years. A summary of the basic data is shown in Table 3.2 below.

Table 3.2 – Old Growth and Core Old Growth in the Silver, Bridge and Buck Creek Watersheds

Type	1947 Timber Type	Current Old Growth
Sugar Pine (large)	644 acres	None Shown
Ponderosa Pine (large)	88,074 acres	6,116 acres
Pine Associated	None Shown	4,108 acres
Lodgepole Pine (large)	None Shown	2,965 acres
Mountain Hemlock	None Shown	1,210 acres
Total Old Growth	88,718 acres	14,399 acres
Total Core Old Growth	41,898 acres (47% of total)	752 acres (5% of total)

The Fremont National Forest has never mapped the late seral stage in any of the forested types. It has mapped the old seral stage using Region 6 definitions for old growth for Ponderosa Pine, Lodgepole Pine, and White Fir prepared by Hopkins 1992. The lack of information on the late seral stage represents a data gap in this analysis. However, based on the high level of agreement between the current ecoclass layer and the types in the 1947 Timber Type Map, the change in historical old growth conditions can be compared to current old growth conditions with a high degree of certainty. From the data and inspection of current stand conditions it can be concluded that the ponderosa pine forested types are below the historical range of variability (HRV) for the old growth type. This conclusion is based on the age classes of the understory vegetation that are not presently old enough to have been a significant component of the pre-1900 stands. Hopkins describes old growth ponderosa pine stands (pre-1900) as having approximately 20-30 trees per acre in the 17-inch and larger diameter classes with fewer than 5 seedlings per acre and less than one down log per acre. Numerous spike-topped trees occurred in these stands. Examination of old photographs tends to confirm that the pine stands were composed of single-storied large tree overstorys with few seedlings and saplings in the understory. Fire suppression since the turn of the century and logging practices post 1947 provided the soil conditions and absence of thinning fires that promoted development of an early-to-mid-seral dense understory of pine and white fir across the landscape. Lodgepole pine stands are at or above the historic range of variability for late condition as compared to the 1947 timber types. This would be expected in areas where fire suppression has been effective. The Sierra Lodgepole pine, upon reaching the age of 120-150 years, generally is thinned from above by Mountain Pine beetles. In the absence of fire, these trees tend to remain as snags for 11-20 years and then collapse into tangled jackstrawed down wood. Such conditions provide excellent habitat for several species of woodpeckers and American marten. Core old growth, defined here as old growth stands with an internal 600-foot buffer, declined dramatically from 41,898 acres in 1947 to 752 acres at present. The 600-foot internal buffer represents an estimate of the conditions required to prevent invasive predatory species from incursions into nesting sites of species requiring old growth for reproduction. In percentages of the types, this means that in 1947 approximately 47% of the old growth existed in internally buffered cores, while today only 5% of the total remaining old growth has such protected cores and represents only 1.7% of the original protected core (Wooley, 2001).

In summary, fire suppression over the last 100 years has allowed young conifers to grow in higher densities than occurred historically. This build up of understory trees heightens the risk of catastrophic fire, and may cause trees to become stressed and susceptible to insects, disease, and density-related mortality. Conifers have also expanded into many of the dry and moist meadows and riparian areas throughout the watershed, promoting competition with riparian vegetation – willows, aspen, cottonwood, and alder – necessary to maintain proper stream types and bank stability. In the northern portion of the watershed, junipers are slowly expanding into the drier, deeper-soil pine sites. All of these factors may be contributing to lower base flows within the watershed, but the extent is unknown. Additionally, the effects of management activities on soil resources (site productivity) has been fairly extensive throughout the watershed, a result of past timber harvest activities. Associated with these activities were silvicultural treatments that moved forest stands away from HRV. For all these reasons, the upland vegetation element receives a *functioning appropriately but-at-risk* rating for the entire Silver Lake Watershed assessment area, and for each of the three individual watersheds.

B) Roads and soil impacts, and their effect on the amount of sediment and water reaching riparian areas

In order to address the second part of Question 1, survey crews and resource professionals collected current condition information across the three watersheds, Silver, Bridge, and Buck Creeks, so that an assessment of the effects of roads and adverse soil conditions within these watersheds could be performed. The following methods were used to assess current conditions:

> Roads account for most of the sediment problems in a watershed because they are a link between sediment source areas (skid trails, landings, and cutslopes, etc.) and stream channels. They directly affect the channel morphology of streams by accelerating erosion and sediment delivery and by increasing the magnitude of peak flow (Furniss et al. 1991). Current road locations, densities, and crossings were acquired from the Fremont National Forest GIS road layer. Road crossings were identified from GIS and checked for accuracy. Those crossings determined to be "non-existent" were deleted.
>
> Rosgen (1991) has developed a Road Impact Index, which is a qualitative indicator of sediment delivery risk associated with road density and the number of stream crossings. This index will be used for this assessment (only on a subwatershed basis) and relies on the following formula: Road Impact Index = (acres of road within the subwatershed / acres within the subwatershed) * the number of stream crossings. This method is based on the following assumptions: 1) the higher the road density the higher the potential for sediment yield increases due to the larger acreage of exposed surfaces, 2) the more drainage ways that are crossed the higher probability that direct sediment introduction will occur, and 3) the higher on the slope that the road is from the drainage network, the less probability for delivered sediment to occur (erosion may occur but is less likely to be routed to the stream).
>
> Wemple (1994) focused on the interaction of forested roads with stream networks in Western Oregon and found that nearly 60% of the road network drained into streams and gullies, and are therefore, hydrologically integrated with the stream network. The 60% figure, from Wemples study, will be used in this analysis to estimate the percent increase in drainage network efficiency for each subwatershed. Closed roads are considered to contribute to the overall drainage efficiency and are therefore included.
>
> Data was collected on current disturbances (soil impacts) within the assessment area. The intent of this evaluation was to determine the extent of all lands in an adverse condition. This included all roads, landings, spur roads, and skid trails as well as lands detrimentally compacted, puddled, displaced, or eroded. All three watersheds were mapped as follows: Light/Moderate – adverse impacts occur on less than 20% of the area; and High – adverse impacts occur on more than 20% of the area. In addition, four timber sale harvest units were intensively monitored to determine prior impacts. Two even-aged and two uneven-aged units within the Silver Creek Watershed were sampled with random transects. Results were 31% and 45% for the even-aged units, and 41% and 36% fir the uneven-aged units. All four of the sample sites were within areas that were mapped as "High", having been impacted more than 20%. Although limited in scope, these intensive monitoring results tend to support the evaluation of current soil disturbances over the entire watershed.

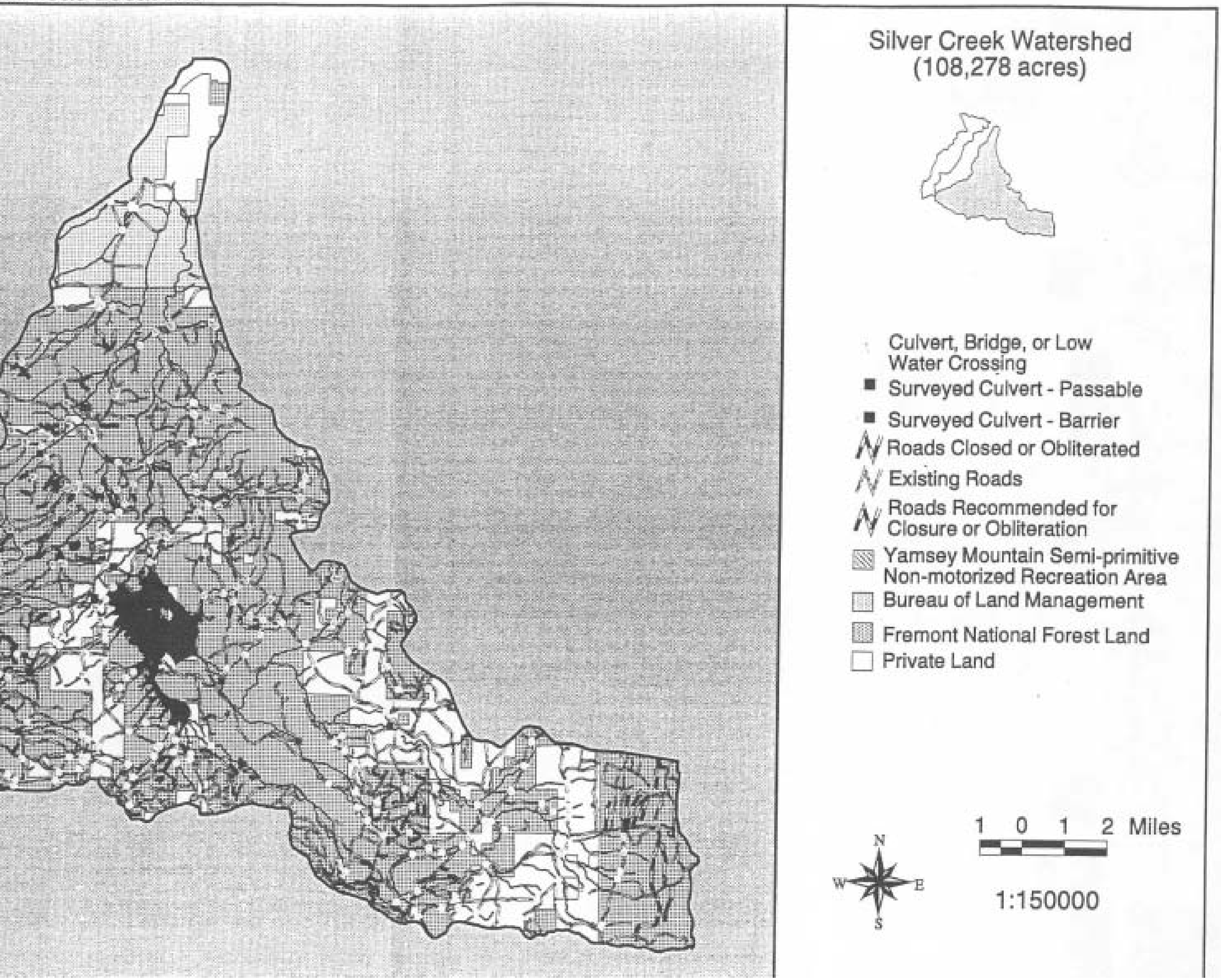
Current Conditions

Silver Creek Watershed: In 1995, there were 611 miles of road within this watershed equating to a road density of 3.6 mi/mi². Over the past six years, the Silver Lake Ranger District has decommissioned approximately 60 miles of roads, nearly 10% of the roads within the watershed, in order to reduce road densities and the negative influence of roads on hydrology and water quality. Currently, there are 551 miles of roads within the watershed, which results in a road density of 3.3 mi/mi² (refer to Figure 3.4 – Silver Creek Watershed Road Locations). Of these roads, seventy miles or 13% are within 300 feet of perennial and intermittent streams. Furthermore, roads cross channels at 274 locations, sites where direct sediment introduction occurs. Based on the above numbers, the Road Impact Index was calculated to be 0.49. Along with the 269 miles of stream channels, an estimated 331 of the 551 miles of roads are hydrologically integrated with the stream network, thus increasing the drainage network by 123% – using Wemple's (1994) study results. In addition, the effects of management activities on soil resources has been fairly extensive within the watershed, a result of past timber harvest activities – about 57% of the lands within the watershed are mapped as having "high" soil impacts (adverse impacts which occur on more than 20% of the area).

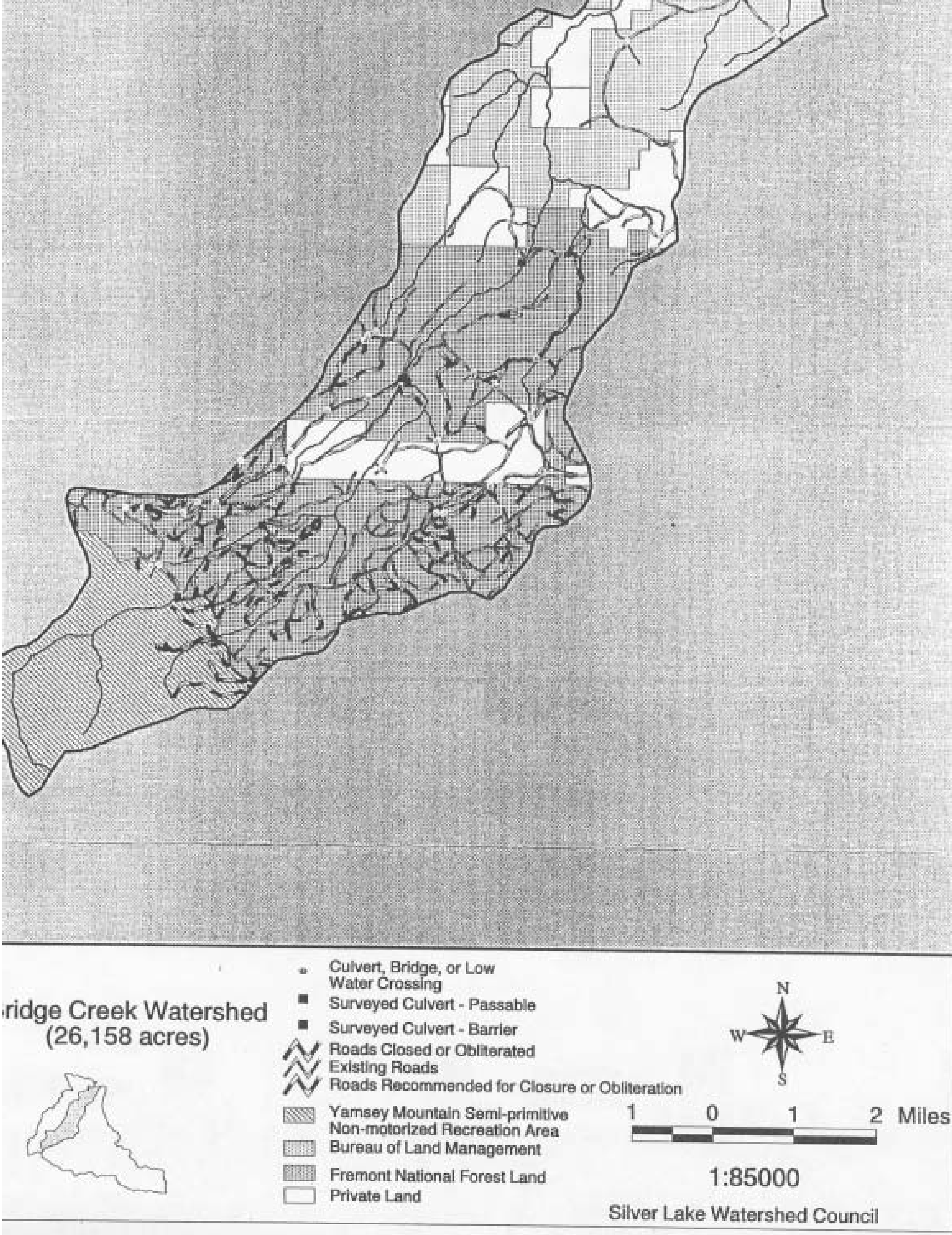
Bridge Creek Watershed: In 1995, there were 124 miles of road within this watershed equating to a road density of 3.1 mi/mi². Over the past six years, the Silver Lake Ranger District has decommissioned approximately 11 miles of roads, nearly 9% of the roads within the watershed, in order to reduce road densities and the negative influence of roads on hydrology and water quality. Currently, there are 113 miles of roads within this watershed, which results in a road density of 2.8 mi/mi² (refer to Figure 3.5 – Bridge Creek Watershed Road Locations). Of these roads, twenty miles or 18% are within 300 feet of perennial and intermittent streams. In addition, roads cross channels at 51 locations, sites where direct sediment introduction occurs. Based on the above numbers, the Road Impact Index was calculated to be 0.48. Along with the 66 miles of stream channels, an estimated 68 of the 113 miles of roads are hydrologically integrated with the stream network, thus increasing the drainage network by 103% – using Wemple's (1994) study results. In addition, the effects of management activities on soil resources has been fairly extensive, a result of past timber harvest activities throughout the watershed. About 35% of the lands within the watershed are mapped as having "high" soil impacts (adverse impacts which occur on more than 20% of the area).

Buck Creek Watershed: In 1995, there were 101 miles of road within this watershed equating to a road density of 2.0 mi/mi². Over the past six years, the Silver Lake Ranger District has decommissioned over 5 miles or 5% of roads within the watershed in order to reduce road densities and the negative influence of roads on hydrology and water quality. Currently, there are 96 miles of roads within this watershed, leading to a road density of 1.9 mi/mi² (refer to Figure 3.6 – Buck Creek Watershed Road Locations). Of these roads, seventeen miles or 18% are within 300 feet of perennial and intermittent streams. At 50 locations throughout the watershed, roads cross channels, sites where direct sediment introduction occurs. Based on the above numbers, the Road Impact Index was calculated to be 0.32. Along with the 80 miles of stream channels, an estimated 58 of the 96 miles of roads are hydrologically integrated with the stream network, thus increasing the drainage network by 72% – using Wemple's (1994) study results. In addition, the effects of management activities on soil resources has been fairly extensive, a result of past timber harvest activities throughout the watershed – about 26% of the lands within the watershed are mapped as having "high" soil impacts (adverse impacts which occur on more than 20% of the area).

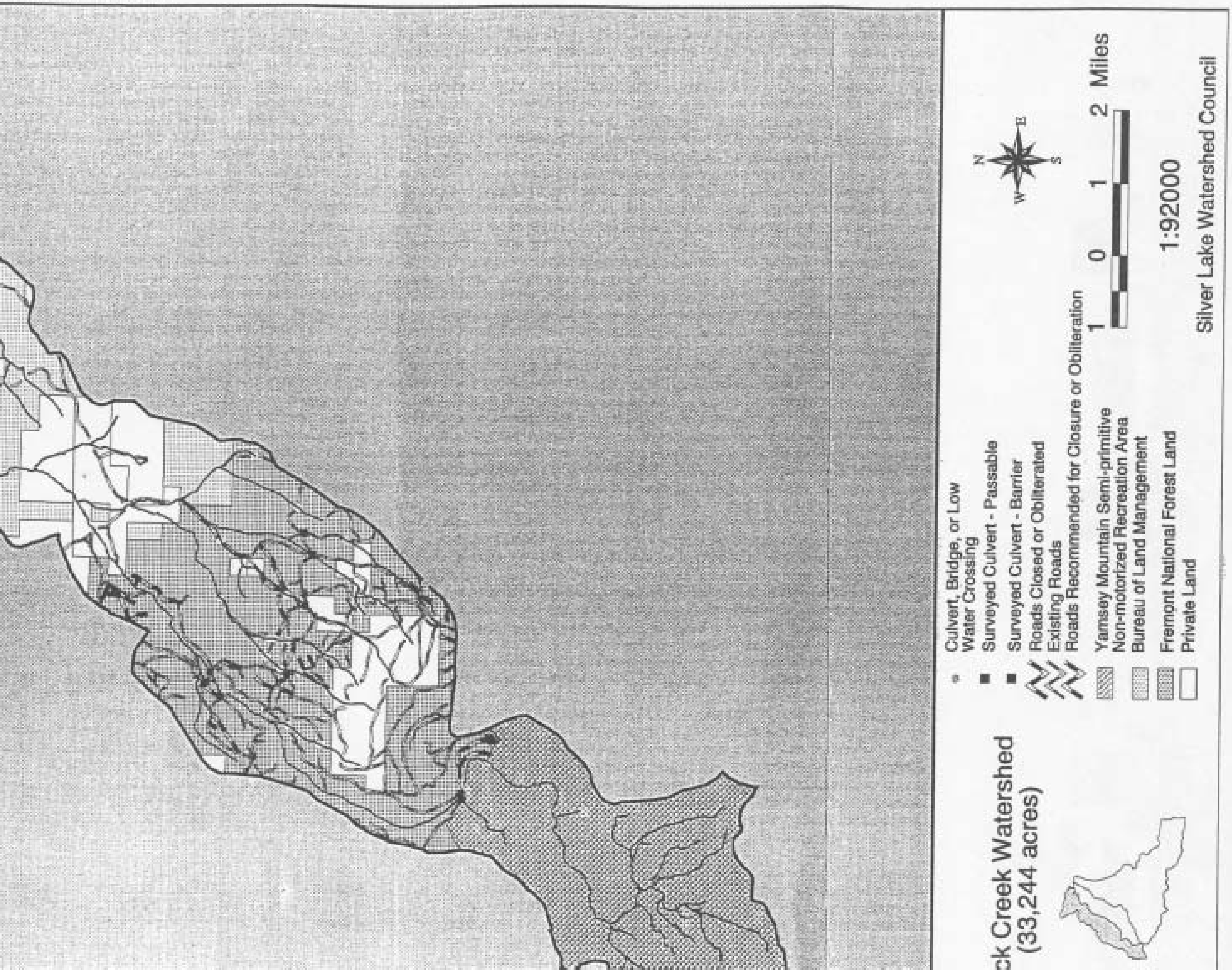
ed Road Locations



…ied Culvert and Road Locations



Road Locations



Desired Conditions

Roads directly affect stream and riparian areas by accelerating erosion and sediment loadings, altering channel morphology, modifying natural drainage networks, and changing runoff characteristics in watersheds. Roads account for most of the sediment problems in a watershed because they are a link between sediment source areas (skid trails, landings, and cutslopes, etc.) and stream channels. They directly affect the channel morphology of streams by accelerating erosion and sediment delivery and by increasing the magnitude of peak flows (Furniss et al. 1991). Wemple (1994) focused on the interaction of forested roads with stream networks and found that nearly 60% of the road network drained into streams and gullies, and are therefore, hydrologically integrated with the stream network. Sediment entering streams from roads is delivered by mass soil movements, surface erosion, failure of stream crossings, and accelerated scour at culvert outlets (Furniss et al. 1991). Further, a study on the Medicine Bow National Forest showed that fine sediment increased as culvert density increased (Eaglin 1991).

To reduce the adverse effects of roads on aquatic resources, road miles should be progressively decreased through permanent closure or obliteration (decommissioning) in watersheds with high (1.7 - 4.7 road mi/mi^2) and extreme (>4.7 road mi/mi^2) road densities (Interior Columbia Basin Ecosystem Management Project (ICBEMP) 1997). A study of eroded material travel distances below fill slopes shows that more than 95% of relief culverts can be prevented from contributing sediment to streams if the travel distance from the culvert outlet to the stream is 300 feet or more. Roads that utilize broad-based dips, instead of culverts, for drainage have nearly 100% of the contributing eroded material stopped within a travel distance of 100 feet of the road prism (Burroughs and King 1989). As a result, INFISH (1995) recommends buffer strips of 300 feet between riparian areas and roads. Also, maintaining a buffer between the road and stream channel provides a filter that minimizes the introduction of fine sediment into the stream channel.

Desired Road Densities:

Functioning Appropriately - Road density less than 1.7 mi/mi^2, and high soil impacts occur on less than 20% of the watershed. ***This is the desired (target) condition.***

Functioning Appropriately but-at-Risk - Road density of 1.7 - 4.7 mi/mi^2

Functioning Inappropriately - Road density greater than 4.7 mi/mi^2.

Summary and Synthesis for the entire Silver Lake Watershed Assessment Area

Even though 76 miles of road have been obliterated within the assessment area over the past six years, there are still 760 miles of roads within the 167,462 acre watershed assessment area, most of which were constructed to provide access for recreation and the vast timber resources within the area. This results in a road density of 2.9 mi/mi^2, and consequently the watershed is **functioning appropriately but-at-risk** (refer to Figures 3.4, 3.5, and 3.6). The three watersheds have similar road densities ranging from 1.9 mi/mi^2 in the Buck Creek Watershed to 3.3 mi/mi^2 in the Silver Creek Watershed, well below the high end of the functioning appropriately but-at-risk range. Thus, all three individual watersheds are **functioning appropriately but-at-risk**. Along with the 415 miles of stream channels within the Silver Lake Watershed, an estimated 456 of the 760 miles of roads are hydrologically integrated with the stream network, thus increasing the drainage network by 110% – based on Wemple's (1994) study results. Two of the watersheds have increased drainage networks that are below this value – Bridge Creek (103%) and Buck Creek (72%). The remaining watershed is above this value – Silver Creek (123%).

The limited stream gage data available for the Silver Lake Watershed indicates that annual peak discharge is dominated by runoff from spring snowmelt with peaks occurring in April and May, although instantaneous peak flows can occur as a result of rain on snow events in December and January. The lack of long-term stream flow data (limited to the site on Silver Creek, which receives regulated flows from Thompson Reservoir) precludes analysis of changes in stream flows due to land management activities within the analysis area. However, current literature suggests that land management activities – like those that have occurred in the Silver Lake Watershed – may alter the timing, magnitude, and frequency of peak flows. In order to see if a similar suggestion could be made locally, data from a nearby watershed with extensive stream flow records, the Upper Chewaucan River Watershed, were analyzed. Analysis of this data does seem to suggest that the effects of land management activities (increased drainage network from roads and detrimental soil compaction) have increased the number of days the Chewaucan River exceeds bankfull flows. Table 3.3 displays the comparison of data summarized from the gauging station on the Chewaucan River during the periods of 1926-1945, the time period of record prior to extensive road building and timber harvesting activities and 1946-1989, the period during, and after, extensive road building and timber harvesting activities. This table displays that the number of days the river exceeds bankfull stage is significantly higher during the latter period of time.

Table 3.3 - Bankfull flows for Average Precipitation Years on the Chewaucan River.

Year	Precipitation (Average)	Days per Year within the Range of 80% to 120% Bankfull (Average)	Days per year exceeding 120% Bankfull (Average)	Days per year exceeding Bankfull (Average)
1926-1945	14.91	22	1	8
1946-1989	14.89	18	12	20

This information is included as road densities, as well as levels of past timber harvesting activities, within the Silver Lake Watershed are quite similar to those in the Upper Chewaucan. Thus, it is believed that the effects of the increased drainage network throughout the Silver Lake Watershed, from roads and detrimental soil compaction, have modified the timing, magnitude, and frequency of peak flows, but the extent is unknown. Thompson Reservoir complicates the analysis because it has modified both peak and low flows within Silver Creek.

Besides altering peak flows, roads also increase sediment delivery into streams. Of the 760 miles of roads, 107 (14%) are within 300 feet of perennial and intermittent streams. Furthermore, roads cross channels at 375 locations, sites where direct sediment introduction occurs. Based on the weighted average for the subwatersheds, the Road Impact Index was calculated to be 0.46. Road Impact Index numbers were greater than the average in two of the three watersheds, Silver Creek at 0.49, and Bridge Creek at 0.48). The remaining watershed, Buck Creek, is below the average at 0.32. As stated in the desired conditions section, the Road Impact Index is an indicator of sediment delivery risk associated with road density and the number of stream crossings.

Table 3.4 - Road Density, Location and Drainage Network in the Silver Lake Watershed.

Watershed	Road Density (mi/mi²)	Road Miles	# of Crossings / Crossings per Mile of Stream^	Road Impact Index (RII)	Road Miles within 300 feet of Streams*	Road Density (mi/mi²) within 300 feet of Streams*	Increase In Drainage Network (%)
Current Conditions							
Silver Creek	3.3	551	274 / 1.02	0.49wa	70.0	3.1	123
Bridge Creek	2.8	113	51 / 0.77	0.48	20.0	3.2	103
Buck Creek	1.9	96	50 / 0.63	0.32	16.9	2.1	72
Silver Lake Watershed	2.9	760	375 / 0.90	0.46wa	106.9	2.9	110
If Recommendations Are Implemented							
Silver Creek	3.0	502	256 / 0.95	0.42wa	63.7	2.8	112
Bridge Creek	2.3	92	40 / 0.61	0.31	15.6	2.5	84
Buck Creek	1.7	88	46 / 0.58	0.27	14.4	1.8	66
Silver Lake Watershed	2.6	682	342 / 0.82	0.37wa	93.7	2.6	99

^ includes perennial, intermittent and ephemeral channels
* perennial and intermittent stream only
wa – weighted average of the subwatersheds

Emphasis for decommissioning should be placed on those roads within 300 feet of streams or have numerous stream crossings. The remaining roads, primarily those roads within 600 feet of streams, should be properly drained to reduce the hydrological connection to stream channels, resulting in less water and sediment flowing down roads and their ditches. This promotes better infiltration of water into forest soils to be slowly released into stream channels.

Chapter 4

Riparian Vegetation and Stream Channels

Chapter 4
Riparian Vegetation and Stream Channels

Key Question #2: Is vegetation in riparian areas contributing to the appropriate stream channel types and hydrologic regime?

A) Riparian vegetation and associated bank stability

In order to address this part of Question 2, survey crews and resource professionals gathered and summarized current condition information on a stream reach basis so that an assessment of riparian vegetation and bank stability could be performed. In general, a reach is a segment of stream of similar gradient, valley type, etc. For example, a segment of stream flowing through a gentle meadow valley would be a separate reach relative to a segment occurring in a steeper mountain area. Only the primary perennial streams within each watershed were surveyed. The following methods were used to assess current conditions:

During stream surveys conducted in 2000, the dominant vegetation types within the riparian area of each measured reach were documented. In addition, the associated bank stability was described. Actively eroding banks, above the bankfull height, were counted as unstable. Below is a short summary of the streams, and number of reaches surveyed, within the three watersheds.

Silver Creek Watershed: Four streams were surveyed within this watershed. In Silver Creek, seven of the nine reaches (just over 10 miles) were surveyed; West Fork Silver Creek was divided into fourteen reaches, of which thirteen (over 18 miles) were surveyed; nearly 5 miles of North Fork Silver Creek was divided into two reaches; and Guyer Creek was divided into six reaches, of which five (nearly 9 miles) were surveyed.

It should be mentioned that no surveys occurred within Benny, Squaw, or Indian Creeks – or any other channels within these three subwatersheds. These streams are intermittent, and due to prioritization – based on funding and time – were not surveyed. However, a general description of streams within these subwatersheds will be given based on field reconnaissance associated with past projects within the area.

Bridge Creek Watershed: Nearly the entire length of Bridge Creek, starting from its headwaters in the Yamsay Mountain Semi-Primitive Non-Motorized Recreation Area to its entrance into Paulina Marsh, was surveyed. This included thirteen of the fourteen reaches, which totaled more than 16 miles.

Buck Creek Watershed: Buck Creek was divided into twenty-one reaches, of which nineteen (over 25 miles) were surveyed. This included reaches near its entrance into Paulina Marsh to its headwaters in the Yamsay Mountain Semi-Primitive Non-Motorized Recreation Area.

Current Conditions

Vegetative compositions and dominance along flood-prone areas of the Silver Lake Watershed streams varies, depending on stream type. Along the alluvial, low-gradient C and E stream channel types, sedge, rush, and willow are commonly observed. Sedge species include Aquatic Sedge (*Carex aquatilis*), Nebraska Sedge (*Carex nebraskensis*), Wooly Sedge (*Carex lanuginosa*), Beaked Sedge (*Carex rostrata*), and Inflated Sedge (*Carex vesicaria*), the latter two found in areas that are saturated and marshy throughout the summer. Additional wetland species that are commonly observed colonizing disturbed sites include Creeping Spikerush (*Eleocharis palustris*), and to a lesser degree Few-flowered Spikerush (*Eleocharis pauciflora*). Common rush species include the following: Baltic Rush (*Juncus balticus*), Sword-leaf or Dagger-leaf Rush (*Juncus ensifolius*), Nevada Rush (*Juncus ensifolius*), and Long-style Rush (*Juncus longistylis*). The Nevada and Baltic Rush is common, found in low gradient meadow systems, often below bankfull depth. The Long-style rush has a wide range throughout the watershed, being found on most stream types, low gradient E channels and higher gradient B channels. The Sword-leaf rush is less common and most often occurs within low gradient stream types (C and E).

Four willow species occur within the watershed: Geyer Willow (*Salix geyeriana*), Whiplash Willow (*Salix lasiandra*), Booth's Willow (*Salix boothii*), and Scouler's Willow (*Salix scoulaeriana*). Geyer and Whiplash Willows occur throughout the watershed along most stream types, with Geyer being most common. Booth's willow is less common, but is often found in C stream reaches within the lower segments of the three main streams. Finally, Scouler's Willow is usually found in moist upland areas.

Other deciduous shrub and tree species found along watershed streams include Mountain Alder (*Alnus incana*), Black Cottonwood (*Populus balsamifera* var. *trichorpa*), Quaking Aspen (*Populus tremuloides*), Bog Birch (*Betula glandulosa*), and Red Osier Dogwood (*Corylus stolonifera*). Mountain Alder and Black Cottonwood are commonly along the B channel reaches of the Chewaucan River and other streams within the watershed. Quaking Aspen is frequent along B channel types, a common subdominant along tributary streams. Bog Birch is less common and can be found in wet areas along most stream types.

The summary tables that follow describe riparian and upland vegetation for all stream reaches surveyed within the three watersheds. For reach locations refer to Figures 4.1, 4.2, and 4.3 – Silver, Bridge, and Buck Creek Watershed Reach and Monitoring Locations.

Silver Creek Watershed: The following tables (Tables 4.1, 4.2, 4.3, and 4.4) are a summary of current condition information that was collected to describe the dominant vegetation types and the associated bank stability within riparian areas of Silver, West Fork Silver, North Fork Silver, and Guyer Creeks.

Table 4.1 - Silver Creek – Riparian Vegetation and Associated Bank Stability

Reach Information					Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation – Species and Class		Bank Stability (%)
					Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
1	0.7	USFS	17	1	HW 1-4	SE	GR	SB 1	GR	99
2		Private								
3		Private								
4	1.6	BLM	22	1	HD 1	HA 1-4	SE	CP 1-5	MM 1-2	100
5	1.5	USFS	22	1	HD 1	HW 1-4	SE	CP 1-5	MM 1	98
6	1.8	USFS	28	1	HA 1-4	HD 1	SE	CP 1-5	CJ 1-3	99
7	2.3	USFS	24	1	SE	GR	HW 1-4	CP 1-5	CL 1-4	99
8	1.2	USFS	24	1	SE	GR	HA 1-4	CP 1-4	CL 1-4	100
9	1.3	USFS	24	2	SE	GR	HA 1-4	CP 1-4	CL 1-4	99

Vegetation Abbreviations: *Conifers:* CP-Ponderosa, CW-White Fir, CL-Lodgepole, CJ-Juniper, MH-Mountain Hemlock; Class (diameter breast height): 1-Shrub/Seedling (1"-4.9"), 2-Sapling/Pole (5"-8.9"), 3-Small Trees (9"-20.9"), 4-Large Trees (21"-31.9"), 5-Mature Trees (>32")
Riparian Hardwoods and Shrubs: HA-Alder, HW-Willow, HC-Cottonwood, HQ-Quaking Aspen, HD-Dogwood, HB-Bog Birch, SP-Spirea, SR-Ribes, HX-Other; Class (height): 1 – (0-2ft.), 2 – (2-5ft.), 3 (5-10ft.), 4 (>10ft.)
Shrubs & Grass/Forb: SB-Big Sage, SS-Silver Sage, MM-Mountain Mahogany, RB-Rabbit Brush, GR-Grass, SE-Sedge, RU-Rush, LK-Larkspur, LC-Lupine

Table 4.2 - West Fork Silver Creek – Riparian Vegetation and Associated Bank Stability

Reach Information					Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation – Species and Class		Bank Stability (%)
					Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
1	0.5	BLM	6	1	HA 1-4	SE	HW 1-4	SB	CJ 1-3	97
2	0.3	BLM	10	1	SE	HW 1-3	HA 1-3	SB	CJ 1-3	97
3	1.1	BLM	12	1	HA 1-4	SE	HX 1-2	CP 3-5	CJ 2-3	98
4	3.0	USFS	11	1	HA 1-4	SE	HX 1-2	CP 3-5	CL 2-4	99
5	1.2	USFS	9	<1	SE	GR	HA 2-3	CP 3-5	CL 2-4	95
5a		Private								
6	1.2	USFS	8	<1	SE	HA 4	HW 2-4	CP 3-4	SB	99
7	2.0	USFS	8	3	HA 1-4	HD 2-3	HX 1	CP 3-4	CW 2-3	99
8	3.0	USFS	8	1-2	HA 1-4	SP 1	GR	CL 1-4	CW 1-4	100
9	1.5	USFS	7	1-2	HW 1-4	HB 1-3	HA 1-4	CL 1-4	CW 1-4	99

Table 4.2 - West Fork Silver Creek – Riparian Vegetation and Associated Bank Stability (continued)

Reach Information					Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation – Species and Class		Bank Stability (%)
					Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
10	1.2	USFS	7	<1	HW 3	HB 2	SP 1	CW 4	CP 4-5	100
11	1.7	USFS	3	1-2	HW 1-3	HB 1-3	SE	CL 1-4	CP 1-3	100
12	0.7	USFS	3	2-4	HB 1	GR	SE 1-4	CL 3	CW 2-4	99
13	1.0	USFS	4	>4	SE	GR	LK/LC 1	CL 1-4	CW 1-4	100

Vegetation Abbreviations: *Conifers:* CP-Ponderosa, CW-White Fir, CL-Lodgepole, CJ-Juniper, MH-Mountain Hemlock; Class (diameter breast height): 1-Shrub/Seedling (1"-4.9"), 2-Sapling/Pole (5"-8.9"), 3-Small Trees (9"-20.9"), 4-Large Trees (21"-31.9"), 5-Mature Trees (>32")
Riparian Hardwoods and Shrubs: HA-Alder, HW-Willow, HC-Cottonwood, HQ-Quaking Aspen, HD-Dogwood, HB-bog Birch, SP-Spirea, SR-Ribes, HX-Other, Class (height): 1 – (0-2ft.), 2 – (2-5ft.), 3 (5-10ft.), 4 (>10ft.)
Shrubs & Grass/Forb: SB-Big Sage, SS-Silver Sage, MM-Mountain Mahogany, RB-Rabbit Brush, GR-Grass, SE-Sedge, RU-Rush, LK-Larkspur, LC-Lupine

Table 4.3 - North Fork Silver Creek – Riparian Vegetation and Associated Bank Stability

Reach Information					Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation – Species and Class		Bank Stability (%)
					Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
1	2.3	USFS	5	1-4	HA 1-4	SE	GR	CL 1-3	CP 1-5	99
2	2.6	USFS	5	2-4	HA 1-4	SE	GR	CL 1-4	CW 1-4	100

Vegetation Abbreviations: *Conifers:* CP-Ponderosa, CW-White Fir, CL-Lodgepole, CJ-Juniper, MH-Mountain Hemlock; Class (diameter breast height): 1-Shrub/Seedling (1"-4.9"), 2-Sapling/Pole (5"-8.9"), 3-Small Trees (9"-20.9"), 4-Large Trees (21"-31.9"), 5-Mature Trees (>32")
Riparian Hardwoods and Shrubs: HA-Alder, HW-Willow, HC-Cottonwood, HQ-Quaking Aspen, HD-Dogwood, HB-bog Birch, SP-Spirea, SR-Ribes, HX-Other, Class (height): 1 – (0-2ft.), 2 – (2-5ft.), 3 (5-10ft.), 4 (>10ft.)
Shrubs & Grass/Forb: SB-Big Sage, SS-Silver Sage, MM-Mountain Mahogany, RB-Rabbit Brush, GR-Grass, SE-Sedge, RU-Rush, LK-Larkspur, LC-Lupine

Table 4.4 - Guyer Creek – Riparian Vegetation and Associated Bank Stability

Reach Information					Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation – Species and Class		Bank Stability (%)
					Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
1		Private								
2	1.9	USFS	8	2	HA 1-4	SP 1	GR	CL 1-4	CP 1-5	99
3	2.9	USFS	7	2-4	HW 1-4	HB 1-3	GR	CL 1-4	CP 1-5	99
4	0.7	USFS	5	2-4	HW 1-4	HB 1-3	SE	CL 1-4	GR	100
5	2.0	USFS	5	2-4	HW 1-4	HB 1-3	SE	CL 1-4	CW 1-4	100
6	1.1	USFS	4	>4	SE	GR	HW 1-4	CL 1-3	CW 1-4	100

Vegetation Abbreviations: *Conifers:* CP-Ponderosa, CW-White Fir, CL-Lodgepole, CJ-Juniper, MH-Mountain Hemlock; Class (diameter breast height): 1-Shrub/Seedling (1"-4.9"), 2-Sapling/Pole (5"-8.9"), 3-Small Trees (9"-20.9"), 4-Large Trees (21"-31.9"), 5-Mature Trees (>32")
Riparian Hardwoods and Shrubs: HA-Alder, HW-Willow, HC-Cottonwood, HQ-Quaking Aspen, HD-Dogwood, HB-bog Birch, SP-Spirea, SR-Ribes, HX-Other, Class (height): 1 – (0-2ft.), 2 – (2-5ft.), 3 (5-10ft.), 4 (>10ft.)
Shrubs & Grass/Forb: SB-Big Sage, SS-Silver Sage, MM-Mountain Mahogany, RB-Rabbit Brush, GR-Grass, SE-Sedge, RU-Rush, LK-Larkspur, LC-Lupine

Benny, Squaw, and Indian Creek Subwatersheds of the Silver Creek Watershed: Due to prioritization and time, no surveys occurred within these three subwatersheds. However, a general description of streams will be given, based on field reconnaissance (including bottom-line surveys – bank stability and large woody debris) associated with past projects, which provides some insight to the current condition of stream channels and riparian vegetation. The streams within these subwatersheds are intermittent and transport water primarily during spring snowmelt and intense thunderstorm events. Bank instability within these subwatersheds is localized, occurring mainly in the lower gradient, depositional reaches. Unstable banks are typically less than 36 inches in height and 10-50 feet long. Seasonal seeps and springs occur along the major drainages, with aspen present in varying conditions. Grasses, sedge, willow, aspen, and conifers are the dominant vegetation types within riparian areas, although False Hellebore or sagebrush does dominate a few sites.

Bridge Creek Watershed: The following table (Table 4.5) is a summary of current condition information that was collected to describe the dominant vegetation types and the associated bank stability within riparian areas of Bridge Creek.

Table 4.5 - Bridge Creek – Riparian Vegetation and Associated Bank Stability

Reach Information					Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation Species and Class		Bank Stability (%)
					Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
1	0.5	Private	6	<1	SE	GR	HW 1-4	SB	GR	95
2	1.7	Private	7	<1	SE	GR	HW 1-4	SB	CJ 1-3	94
3	1.5	Private	8	1	HW 1-4	GR	SE	SB	CJ 1-3	91
4		Private								
5	0.7	Private	11	1	SE	GR	HW 1-4	CJ 1-3	SB	87
6	1.7	BLM/FS	9	1	HA/HW 1-4	SE	HX 1	CL 1-3	CP 1-5	98
7	2.2	USFS	10	1-4	HA 1-4	SR 1	SE	CL 1-4	CP 1-5	99
8	1.0	USFS	10	<2	HA 1-4	SR 1	SE	CL 1-3	CP 1-5	100
9	0.6	Private	9	1-2	HA 1-4	SR 1	SE	CL 1-3	CP 1-5	100
10	1.5	USFS	9	2-4	HA 1-4	SR 1	SE	CL 1-3	CP 1-5	100
11	1.4	USFS	10	2-4	HA 1-4	SR 1	SE	CW 1-3	CL 1-3	100
12	0.7	USFS	6	2-8	HA/HW 1-4	SE	GR	CL 1-3	MH 1-3	100
13	0.8	USFS	7	1	SE	GR	CL 1-3	CL 1-3	MH 1-3	100
14	2.3	USFS	6	2-8	SE	GR	CL 1-3	CL 1-3	MH 1-3	100

Vegetation Abbreviations: *Conifers:* CP-Ponderosa, CW-White Fir, CL-Lodgepole, CJ-Juniper, MH-Mountain Hemlock; Class (diameter breast height): 1-Shrub/Seedling (1"-4.9"), 2-Sapling/Pole (5"-8.9"), 3-Small Trees (9"-20.9"), 4-Large Trees (21"-31.9"), 5-Mature Trees (>32")
Riparian Hardwoods and Shrubs: HA-Alder, HW-Willow, HC-Cottonwood, HQ-Quaking Aspen, HD-Dogwood, HB-bog Birch, SP-Spirea, SR-Ribes, HX-Other; Class (height): 1 – (0-2ft.), 2 – (2-5ft.), 3 (5-10ft.), 4 (>10ft.)
Shrubs & Grass/Forb: SB-Big Sage, SS-Silver Sage, MM-Mountain Mahogany, RB-Rabbit Brush, GR-Grass, SE-Sedge, RU-Rush, LK-Larkspur, LC-Lupine

Buck Creek Watershed: The following table (Table 4.6) is a summary of current condition information that was collected to describe the dominant vegetation types and the associated bank stability within riparian areas of Buck Creek.

Table 4.6 - Buck Creek – Riparian Vegetation and Associated Bank Stability

Reach Information					Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation Species and Class		Bank Stability (%)
					Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
1		Private								
2	2.0	BLM	10	1	SE	GR	HA 1-4	CP 1-5	CJ 1-3	92
3	1.5	Private	8	<1	SE	HW 1-4	GR	CJ 1-3	GR	99
4		Private								
5	0.6	Private	7	<1	SE	GR	HW 1-4	CJ 1-3	RB 1	94
6	0.5	Private	9	1-2	SE	GR	HW 1-4	CJ 1-3	RB 1	99
7	2.4	Private	8	<1	SE	GR	HW 1-4	CJ 1-4	RB 1	96
8	0.8	Private	12	<1	SE	GR	HA 1-4	CP 1-5	CJ 1-3	96
9	0.6	BLM	12	<1	SE	GR	HA 1-4	CP 1-5	CJ 1-3	96
10	0.8	BLM	15	1-2	SE	GR	HA 1-4	CP 1-5	CL 1-3	96
11	0.8	Private	15	1	SE	GR	HA 1-4	CJ 1-3	SB	93
12	1.4	Private	15	<2	SE	GR	HA 1-4	CL 1-4	CP 1-4	96
13	1.3	USFS	16	1	HA 1-4	SE	GR	CL 1-4	CP 1-4	99
14	1.1	USFS	17	1-4	HA 1-4	SE	GR	CL 1-4	CP 1-3	99
15	1.3	USFS	14	1-2	HA 1-4	HD 1-4	GR	CW 1-4	CP 1-4	99

Table 4.6 - Buck Creek – Riparian Vegetation and Associated Bank Stability (continued)

Reach Information					Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation – Species and Class		Bank Stability (%)
					Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
16	2.9	USFS	13	2	HA 1-4	HD 1	SE	CW 1-3	CP 1-4	99
17	1.5	USFS	12	2	HA 1-4	SR 1	GR	CW 1-4	CP 1-4	99
18	1.1	USFS	13	2-8	HW 1-4	FS	GR	CL 1-3	MH 1-2	99
19	2.3	USFS	10	1-3	HW 1-4	FS	GR	CL 1-3	CP 1-3	100
20	1.4	USFS	5	1-4	SE	FS	GR	CL 1-3	GR	99
21	1.0	USFS	5	>4	SE	FS	GR	MH 1-4	CL 1-4	99

Vegetation Abbreviations: *Conifers:* CP-Ponderosa, CW-White Fir, CL-Lodgepole, CJ-Juniper, MH-Mountain Hemlock; Class (diameter breast height): 1-Shrub/Seedling (1"-4.9"), 2-Sapling/Pole (5"-8.9"), 3-Small Trees (9"-20.9"), 4-Large Trees (21"-31.9"), 5-Mature Trees (>32")
Riparian Hardwoods and Shrubs: HA-Alder, HW-Willow, HC-Cottonwood, HQ-Quaking Aspen, HD-Dogwood, HB-bog Birch, SP-Spirea, SR-Ribes, HX-Other, Class (height): 1 – (0-2ft.), 2 – (2-5ft.), 3 (5-10ft.), 4 (>10ft.)
Shrubs & Grass/Forb: SB-Big Sage, SS-Silver Sage, MM-Mountain Mahogany, RB-Rabbit Brush, GR-Grass, SE-Sedge, RU-Rush, LK-Larkspur, LC-Lupine, FS-Forb/Flower

Desired Conditions

One of the many functions of riparian plants is to stabilize banks through root mass. Manning et al. (1989) documented that sedge and rush species produced significantly more root mass than dry-land grasses, making these plants conducive to high bank stability. Other vegetation types such as willows, cottonwoods, and conifers provide additional bank stability. The stems of these herbaceous and shrub species provide roughness and resistance to high flows, which allows for sediment trapping and bank building (Elmore and Beschta 1987). Under these conditions, water is stored during the wet season and slowly released to the stream during the summer months. Further, in an area where sheets of ice form on the stream surface during the winter – such as the Silver Lake Watershed – riparian vegetation helps protect the banks from erosion as ice breaks-up during spring thaw (Platts 1991).

The vegetation types that contribute to the above conditions have been described. Willow, sedge, and rush associations characterize late-seral communities in low gradient meadow stream systems, where approximately 95% of the riparian area provides conditions for late-seral species (Burton et al. 1992). These conditions also provide the necessary habitat and food source for beavers, a keystone species for riparian health. Along steeper-gradient mountain streams, where at least 75% of the bank substrate supports late-seral species, Mountain Alder will dominate the site while Black Cottonwood, willows, sedges, grasses, are subdominant (Burton et al. 1992, Kovalchik 1987). Early seral species, such as grasses, occupy riparian areas, but under reference conditions these species are subdominant (Kovalchik 1987). The relationship between these plant types and bank stability is reflected in the Native Inland Fish Strategy (USDA 1995) which details standards and guidelines that suggest bank stability should be greater than 80%, while the Interior Columbia Basin Ecosystem Management Project recommends 90% for areas where this is attainable (ICBEMP 1997). Bowers et al. (1979) documented the presence of redband trout when streambanks are at least 80% stable with the presence of undercut banks.

Desired Riparian Vegetation and Bank Stability:

Functioning Appropriately - Riparian communities are highly similar to the late-seral species composition and structure described by Burton et al. (1992), Kovalchik (1987), and bank stability >95%. ***This is the desired (target) condition.***

Functioning Appropriately but-at-Risk - Riparian communities are moderately similar to the late-seral species composition and structure described by Burton et al. (1992), Kovalchik (1987), and bank stability is 80-95%.

Functioning Inappropriately - Riparian communities have low similarity to the late-seral species composition and structure described by Burton et al. (1992), Kovalchik (1987), and bank stability is <80%.

Summary and Synthesis for the entire Silver Lake Watershed Assessment Area

Summary of, and factors contributing to, current conditions for the Silver Creek Watershed: The following tables (Tables 4.7, 4.8, 4.9, and 4.10) summarize current and desired conditions for vegetation types and associated bank stability within riparian areas of Silver, West Fork Silver, North Fork Silver and Guyer Creeks. Ratings given within these tables are based on a comparison of current and desired conditions (see desired conditions section for ratings) within each of the surveyed stream reaches. Following each table is a discussion of these ratings and the factors contributing to current conditions, as well as any trends in conditions. For reach locations refer to Figure 5.3 – Silver Creek Watershed Reach and Monitoring Locations.

Silver Creek

Table 4.7 - Silver Creek – Riparian Vegetation and Associated Bank Stability

Reach Information					Condition	Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation – Species and Class		Bank Stability (%)
						Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
1	0.7	USFS	17	1	1 Desired	HW 1-4	SE	GR	SB 1	GR	>90
					1 Current	HW 1-4	SE	GR	SB 1	GR	99
					1 Rating	Functioning Appropriately					
2		Private			2 Desired						
					2 Current						
					2 Rating						
3		Private			3 Desired						
					3 Current						
					3 Rating						
4	1.6	BLM	22	1	4 Desired	HD 1	HA 1-4	SE	CP 1-5	MM 1-2	>90
					4 Current	HD 1	HA 1-4	SE	CP 1-5	MM 1-2	100
					4 Rating	Functioning Appropriately					
5	1.5	USFS	22	1	5 Desired	HD 1	HW 1-4	SE	CP 3-5	MM 1-2	>90
					5 Current	HD 1	HW 1-4	SE	CP 1-5	MM 1	98
					5 Rating	Functioning Appropriately					
6	1.8	USFS	23	1	6 Desired	HA 1-4	HD 1	SE	CP 3-5	MM 1-2	>90
					6 Current	HA 1-4	HD 1	SE	CP 1-5	CJ 1-3	99
					6 Rating	Functioning Appropriately					
7	2.3	USFS	23	2	7 Desired	SE	HW 1-4	HA 1-4	CP 3-5	CL 2-4	>90
					7 Current	SE	GR	HW 1-4	CP 1-5	CL 1-4	99
					7 Rating	Functioning Appropriately					
8	1.2	USFS	23	1	8 Desired	SE	HA 1-4	HW 1-4	CP 3-5	CL 2-4	>90
					8 Current	SE	GR	HA 1-4	CP 1-4	CL 1-4	100
					8 Rating	Functioning Appropriately					
9	1.3	USFS	23	2	9 Desired	SE	HA 1-4	HW 1-4	CP 2-5	CL 2-4	>90
					9 Current	SE	GR	HA 1-4	CP 1-4	CL 1-4	99
					9 Rating	Functioning Appropriately					

Vegetation Abbreviations: *Conifers*: CP-Ponderosa, CW-White Fir, CL-Lodgepole, CJ-Juniper, MH-Mountain Hemlock; Class (diameter breast height): 1-Shrub/Seedling (1"-4.9"), 2-Sapling/Pole (5"-8.9"), 3-Small Trees (9"-20.9"), 4-Large Trees (21"-31.9"), 5-Mature Trees (>32")
Riparian Hardwoods and Shrubs: HA-Alder, HW-Willow, HC-Cottonwood, HQ-Quaking Aspen, HD-Dogwood, HB-Bog Birch, SP-Spirea, SR-Ribes, HX-Other. Class (height): 1 – (0-2ft.), 2 – (2-5ft.), 3 (5-10ft.), 4 (>10ft.)
Shrubs & Grass/Forb: SB-Big Sage, SS-Silver Sage, MM-Mountain Mahogany, RB-Rabbit Brush, GR-Grass, SE-Sedge, RU-Rush, LK-Larkspur, LC-Lupine

The dominant plant types in all nine of the reaches – willow, dogwood, sedge, and grass – are highly similar to late-seral species in composition and structure, resulting in adequate cover to protect stream banks and dissipate energy during high flows. There is evidence, however, of pine encroachment into the riparian area over much of the streams length in reaches 4 through 9. There are also small, localized areas of bank instability, mainly in reaches 1, 5 and 7. Overall, late-seral species dominate and bank stability exceeds 98% in all surveyed reaches; consequently, this element is **functioning appropriately**.

The dominance of late-seral species in all reaches promotes their high bank stability values. Past livestock practices have likely influenced vegetative conditions but current grazing strategies are allowing riparian areas to be near their potential. Grazing strategies were changed in 1992 with all reaches being in a pasture that receives early-season grazing (livestock are off the pasture by August 15th. The altered fire regime continues to promote higher densities of young pine in riparian areas, creating a minor shift in relative species abundance.

West Fork Silver Creek

Table 4.8 - West Fork Silver Creek – Riparian Vegetation and Associated Bank Stability

Reach Information					Condition	Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation – Species and Class		Bank Stability (%)
						Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
1	0.5	BLM	8	1	1 Desired	HA 1-4	SE	HW 1-4	GR	SB	>90
					1 Current	HA 1-3	SE	HW 1-4	SB	CJ 1-3	97
					1 Rating	Functioning Appropriately					
2	0.2	BLM	10	1	2 Desired	SE	HW 1-4	HA 1-4	GR	SB	>90
					2 Current	SE	HW 1-3	HA 1-2	SB	CJ 1-3	97
					2 Rating	Functioning Appropriately					
3	1.1	BLM	12	3	3 Desired	HA 1-4	SE	HX 1-2	CP 3-5	GR	>90
					3 Current	HA 1-4	SE	HX 1-2	CP 3-5	CJ 2-3	96
					3 Rating	Functioning Appropriately					
4	3.0	USFS	11	1	4 Desired	HA 1-4	SE	HX 1-2	CP 3-5	CL 2-4	>90
					4 Current	HA 1-4	SE	HX 1-2	CP 3-5	CL 2-4	99
					4 Rating	Functioning Appropriately					
5	1.2	USFS	9	<1	5 Desired	SE	HW 1-4	HA 1-3	CP 3-5	CL 2-4	>90
					5 Current	SE	GR	HA 2-3	CP 3-5	CL 2-4	95
					5 Rating	Functioning Appropriately but-at-Risk					
5a		Private			5a Desired						
					5a Current						
					5a Rating						
6	1.2	USFS	8	<1	6 Desired	SE	HA 1-4	HW 1-4	CP 3-5	GR	>90
					6 Current	SE	HA 4	HW 2-4	CP 3-4	SB	99
					6 Rating	Functioning Appropriately					
7	2.0	USFS	8	3	7 Desired	HA 1-4	HD 2-3	HX 1	CP 3-5	CW 3-5	>90
					7 Current	HA 1-4	HD 2-3	HX 1	CP 3-4	CW 2-3	99
					7 Rating	Functioning Appropriately					
8	3.0	USFS	8	1-2	8 Desired	HA 1-4	SP 1-2	HW 1-4	CL 2-4	CW 3-5	>90
					8 Current	HA 1-4	SP 1	GR	CL 1-4	CW 1-4	100
					8 Rating	Functioning Appropriately					
9	1.5	USFS	7	1-2	9 Desired	HW 1-4	HB 1-3	HA 1-4	CL 2-4	CW 3-5	>90
					9 Current	HW 1-4	HB 1-3	HA 1-4	CL 1-4	CW 1-4	99
					9 Rating	Functioning Appropriately					
10	1.3	USFS	7	<1	10 Desired	HW 1-4	HB 1-3	SP 1	CP 3-5	CW 3-5	>90
					10 Current	HW 3	HB 2	SP 1	CW 4	CP 4-5	100
					10 Rating	Functioning Appropriately					
11	1.7	USFS	5	1-2	11 Desired	HW 1-4	HB 1-3	SE	CL 2-4	CP 3-5	>90
					11 Current	HW 1-3	HB 1-3	SE	CL 1-4	CP 1-3	100
					11 Rating	Functioning Appropriately					
12	0.7	USFS	5	2-4	12 Desired	HW 1-4	SE	HB 1-4	CL 2-4	CW 3-5	>90
					12 Current	HW 1-3	GR	SE	CL 3	CW 2-4	99
					12 Rating	Functioning Appropriately					
13	1.0	USFS	4	>4	13 Desired	SE	GR	LK/LC 1	CL 2-4	CW 3-5	>90
					13 Current	SE	GR	LK/LC 1	CL 1-4	CW 1-4	100
					13 Rating	Functioning Appropriately					

Vegetation Abbreviations: *Conifers:* CP-Ponderosa, CW-White Fir, CL-Lodgepole, CJ-Juniper, MH-Mountain Hemlock; Class (diameter breast height): 1-Shrub/Seedling (1"-4.9"), 2-Sapling/Pole (5"-8.9"), 3-Small Trees (9"-20.9"), 4-Large Trees (21"-31.9"), 5-Mature Trees (>32")
Riparian Hardwoods and Shrubs: HA-Alder, HW-Willow, HC-Cottonwood, HQ-Quaking Aspen, HD-Dogwood, HB-bog Birch, SP-Spirea, SR-Ribes, HX-Other. Class (height): 1 – (0-2ft.), 2 – (2-5ft.), 3 (5-10ft.), 4 (>10ft.)
Shrubs & Grass/Forb: SB-Big Sage, SS-Silver Sage, MM-Mountain Mahogany, RB-Rabbit Brush, GR-Grass, SE-Sedge, RU-Rush, LK-Larkspur, LC-Lupine

The dominant riparian vegetation – sedge, alder, dogwood, willow, grass and lodgepole pine – within all surveyed reaches, with the exception of Reach 5, is highly similar to late-seral species composition and structure, and combined with bank stability values, results in a **functioning appropriately** rating for each reach. Reach 5, on the other hand, is **functioning appropriately but-at-risk** due to a higher abundance of grass and the lack of willow in the older age-classes and its lower bank stability values. Additionally, there is evidence of lodgepole pine encroachment into the riparian area over much of the streams length, especially in the upper six reaches (reaches 8-13). There are also small, localized areas of bank instability, mainly in reaches 3 and 5.

The dominance of late-seral species in all reaches promotes their high bank stability values. In Reach 5, banks are continuing to build and recover as riparian vegetation moves closer to its desired condition – grass and wild iris are more common than expected indicating that plant succession in moving towards, but has not yet reached, a late-seral community. Past livestock practices have likely influenced vegetative conditions, especially the lack of mature willow, but current grazing strategies are allowing riparian areas to move towards their potential. Grazing strategies within the lower reaches currently involves early season use, with reaches 6, 7, and 8 receiving short season/early grazing, while the upper reaches are excluded from grazing. Also, a sizable portion of the stream (reaches 6-13) was not grazed during the period of 1990-1996. The altered fire regime continues to promote higher densities of lodgepole pine in riparian areas, creating a minor shift in relative species abundance with fewer shade intolerant species such as willow and aspen. For example, surveys and associated photographs in reaches 10 and 11 indicate that pole to small tree size lodgepole pine are competing with willow in the riparian area. An additional factor affecting bank stability within the lower reaches of this stream might be the increased drainage network associated with roads throughout the subwatershed, possibly influencing the timing and magnitude of stream flows and their effects on channel scouring.

<u>North Fork Silver Creek</u>

Table 4.9 - North Fork Silver Creek – Riparian Vegetation and Associated Bank Stability

Reach Information					Condition	Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	Riparian Vegetation (Flood-Prone Width) Species and Class			Upland Vegetation Species and Class		Bank Stability (%)
						Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
1	2.3	USFS	5	1-4	1 Desired	HA 1-4	SE	GR	CP 3-5	CL 2-4	>90
					1 Current	HA 1-4	SE	GR	CL 1-3	CP 1-5	99
					1 Rating	Functioning Appropriately					
2	2.6	USFS	5	2-4	2 Desired	HA 1-4	SE	GR	CW 3-5	CL 2-4	>90
					2 Current	HA 1-4	SE	GR	CL 1-4	CW 1-4	100
					2 Rating	Functioning Appropriately					

Vegetation Abbreviations: *Conifers:* CP-Ponderosa, CW-White Fir, CL-Lodgepole, CJ-Juniper, MH-Mountain Hemlock; Class (diameter breast height): 1-Shrub/Seedling (1"-4.9"), 2-Sapling/Pole (5"-8.9"), 3-Small Trees (9"-20.9"), 4-Large Trees (21"-31.9"), 5-Mature Trees (>32")
Riparian Hardwoods and Shrubs: HA-Alder, HW-Willow, HC-Cottonwood, HQ-Quaking Aspen, HD-Dogwood, HB-bog Birch, SP-Spirea, SR-Ribes, HX-Other, Class (height): 1 – (0-2ft.), 2 – (2-5ft.), 3 (5-10ft.), 4 (>10ft.)
Shrubs & Grass/Forb: SB-Big Sage, SS-Silver Sage, MM-Mountain Mahogany, RB-Rabbit Brush, GR-Grass, SE-Sedge, RU-Rush, LK-Larkspur, LC-Lupine

The dominant plant types in both of the reaches – alder, sedge, and grass – are highly similar to late-seral species in composition and structure, resulting in adequate cover to protect stream banks and dissipate energy during high flows. There is evidence, however, of lodgepole pine encroachment into the riparian area over much of the streams length. Overall, late-seral species dominate and bank stability exceeds 98%; consequently, this element is **functioning appropriately**.

The abundance of late-seral species in all reaches promotes their high bank stability values. The majority of the area did not have authorized livestock use from 1990-1997 (part of a vacant allotment, or received non-use), and the area that encompasses reaches 2-4 will continue to be excluded from grazing. Current grazing strategies in Reach 1 are conducive to keeping riparian areas in a condition that is near their potential. The altered fire regime continues to promote higher densities of young lodgepole pine in riparian areas, creating a minor shift in relative species abundance with fewer shade intolerant species such as willow and aspen.

Guyer Creek

Table 4.10 - Guyer Creek – Riparian Vegetation and Associated Bank Stability

Reach Information					Condition	Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation – Species and Class		Bank Stability (%)
						Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
1		Private			1 Desired						
					1 Current						-
					1 Rating						
2	1.9	USFS	8	2	2 Desired	HA 1-4	SP 1	GR	CL 2-4	CP 1-5	>90
					2 Current	HA 1-4	SP 1	GR	CL 1-4	CP 1-5	99
					2 Rating	Functioning Appropriately					
3	2.9	USFS	7	2-4	3 Desired	HW 1-4	HB 1-3	GR	CL 2-4	CP 3-5	>90
					3 Current	HW 1-4	HB 1-3	GR	CL 1-4	CP 1-5	99
					3 Rating	Functioning Appropriately					
4	0.7	USFS	5	2-4	4 Desired	HW 1-4	HB 1-3	SE	CL 2-4	GR	>90
					4 Current	HW 1-4	HB 1-3	SE	CL 1-4	GR	100
					4 Rating	Functioning Appropriately					
5	2.0	USFS	5	2-4	5 Desired	HW 1-4	HB 1-3	SE	CL 2-4	CW 3-5	>90
					5 Current	HW 1-4	HB 1-3	SE	CL 1-4	CW 1-4	100
					5 Rating	Functioning Appropriately					
6	1.1	USFS	4	>4	6 Desired	SE	GR	HW 1-4	CL 2-4	CW 2-5	>90
					6 Current	SE	GR	HW 1-4	CL 1-3	CW 1-4	100
					6 Rating	Functioning Appropriately					

Vegetation Abbreviations: *Conifers:* CP-Ponderosa, CW-White Fir, CL-Lodgepole, CJ-Juniper, MH-Mountain Hemlock; Class (diameter breast height): 1-Shrub/Seedling (1"-4.9"), 2-Sapling/Pole (5"-8.9"), 3-Small Trees (9"-20.9"), 4-Large Trees (21"-31.9"), 5-Mature Trees (>32")
Riparian Hardwoods and Shrubs: HA-Alder, HW-Willow, HC-Cottonwood, HQ-Quaking Aspen, HD-Dogwood, HB-bog Birch, SP-Spirea, SR-Ribes, HX-Other; Class (height): 1 – (0-2ft.), 2 – (2-5ft.), 3 (5-10ft.), 4 (>10ft.)
Shrubs & Grass/Forb: SB-Big Sage, SS-Silver Sage, MM-Mountain Mahogany, RB-Rabbit Brush, GR-Grass, SE-Sedge, RU-Rush, LK-Larkspur, LC-Lupine

The dominant plant types in all reaches are highly similar to late-seral species in composition and structure, resulting in bank stability values of 99% of greater. For these reasons, all five surveyed reaches are **functioning appropriately**. Again, there is evidence of lodgepole pine encroachment into the riparian area in every reach. Old beaver ponds/dams in Reach 5 are still functioning, maintaining wetland/riparian habitat.

Similar to both West Fork Silver and North Fork Silver Creeks, the abundance of late-seral vegetation, primarily alder, willow, and sedge, promotes the high bank stability values found along the entire length of Guyer Creek. All of the reaches surveyed are in an allotment that was either vacant or in non-use from 1990-1997. Current grazing strategies in Reach 2 and the lower portion of Reach 3 call for short season/early grazing, which will continue to allow riparian areas to move towards their potential, while the upper reaches will remain ungrazed as they have been administratively excluded from the allotment. The altered fire regime continues to promote higher densities of lodgepole pine in riparian areas, creating a minor shift in relative species abundance.

Summary of, and factors contributing to, current conditions for Benny, Squaw, and Indian Creeks – Benny, Squaw, and Indian Creek Subwatersheds of the Silver Creek Watershed: No surveys occurred within these three subwatersheds, however, past field reconnaissance (including bottom-line surveys – bank stability and large woody debris) provides some insight to the current condition of stream channels and riparian conditions. Bank instability is localized within these subwatersheds, occurring primarily in the lower-gradient, depositional reaches. This bank instability is likely the cumulative effect of past grazing practices, extensive logging activities, and the increased drainage network associated with roads throughout the subwatershed – which is possibly influencing the timing and magnitude of stream flows and their effects on channel scouring. Vegetation composition within riparian areas includes grasses, sedges, willow, aspen, and conifers, which is similar to the vegetation composition that is expected within these areas. However, where channels have downcut, riparian vegetation is sparse and lacks diversity and vigor – grasses and False Hellebore do dominate some sites, evidence of disturbance or overuse in these areas. Also, aspen is present in varying conditions with some stands struggling to survive. For these reasons, riparian vegetation and associated bank stability within Benny Creek, Squaw Creek and Indian Creek subwatersheds is **functioning appropriately but-at-risk**.

Summary of, and factors contributing to, current conditions for the Bridge Creek Watershed: The following table (Table 4.11) summarizes current and desired conditions for vegetation types and associated bank stability within riparian areas of Bridge Creek. Ratings given within these tables are based on a comparison of current and desired conditions (see desired conditions section for ratings) within each of the surveyed stream reaches. Following each table is a discussion of these ratings and the factors contributing to current conditions, as well as any trends in conditions. For reach locations refer to Figure 5.4 – Bridge Creek Watershed Reach and Monitoring Locations.

Bridge Creek

Table 4.11 - Bridge Creek – Riparian Vegetation and Associated Bank Stability

Reach Information					Condition	Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Desired Wetted Width (*)	Gradient (%)	Reach	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation – Species and Class		Bank Stability (%)
						Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
1	0.6	Private		<1	1 Desired	SB	HW 1-4	GR	GR	SB	>90
			8		1 Current	SE	GR	HW 1-4	SB	GR	95
					1 Rating	Functioning Appropriately but-at-Risk					
2	1.7	Private		<2	2 Desired	SE	HW 1-4	GR	GR	SB	>90
			7		2 Current	SE	GR	HW 1-4	SB	CJ 1-3	94
					2 Rating	Functioning Appropriately but-at-Risk					
3	1.3	Private		1	3 Desired	HW 1-4	HQ 1-4	SE	GR	SB	>90
			8		3 Current	HW 1-4	GR	SE	SB	CJ 1-3	91
					3 Rating	Functioning Appropriately but-at-Risk					
4		Private			4 Desired						
					4 Current						
					4 Rating						
5	0.7	Private		8	5 Desired	SE	HW 1-4	HQ 1-4	SB	GR	>90
			11		5 Current	SE	GR	HW 1-4	CJ 1-3	SB	82
					5 Rating	Functioning Appropriately but-at-Risk					
6	1.7	BLM/FS	9	1	6 Desired	HA/HW 1-4	SE	HX 1	CL 2-4	CP 3-5	>90
			9		6 Current	HA/HW 1-4	SE	HX 1	CL 1-3	CP 1-5	98
					6 Rating	Functioning Appropriately					
7	2.2	USFS	10	1-4	7 Desired	HA 1-4	SR 1	SE	CL 2-4	CP 3-5	>90
			10		7 Current	HA 1-4	SR 1	SE	CL 1-4	CP 1-5	99
					7 Rating	Functioning Appropriately					
8	1.0	USFS	10	<1	8 Desired	HA 1-4	SR 1	SE	CL 2-4	CP 3-5	>90
			10		8 Current	HA 1-4	SR 1	SE	CL 1-3	CP 1-5	100
					8 Rating	Functioning Appropriately					
9	0.6	Private	9	1-2	9 Desired	HA 1-4	SR 1	SE	CL 2-4	CP 3-5	>90
			9		9 Current	HA 1-4	SR 1	SE	CL 1-3	CP 1-5	100
					9 Rating	Functioning Appropriately					
10	1.5	USFS	9	2-4	10 Desired	HA 1-4	SR 1	SE	CL 2-4	CP 3-5	>90
			9		10 Current	HA 1-4	SR 1	SE	CL 1-3	CP 1-5	100
					10 Rating	Functioning Appropriately					
11	1.4	USFS	10	2-4	11 Desired	HA 1-4	SR 1	SE	CW 3-5	CL 2-4	>90
			10		11 Current	HA 1-4	SR 1	SE	CW 1-3	CL 1-3	100
					11 Rating	Functioning Appropriately					
12	0.7	USFS	6	2-8	12 Desired	HA/HW 1-4	SE	GR	CL 2-4	MH 2-5	>90
			6		12 Current	HA/HW 1-4	SE	GR	CL 1-3	MH 1-3	100
					12 Rating	Functioning Appropriately					
13	0.5	USFS	7	1	13 Desired	SE	GR	CL 2-4	CL 2-4	MH 2-5	>90
			7		13 Current	SE	GR	CL 1-3	CL 1-3	MH 1-3	100
					13 Rating	Functioning Appropriately					

Table 4.11 - Bridge Creek – Riparian Vegetation and Associated Bank Stability (continued)

Reach Information					Condition	Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Desired Wetted Width(")	Gradient (%)	Reach	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation – Species and Class		Bank Stability (%)
						Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
14	2.3	USFS	6	2.8	14 Desired	SE	GR	CL 2-4	CL 2-4	MH 2-5	>90
			6		14 Current	SE	GR	CL 1-3	CL 1-3	MH 1-3	100
					14 Rating	Functioning Appropriately					

Vegetation Abbreviations: *Conifers*: CP-Ponderosa, CW-White Fir, CL-Lodgepole, CJ-Juniper, MH-Mountain Hemlock; Class (diameter breast height): 1-Shrub/Seedling (1"-4.9"), 2-Sapling/Pole (5"-8.9"), 3-Small Trees (9"-20.9"), 4-Large Trees (21"-31.9"), 5-Mature Trees (>32")
Riparian Hardwoods and Shrubs: HA-Alder, HW-Willow, HC-Cottonwood, HQ-Quaking Aspen, HD-Dogwood, HB-bog Birch, SP-Spirea, SR-Ribes, HX-Other, Class (height): 1 – (0-2ft.), 2 – (2-5ft.), 3 (5-10ft.), 4 (>10ft.)
Shrubs & Grass/Forb: SB-Big Sage, SS-Silver Sage, MM-Mountain Mahogany, RB-Rabbit Brush, GR-Grass, SE-Sedge, RU-Rush, LK-Larkspur, LC-Lupine

The bank stability values in the lower four meadow reaches are all less than or equal to 95%, resulting in **functioning appropriately but-at-risk ratings**. In addition, grass (wild iris, an indicator of past disturbance, was also noted) is more dominant than expected for these sites, indicating that plant succession is moving towards, but has not yet reached a late-seral community. The remaining nine reaches (reaches 6-14), which primarily occur in steeper gradient forested areas, are **functioning appropriately** due to the dominance of late-seral species and bank stability being greater than 95%. However, the encroachment of lodgepole pine into the riparian area was noted along many of these reaches. Also, localized areas of bank instability were noted Reach 6.

Land along reaches 1-5 is privately owned with pastures that are typically grazed throughout the summer and early fall months, a practice that contributes to early-seral plant species associated with bank instability. An additional factor affecting bank stability within the lower reaches of this stream might be the increased drainage network associated with roads throughout the watershed, possibly influencing the timing and magnitude of stream flows and their effects on channel scouring. In the higher gradient reaches (reaches 6-14) bank stability is greater than 98%, the result of naturally stable stream types and the dominance of late-seral species. The scattered encroachment of lodgepole pine into riparian areas within these upper reaches is likely the result of the altered fire regime.

Summary of, and factors contributing to, current conditions for the Buck Creek Watershed: The following table (Table 4.12) summarizes current and desired conditions for vegetation types and associated bank stability within riparian areas of Buck Creek. Ratings given within these tables are based on a comparison of current and desired conditions (see desired conditions section for ratings) within each of the surveyed stream reaches. Following each table is a discussion of these ratings and the factors contributing to current conditions, as well as any trends in conditions. For reach locations refer to Figure 5.3 – Buck Creek Watershed Reach and Monitoring Locations.

Buck Creek

Table 4.12 - Buck Creek – Riparian Vegetation and Associated Bank Stability

Reach Information					Condition	Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Desired Wetted Width(")	Gradient (%)	Reach	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation – Species and Class		Bank Stability (%)
						Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
1		Private			1 Desired						
					1 Current						
					1 Rating						
2	2.0	BLM		1	2 Desired	SE	HA 1-4	GR	CP 3-5	HQ 1-4	>90
			10		2 Current	SE	GR	HA 1-4	CP 1-5	CJ 1-3	92
					2 Rating	Functioning Appropriately but-at-Risk					
3	1.5	Private		<3	3 Desired	SE	HW 1-4	GR	SB-1	GR	>90
			8		3 Current	SE	HW 1-4	GR	CJ 1-3	GR	99
					3 Rating	Functioning Appropriately					
4		Private			4 Desired						
					4 Current						
					4 Rating						

Table 4.12 - Buck Creek – Riparian Vegetation and Associated Bank Stability (continued)

Reach Information					Condition	Riparian Area Vegetation and Associated Bank Stability					
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	Riparian Vegetation (Flood-Prone Width) – Species and Class			Upland Vegetation – Species and Class		Bank Stability (%)
						Dom.	Sub-Dom. 1	Sub-Dom. 2	Dom.	Sub-Dom. 1	
5	0.6	Private		<1	5 Desired	SE	HW 1-4	HQ 1-4	SB	GR	>90
			7		5 Current	SE	GR	HW 1-4	CJ 1-3	RB	94
					5 Rating	Functioning Appropriately but-at-Risk					
6	0.5	Private		1-2	6 Desired	SE	HW 1-4	HQ 1-4	SB	GR	>90
			9		6 Current	SE	GR	HW 1-4	CJ 1-3	RB	99
					6 Rating	Functioning Appropriately					
7	2.4	Private		<1	7 Desired	SE	HW 1-4	GR	SB	GR	>90
			8		7 Current	SE	GR	HW 1-4	CJ 1-4	RB	98
					7 Rating	Functioning Appropriately					
8	0.8	Private		<1	8 Desired	SE	HA 1-4	HW 1-4	CP 2-5	GR	>90
			12		8 Current	SE	GR	HA 1-4	CP 1-5	CJ 1-3	96
					8 Rating	Functioning Appropriately					
9	0.6	BLM		<1	9 Desired	SE	HA 1-4	HW 1-4	CP 2-5	GR	>90
			12		9 Current	SE	GR	HA 1-4	CP 1-5	CJ 1-3	96
					9 Rating	Functioning Appropriately					
10	0.8	BLM		1-2	10 Desired	SE	HA 1-4	HD 1-4	CP 3-5	CL 2-4	>90
			13		10 Current	SE	GR	HA 1-4	CP 1-5	CL 1-3	96
					10 Rating	Functioning Appropriately					
11	0.8	Private		1	11 Desired	SE	HA 1-4	HW 1-4	SB	GR	>90
			13		11 Current	SE	GR	HA 1-4	CJ 1-3	SB	93
					11 Rating	Functioning Appropriately but-at-Risk					
12	1.4	Private		<2	12 Desired	SE	HA 1-4	HW 1-4	CP 3-5	CL 2-4	>90
			13		12 Current	SE	GR	HA 1-4	CL 1-4	CP 1-4	96
					12 Rating	Functioning Appropriately					
13	1.2	USFS		1	13 Desired	HA 1-4	SE	GR	CP 3-5	CL 2-4	>90
			16		13 Current	HA 1-4	SE	GR	CL 1-4	CP 1-4	99
					13 Rating	Functioning Appropriately					
14	1.1	USFS		1-4	14 Desired	HA 2-4	SE	GR	CP 3-5	CP 3-5	>90
			13		14 Current	HA 1-4	SE	GR	CL 1-4	CP 1-5	99
					14 Rating	Functioning Appropriately					
15	1.3	USFS		1-2	15 Desired	HA 1-4	HD 1-4	GR	CW 3-5	CP 3-5	>90
			14		15 Current	HA 1-4	HD 1-4	GR	CW 1-4	CP 1-4	99
					15 Rating	Functioning Appropriately					
16	2.9	USFS		2	16 Desired	HA 1-4	HD 1-4	SE	CW 3-5	CP 3-5	>90
			13		16 Current	HA 1-4	HD 1	SE	CW 1-3	CP 1-4	99
					16 Rating	Functioning Appropriately					
17	1.5	USFS		2	17 Desired	HA 1-4	SR 1	GR	CW 3-5	CP 3-5	>90
			12		17 Current	HA 1-4	SR 1	GR	CW 1-4	CP 1-4	99
					17 Rating	Functioning Appropriately					
18	1.1	USFS		2-6	18 Desired	HW 1-4	FS	GR	CL 2-4	MH 2-5	>90
			13		18 Current	HW 1-4	FS	GR	CL 1-3	MH 1-3	99
					18 Rating	Functioning Appropriately					
19	2.3	USFS		1-3	19 Desired	HW 1-4	FS	GR	CL 2-4	CP 3-5	>90
			10		19 Current	HW 1-4	FS	GR	CL 1-3	CP 1-3	100
					19 Rating	Functioning Appropriately					
20	1.4	USFS		3-4	20 Desired	SE	FS	GR	CL 2-4	GR	>90
			5		20 Current	SE	FS	GR	CL 1-3	GR	99
					20 Rating	Functioning Appropriately					
21	1.0	USFS		>4	21 Desired	SE	FS	GR	MH 2-5	CL 2-4	>90
			5		21 Current	SE	FS	GR	MH 1-4	CL 1-4	99
					21 Rating	Functioning Appropriately					

Vegetation Abbreviations: *Conifers:* CP-Ponderosa, CW-White Fir, CL-Lodgepole, CJ-Juniper, MH-Mountain Hemlock; Class (diameter breast height): 1-Shrub/Seedling (1"-4.9"), 2-Sapling/Pole (5"-8.9"), 3-Small Trees (9"-20.9"), 4-Large Trees (21"-31.9"), 5-Mature Trees (>32")
Riparian Hardwoods and Shrubs: HA-Alder, HW-Willow, HC-Cottonwood, HQ-Quaking Aspen, HD-Dogwood, HB-bog Birch, SP-Spirea, SR-Ribes, HX-Other; Class (height): 1 –(0-2ft.), 2 –(2-5ft.), 3 (5-10ft.), 4 (>10ft.)
Shrubs & Grass/Forb: SB-Big Sage, SS-Silver Sage, MM-Mountain Mahogany, RB-Rabbit Brush, GR-Grass, SE-Sedge, RU-Rush, LK-Larkspur, LC-Lupine, FS-Forb/Flower

The bank stability values in reaches 2, 5, and 11 are all less than or equal to 95%, resulting in **functioning appropriately but-at-risk** ratings. In addition, grass is more dominant than expected for these sites, indicating that plant succession is moving towards, but has not yet reached a late-seral community. The remaining sixteen reaches are **functioning appropriately** due to the dominance of late-seral species and bank stability being greater than 95% (a few reaches did have more grass than expected, but bank stability values were greater than 95%. Encroachment of lodgepole pine into the riparian area was noted in reaches 12-14, with an abundance of smaller trees noted in many of the forested reaches. Also, localized areas of bank instability were noted reach 2, 5, and 7-12.

Most of the lands along reaches 2-12 is privately owned with pastures that have been primarily grazed throughout the summer and early fall months, which has had a great influence on bank stability and vegetative conditions. Along many of these reaches, however, management practices have been modified allowing for the recovery of riparian vegetation and stream channels. Thus, riparian vegetation and stream banks are recovering. An additional factor affecting bank stability within the lower reaches of this stream might be the increased drainage network associated with roads throughout the watershed, possibly influencing the timing and magnitude of stream flows and their effects on channel scouring. In the higher gradient reaches (reaches 14-21) bank stability is greater than 99%, the result of naturally stable stream types and the dominance of late-seral species. The majority of these reaches (reaches 17-21) lie within the Yamsay pasture, which has not been grazed since 1998. The scattered encroachment of lodgepole pine and other conifers into riparian areas within forested reaches is likely the result of the altered fire regime.

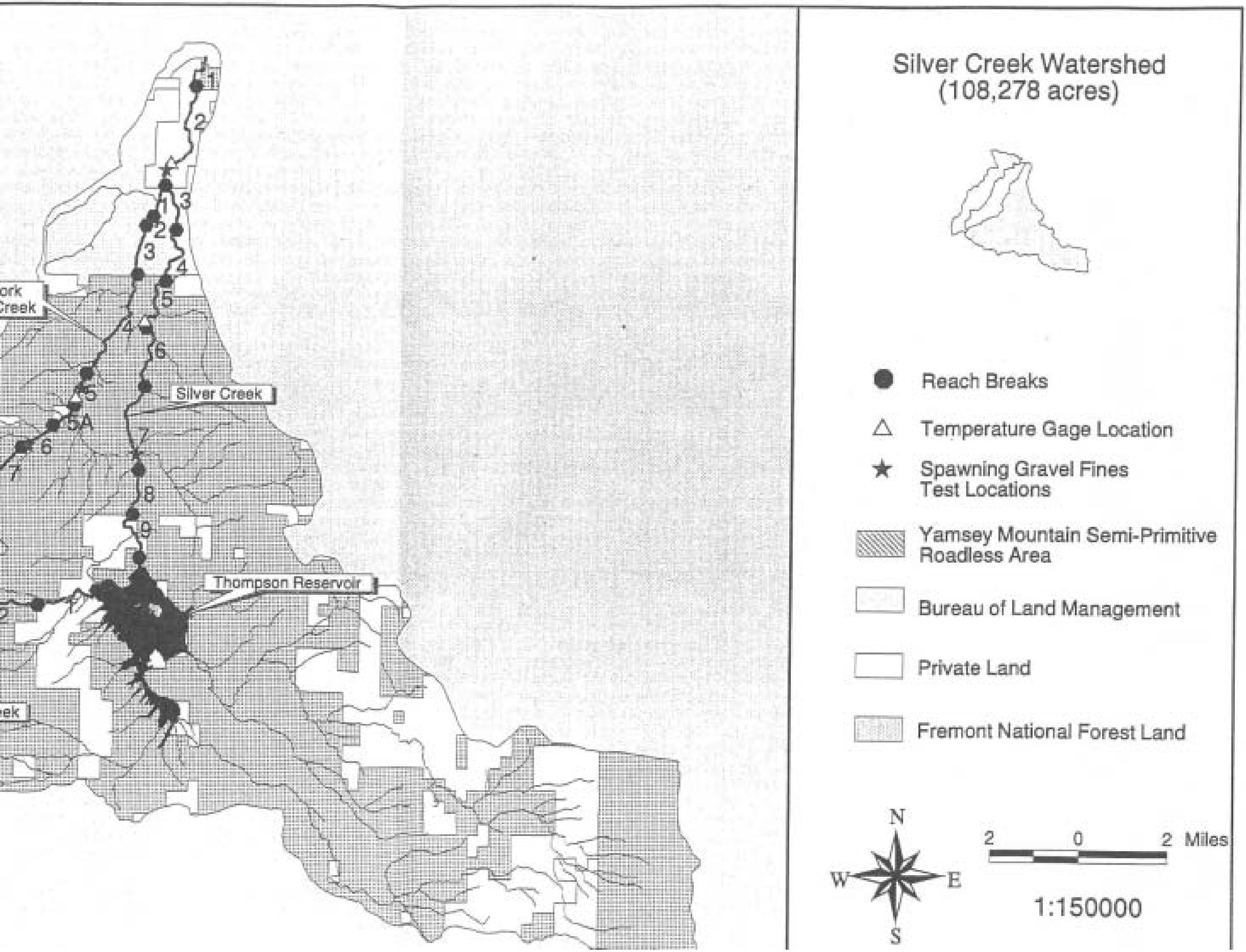
Summary for the Silver Lake Watershed

Approximately 83 miles of stream were surveyed within the three watersheds and were distributed in the following manner: Silver Creek (42 miles), Bridge Creek (16 miles), and Buck Creek (25 miles). The following is a short summary of riparian and stream channel conditions within the entire Silver Lake Watershed. For reach locations refer to Figures 4.1, 4.2, and 4.3 – Silver Creek, Bridge Creek, and Buck Creek Watershed Reach and Monitoring Locations.

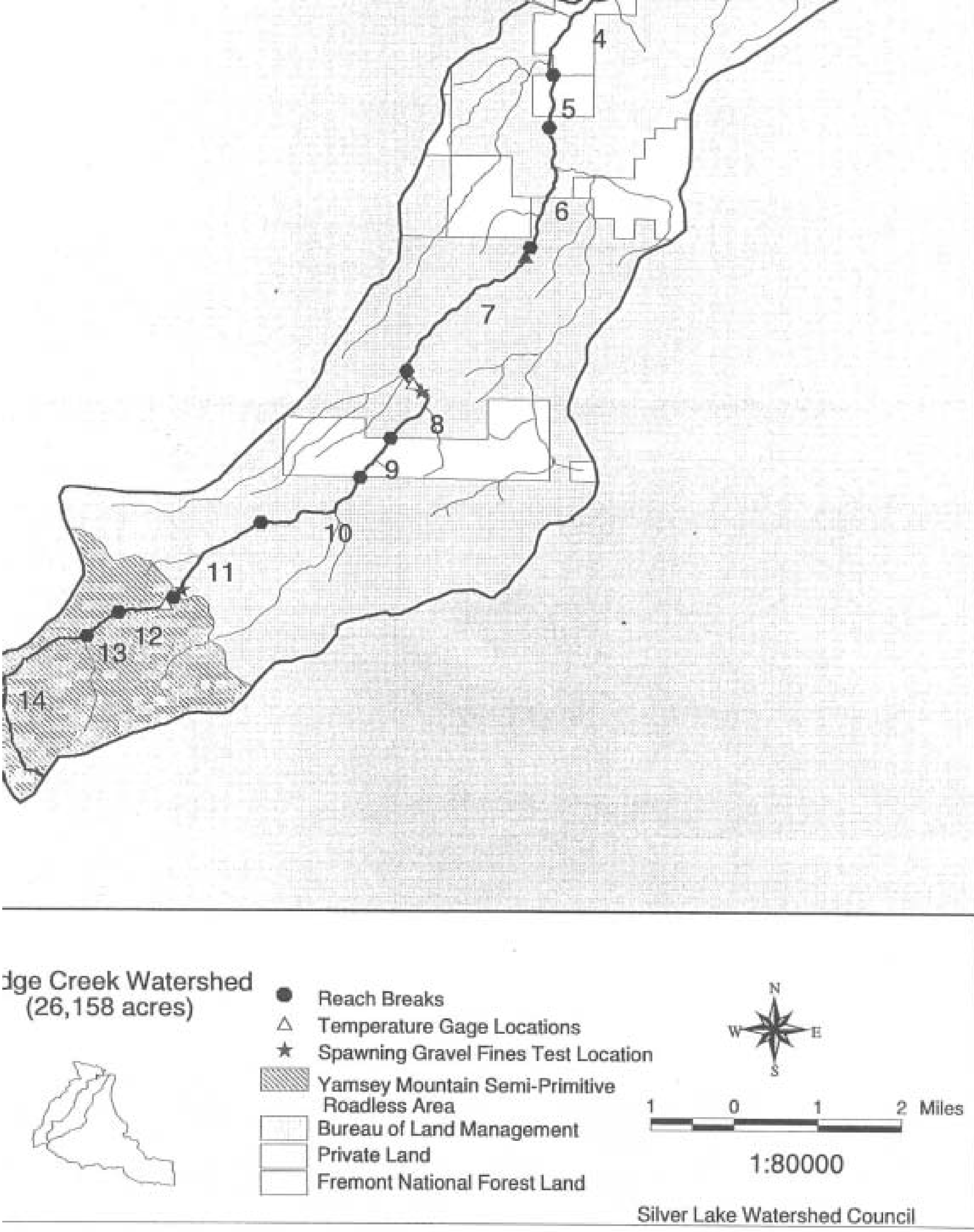
Eighty-six percent of the reaches surveyed (89% of the miles surveyed) have an abundance of late-seral riparian vegetation, and thus are **functioning appropriately**, while 14% of the reaches (11% of the miles surveyed) are **functioning appropriately but-at-risk**. There were no reaches surveyed found to be functioning inappropriately. The majority of those reaches functioning appropriately are B and E stream types, most having an abundance of late seral vegetation and high bank stability, exceeding 95%. The areas that were not rated as functioning appropriately are predominantly C stream types located along the low gradient meadow reaches of Bridge, Buck, and West Fork Silver Creeks. In general, these meadow reaches have bank stability values less than 95% (82%-95%) and are lacking an abundance of sedge and willow. Because gravel point bars are common in C stream types, greater densities of willow are expected relative to other stream types.

The B stream types are usually located in forested reaches and within canyons, areas that are inherently stable. For this reason, forest management activities (such as timber harvest and grazing) have been conducted away from these stream reaches, leaving them relatively unaffected. However, the lack of fire continues to promote higher densities of conifers in riparian areas along B stream types, creating a minor shift in relative species abundance. In addition, many of the E stream types found throughout the watershed are characterized and maintained by late-seral vegetation, resulting from grazing management which appears conducive to late-seral plant composition. As mentioned above, the majority of stream reaches that are not functioning appropriately are the C stream types located along the low gradient meadow reaches of Bridge, Buck and West Fork Silver Creeks. Because these are areas of high forage production, late season grazing practices have altered riparian vegetation. For example, some of these areas have less sedge (more grass) than is desired, and have the potential to produce greater densities of large willow than currently exists; however, cattle graze willow during the late summer because the desirable plant species have lost their palatability and protein contents. An additional factor affecting bank stability within these streams, especially in the lower reaches, might be the increased drainage network associated with roads throughout the watershed, possibly influencing the timing and magnitude of stream flows and their effects on channel scouring.

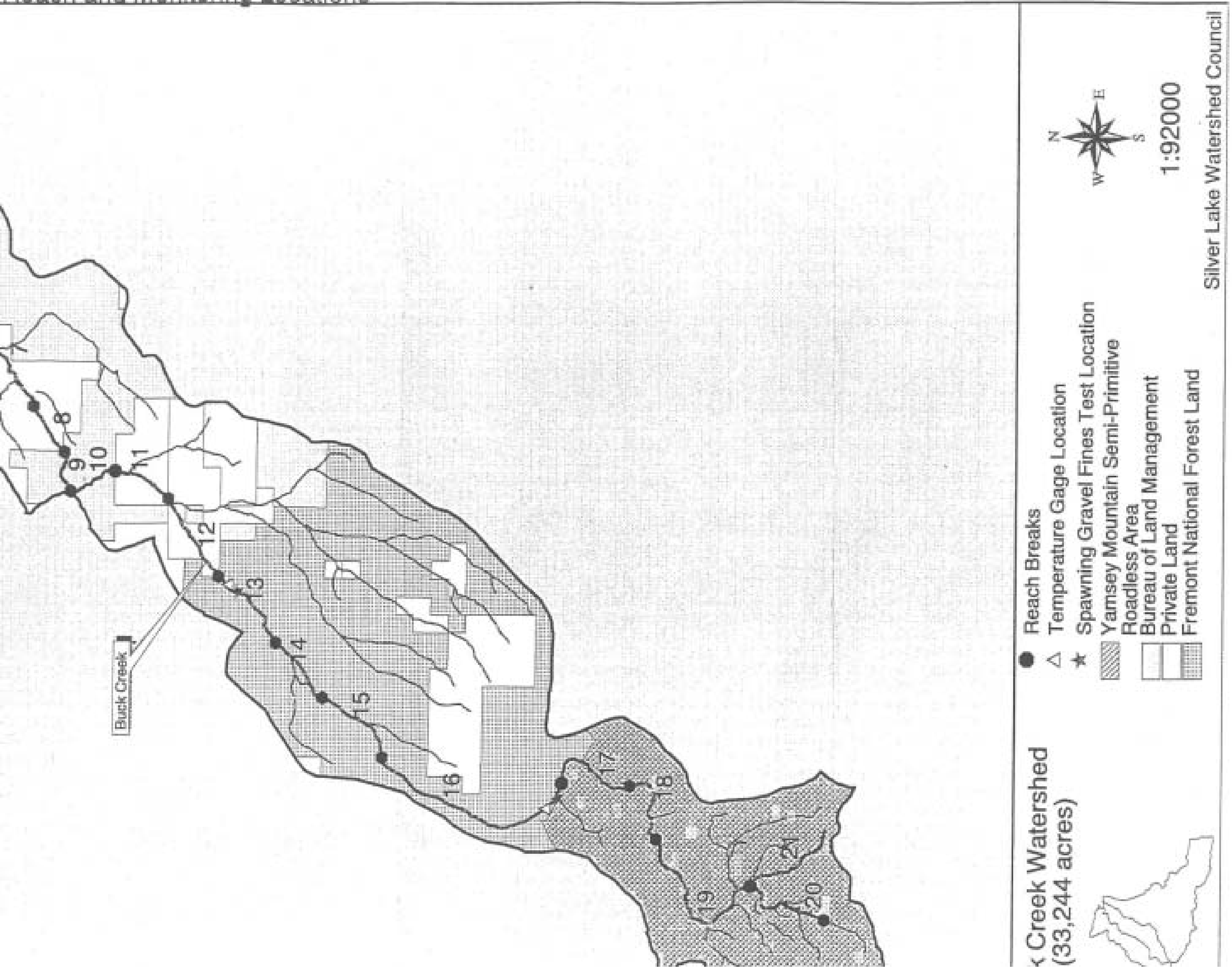
d Reach and Monitoring Locations



d Monitoring Locations



Reach and Monitoring Locations



B) Rosgen Stream Type(s)

In order to address this part of Question 2, survey crews and resource professionals gathered and summarized stream channel characteristics information on a reach basis. In general, a reach is a segment of stream of similar gradient, valley type, etc. For example, a segment of stream flowing through a gentle meadow valley would be a separate reach relative to a segment occurring in a steeper mountain area. Only the primary perennial streams within each watershed were surveyed (refer to part a for a short summary of the streams, and number of reaches surveyed, within the three watersheds).

Methods: As part of the stream surveys that occurred within the three watersheds, field measurements outlined in Rosgen (1996) were conducted to determine stream type. These measurements included entrenchment, bankfull width-to-depth ratio, sinuosity, gradient, and dominant channel substrate. *Entrenchment* is the vertical containment of the stream channel and refers to the ability of a stream to access its floodplain. The stream is entrenched when floodwaters are confined to the channel and is not entrenched when floodwaters are able to access the floodplain. *Bankfull width-to-depth ratio* indicates the shape of the channel, and is the ratio of bankfull width to mean bankfull depth. Bankfull stage is the point at which the stream accesses its floodplain and is a required measurement in order to determine width-to-depth ratios. It is synonymous to the flood stage, has an average return interval of 1.5 years (Leopold 1964), and is considered the channel forming flow. Width-to-depth ratios indicate whether the stream is wide and shallow or narrow and deep. *Sinuosity* refers to the extent with which a stream meanders across the landscape. Highly sinuous streams have many meanders and curves, while streams with low sinuosity are straighter with few meanders and curves. *Gradient* is the slope or steepness of the stream while the *dominant channel substrate* refers to the size of particle or rock that covers the stream channel. The following discussion provides a general description of each of the Rosgen Stream Types found within the surveyed reaches of the watershed (see the desired conditions section for further stream type descriptions).

Rosgen A stream types are associated with landforms of high relief, are deeply incised and characterized by steep gradients. They typically have cascading, step/pool morphology with high energy, sediment supply and transport potential.
Rosgen B stream types typically occur on narrow, gently sloping valleys and terrain and are characterized by moderate gradients and colluvial deposition. They are riffle-dominated channels with infrequently spaced scour pools. These stream types are typically very stable and usually found in forested systems where large woody debris plays an important role in pool formation.
Rosgen C streams types are associated with broad alluvial valleys with well-defined floodplains. They are low gradient, meandering streams characterized by riffle/pool sequences and point bars.
Rosgen E stream types are also found in broad alluvial valleys and meadows with well-developed floodplains. They are low-gradient, highly sinuous streams that are stable due to well-vegetated banks. When vegetation is lacking these channel types are highly sensitive to disturbance, which may result in increased levels of streambank erosion and downcutting. The E stream type provides excellent fish habitat through undercut banks, clean spawning gravels, and numerous deep pools.

Data collected from stream surveys in both the Upper Sycan River and Chewaucan River watersheds indicate that E stream types are expected in low gradient meadow reaches with a drainage area of less than 18 square miles, while C Stream Types are expected where drainage areas exceed approximately 18 square miles.

Current Conditions

Current conditions of stream channels in the Silver Lake Watershed have been governed by climate, geology and past human caused (anthropogenic) activities such as grazing, logging and road construction, and trapping. These activities have affected the hydrologic regime and influenced erosion and sediment delivery to streams, and have altered the natural cycles of disturbance. These factors have combined to cause changes in channel conditions throughout the analysis area and have resulted in channel/riparian conditions different than what existed prior to settlement. Where concentrated grazing, roads and skid trails are located within drainages and/or riparian areas, riparian ecosystems have been affected. Historic beaver activities are located throughout the streams within the analysis area, but in most cases the dams are no longer active and no longer impound water or provide pool habitat and sediment retention to the stream systems. Additionally, encroachment of conifers into the floodplain is evidence that the riparian zones may be narrowing and that streamside riparian areas have a lower water table than potential for the streams.

The summary tables that follow describe the types of stream channels found within the three watersheds. For reach locations refer to Figures 4.1, 4.2, and 4.3 – Silver, Bridge, and Buck Creek Watershed Reach and Monitoring Locations.

Silver Creek Watershed: The following tables (Tables 4.13, 4.14, 4.15, and 4.16) are a summary of the types of stream channels that occur within the surveyed reaches of Silver, West Fork Silver, North Fork Silver, and Guyer Creeks. When two or more stream types are listed for a reach, the dominant is listed first.

Table 4.13 - Silver Creek – Rosgen Stream Types

Reach Information					Rosgen Stream Type(s) and Associated Bankfull W/D Ratio	
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Rosgen Stream Type(s)	Bankfull Width/Depth Ratio
1	0.7	USFS	17	1	C	13
2		Private				
3		Private				
4	1.6	BLM	22	1	C, B_c	18
5	1.5	USFS	22	1	C, B_c	18
6	1.8	USFS	26	1	C, B_c	17
7	2.3	USFS	24	1	B_c, C	25
8	1.2	USFS	24	1	B_c, C	25
9	1.3	USFS	24	2	B, B_c	26

B_c refers to B stream types with lower gradients (<2%)

Table 4.14 - West Fork Silver Creek – Rosgen Stream Types

Reach Information					Rosgen Stream Type(s) and Associated Bankfull W/D Ratio	
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Rosgen Stream Type(s)	Bankfull Width/Depth Ratio
1	0.5	BLM	6	1	C, E	7
2	0.7	BLM	10	1	C, E	13
3	1.1	BLM	12	1	B_c, C	12
4	3.0	USFS	11	1	B_c, C, B, E	12
5	1.2	USFS	9	<1	C, E	12
5a		Private				
6	1.2	USFS	8	<1	E, C, B_c	14
7	2.0	USFS	8	3	B, B_c, E, B_a	13
8	3.0	USFS	8	1-2	E, B	9
9	1.5	USFS	7	1-2	E, B	10
10	1.3	USFS	7	<1	E_b, B	7
11	1.7	USFS	5	1-2	E, E_b	5
12	0.7	USFS	5	2-4	B, E_b	18
13	1.0	USFS	4	>4	A, B_a	8

E_b refers to E stream types with steeper gradients (2-4%); B_a refers to B stream types with steeper gradients (>4%);
B_c refers to B stream types with lower gradients (<2%)

Table 4.15 - North Fork Silver Creek – Rosgen Stream Types

Reach Information					Rosgen Stream Type(s) and Associated Bankfull W/D Ratio	
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Rosgen Stream Type(s)	Bankfull Width/Depth Ratio
1	2.3	USFS	5	1-4	B, E_b, E	10
2	2.6	USFS	5	2-4	B, B_a, E_b, E	9

E_b refers to E stream types with steeper gradients (2-4%); B_a refers to B stream types with steeper gradients (>4%);

Table 4.16 - Guyer Creek – Rosgen Stream Types

Reach Information					Rosgen Stream Type(s) and Associated Bankfull W/D Ratio	
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Rosgen Stream Type(s)	Bankfull Width/Depth Ratio
1		Private				
2	1.9	USFS	8	2	B, E_b, B_a, E	11
3	2.9	USFS	7	2-4	E_b, E, B_c, B	7
4	0.7	USFS	5	2-4	E_b, B	5
5	2.0	USFS	5	2-4	E_b, E, B	7
6	1.1	USFS	4	>4	B_a, B, A	11

E_b refers to E stream types with steeper gradients (2-4%); B_a refers to B stream types with steeper gradients (>4%);
B_c refers to B stream types with lower gradients (<2%)

Benny, Squaw, and Indian Creek Subwatersheds of the Silver Creek Watershed: No surveys occurred within these subwatersheds. Stream channels are intermittent and transport water only during spring snowmelt and intense thunderstorm events. Stream channels within these subwatersheds are typically characterized as Rosgen B stream types, with inclusions of Rosgen C and F stream types in the lower gradient, depositional reaches. The Rosgen B stream types found within these subwatersheds are confined by gentle side-slopes, have stream gradients over 2%, and are composed of stable stream bottom materials (cobble, boulder and bedrock). In the majority of the lower gradient reaches, channels have downcut and are disconnected from their historic floodplain.

Bridge Creek Watershed: The following table (Table 4.17) is a summary of the types of stream channels that occur within the surveyed reaches of Bridge Creek. When two or more stream types are listed for a reach, the dominant is listed first.

Table 4.17 - Bridge Creek – Rosgen Stream Types

Reach Information					Rosgen Stream Type(s) and Associated Bankfull W/D Ratio	
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Rosgen Stream Type(s)	Bankfull Width/Depth Ratio
1	0.8	Private	6	<1	E, C	10
2	1.7	Private	7	<1	E, C, B_c	10
3	1.3	Private	8	1	C, E	14
4		Private				
5	0.7	Private	11	1	C, E	13
6	1.7	BLM/FS	9	1	C, B, E	7
7	2.2	USFS	10	1-4	B, B_a, E_b, E, C	10
8	1.0	USFS	10	<2	B, B_c, E, C	12
9	0.6	Private	9	1-2	B, C	14
10	1.5	USFS	9	2-4	B, E_b	13
11	1.4	USFS	10	2-4	B, B_c	19
12	0.7	USFS	6	2-8	B, B_a, E	8
13	0.5	USFS	7	1	E	8
14	2.3	USFS	6	2-8	E_b, E, B	8

E_b refers to E stream types with steeper gradients (2-4%); B_a refers to B stream types with steeper gradients (>4%);
B_c refers to B stream types with lower gradients (<2%)

Buck Creek Watershed: The following table (Table 4.18) is a summary of the types of stream channels that occur within the surveyed reaches of Buck Creek. When two or more stream types are listed for a reach, the dominant is listed first.

Table 4.18 - Buck Creek – Rosgen Stream Types

Reach Information					Rosgen Stream Type(s) and Associated Bankfull W/D Ratio	
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	Rosgen Stream Type(s)	Bankfull Width/Depth Ratio
1		Private				
2	2.0	BLM	16	1	C, B_c	16
3	1.5	Private	14	<1	C	12
4		Private				
5	0.6	Private	14	<1	C	14
6	0.5	Private	15	1-2	C	12
7	2.4	Private	14	<1	C	12
8	0.8	Private	12	<1	C, B_c	12
9	0.6	BLM	12	<1	C, B_c	21
10	0.8	BLM	15	1-2	C, B_c, B	16
11	0.8	Private	15	1	C, B_c, B	14
12	1.4	Private	15	<2	C, B_c, B, E	12
13	1.5	USFS	18	1	C, B_c, B	16
14	1.1	USFS	17	1-4	C, B, B_c	16
15	1.5	USFS	14	1-2	B_c, B	17
16	2.9	USFS	13	2	B	19
17	1.5	USFS	12	2	B	15
18	1.1	USFS	13	2-8	B, B_a, A	18
19	2.5	USFS	10	1-3	B, C	14
20	1.4	USFS	5	1-4	B, E_b, E	9
21	1.0	USFS	5	>4	B, E_b, E, A	12

E_b refers to E stream types with steeper gradients (2-4%); B_a refers to B stream types with steeper gradients (>4%);
B_c refers to B stream types with lower gradients (<2%)

Desired Conditions

Stream classification systems are an attempt to simplify complex relationships between streams and associated watersheds. Anderson et al. (1998) suggests that a purpose of classification systems is to describe a stream's position in the landscape and the range of variability for parameters related to channel size, shape, and pattern. Channel morphology measurements associated with a particular classification system provide a great deal of information in determining whether or not the width-to-depth ratio, sinuosity, and gradient of a stream are in balance with the landscape setting. A stream's ability to dissipate energy is closely tied to its sinuosity, width-to-depth ratio, and gradient. When one of these parameters is altered, the stream becomes out of balance in terms of the shape and size expected for its setting. For example, a decrease in sinuosity (stream length relative to valley length) results in a higher stream gradient, which in-turn increases velocities. Increased velocities lead to accelerated erosion, which may further alter channel shape and gradient.

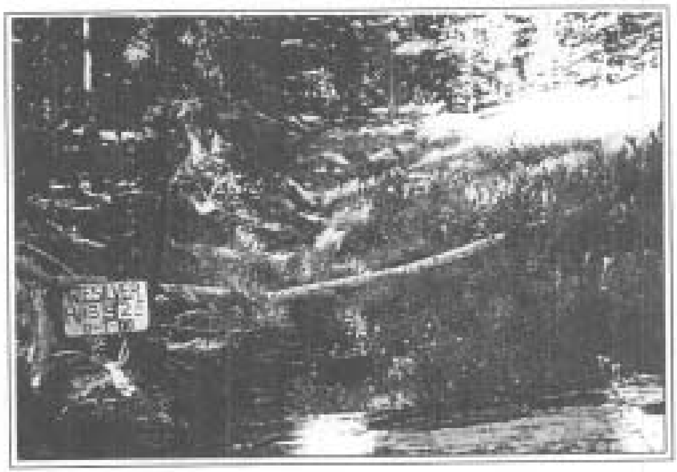
For this assessment, the Rosgen Classification system was selected because it aids in describing the natural potential of each stream, based on numerous measurements, such as entrenchment, bankfull width-to-depth ratio, sinuosity, gradient, and dominant channel substrate (Rosgen 1996). *Entrenchment* is the vertical containment of the stream channel and refers to the ability of a stream to access its floodplain. The stream is entrenched when floodwaters are confined to the channel and is not entrenched when floodwaters are able to access the floodplain. *Bankfull width-to-depth ratio* indicates the shape of the channel, and is the ratio of bankfull width to mean bankfull depth. Bankfull stage is the point at which the stream accesses its floodplain and is a required measurement in order to determine width-to-depth ratios. It is synonymous to the flood stage, has an average return interval of 1.5 years (Leopold 1964), and is considered the channel forming flow. Width-to-depth ratios indicate whether the stream is wide and shallow or narrow and deep. *Sinuosity* refers to the extent with which a stream meanders across the landscape. Highly sinuous streams have many meanders and curves, while streams with low sinuosity are straighter with few meanders and curves. Gradient is the slope or steepness of the stream while the *dominant channel substrate* refers to the size of particle or rock that covers the stream channel. Rosgen (1996) describes enhancement methods for each channel type, methods that work with natural processes of the stream.

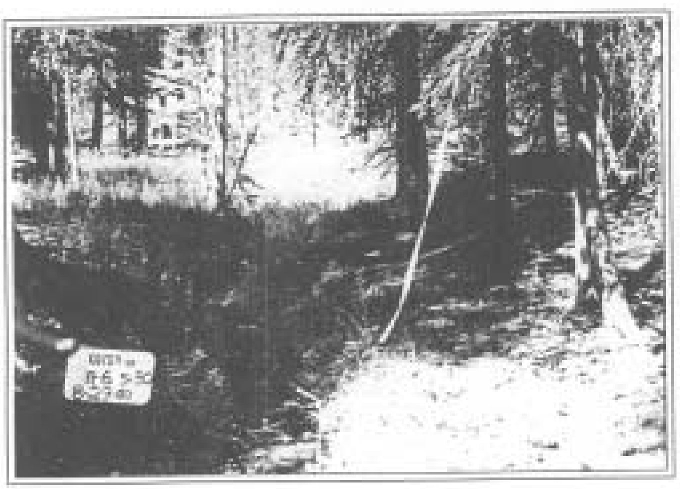
Desired Rosgen Stream Types:

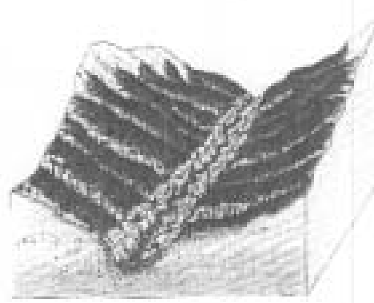
Surveys conducted in the Silver Lake Watershed reveal stream types A, B, C, and E. The stream type descriptions shown below are based on Rosgen (1996). Numbers, which follow the letter designation, refer to substrate size. In this summary, number 3 refers to substrate from baseball to basketball size while number 4 refers to gravel size substrate.

Rosgen A Stream Type

Rosgen A stream types are characterized by steep gradients (between 4 and 10%), with deeply incised channels, and entrenchment ratios <1.4. They have low width/depth ratios (<12) and low sinuosity (<1.2). Local landform and geology dictates channel stability. The A3 channel types, found in the Silver Lake Watershed, are characterized by a high sensitivity to disturbance, very high stream bank erosion potential, and vegetation having a negligible influence in determining channel stability. Overall, these channels exhibit high sediment supply and transport potential. Large woody debris plays a significant role in determining frequency of step pools which provides fish habitat and overall channel stability.







Delineative Criteria (A3)

Landform/soils: Steep narrow depositional slopes typical of glacial moraines and debris slides associated with unconsolidated, heterogenous and non-cohesive materials.

Channel Materials: Predominately cobble with a mixture of boulders, gravel and sand.

Slope Range: .04 - .10 (A3a+ > .10)

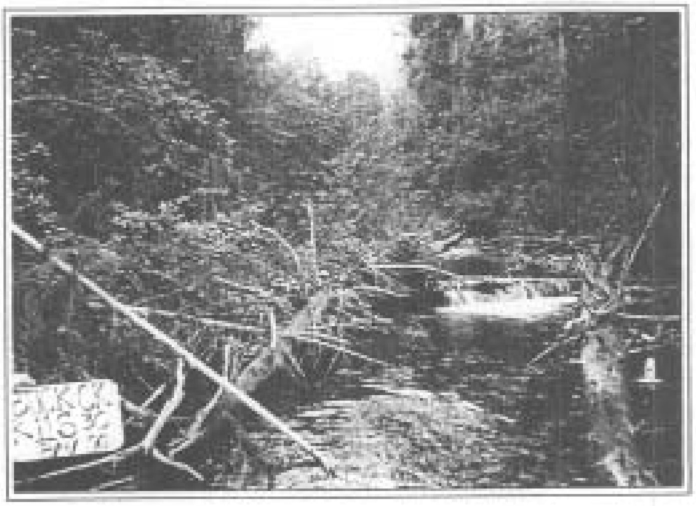
Entrenchment ratio: < 1.4

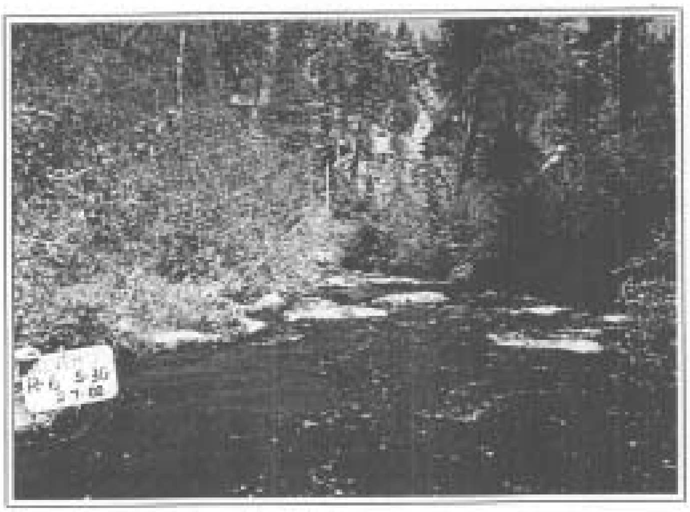
Width/depth Ratio: < 12

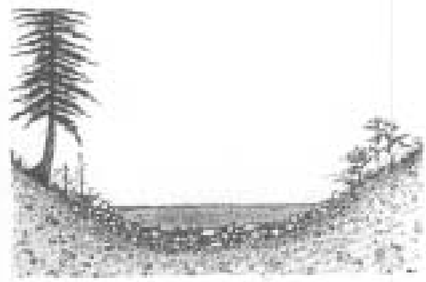
Sinuosity: <1.2

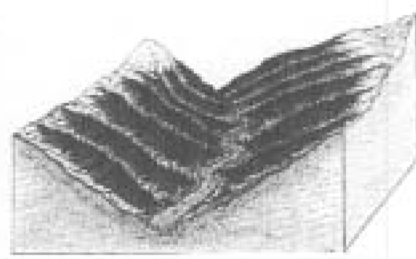
Rosgen B Stream Type

Rosgen B stream types are moderately steep (between 2 and 4%), with rapids and riffles common and scour pools irregularly spaced. These stream types are moderately entrenched (1.4-2.2), with moderate width-to-depth ratios (>12) and sinuosity (>1.2). They are found within "V" type valleys, usually in forested systems, with substrates ranging from gravel (B3) to cobble (B4). Vegetation has a moderate influence in determining channel stability. These channel types are characterized by low to moderate sensitivity to disturbance and low streambank erosion. Fish habitat is often associated with large woody debris which contributes to scour pool formation and cover.









Delineative Criteria (B3)

Landform/soils: Narrow, moderately steep colluvial valley with gentle side slopes. Soils are colluvium and/or alluvium. Often in fault line valleys or on well vegetated alluvial fans.

Channel Materials: Predominately cobble with lesser amounts of boulders, gravel and sand. Streambanks are stable due to coarse material.

Slope Range: .02 - .04 (B3c, < .02)

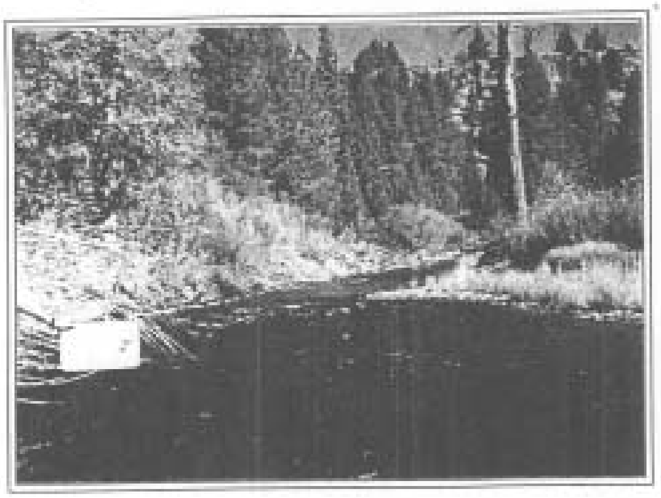
Width/depth Ratio: > 12

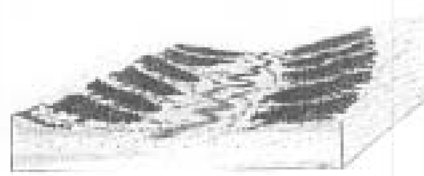
Entrenchment Ratio: 1.4-2.2

Sinuosity: >1.2

Rosgen C Stream Type

Rosgen C streams types are lower gradient streams which are slightly entrenched (>2.2), have moderate to high (>12) width-to-depth ratios, high sinuosity values (>1.4), and are characterized by riffle/pool sequences. Streams within the watershed are often found in low gradient alluvial valleys with substrates dominated by gravel (C4). Channels have characteristic point bars and broad, well defined floodplains. Vegetation has a very high influence in determining channel stability, and when vegetation is disturbed and removed, these channel types are highly sensitive to both lateral (bank) and vertical (downcutting) erosion. Natural sediment supply is moderate to high except in those areas where stream banks are well vegetated. These streams are highly sensitive to changes in sediment and stream flow.





Delineative Criteria (C4)

Landform/soils: Broad, gentle gradient alluvial valleys and river deltas. Soils are alluvium.

Channel Materials: Predominately gravel, with lesser amounts of cobble, sand and silt/clay.

Slope Range: < .02 (C4c- .001)

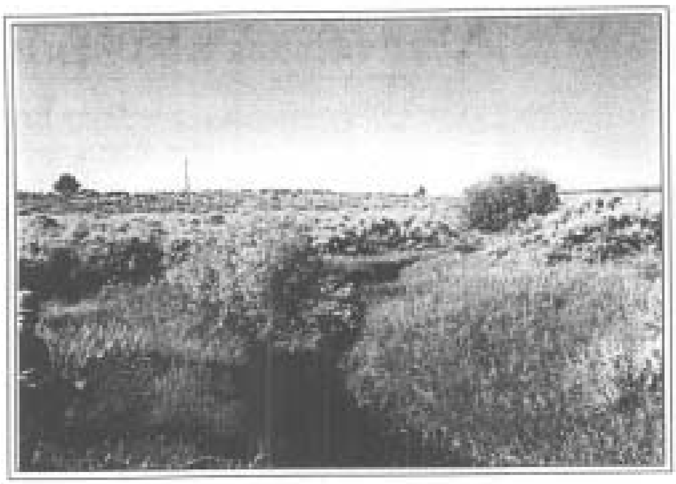
Entrenchment ratio: > 2.2

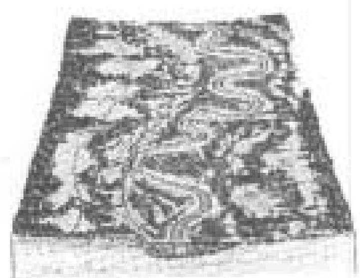
Width/depth Ratio: > 12

Sinuosity: > 1.4

Rosgen E Stream Type

Rosgen E stream types are low-gradient streams (<2%, but can reach 4%) which are slightly entrenched (>2.2) with low width-to-depth ratios (<12), and high sinuosity (>1.5), with riffle/pool sequences and well developed floodplains. In the Silver Lake Watershed, channel substrate is dominated by gravel (E4) and to a lesser degree cobble (E3). Valleys are usually wide and gently sloped. Vegetation has a very high influence on channel stability. When it is lacking, these channel types are highly sensitive to disturbance which may result in increased levels of streambank erosion and downcutting. These streams are highly sensitive to changes in sediment and stream flow. The E stream type provides excellent fish habitat through undercut banks, clean spawning gravels, and numerous deep pools.





Delineative Criteria (E4)

Landform/soils: Gentle slopes in broad riverine or lacustrine valleys and river deltas.

Channel Materials: Gravel dominated bed with smaller accumulations of sand and occasional cobble. Streambanks composed of sandy/gravel mixture with dense root mat.

Slope Range: < 0.02

Entrenchment ratio: > 2.2

Width/depth Ratio: < 12

Sinuosity: >1.5

Properly functioning Rosgen A stream types are characterized by steep gradients (between 4 and 10%), with deeply incised channels and entrenchment ratios less than 1.4. They have low width/depth ratios (<12) and low sinuosity (<1.2). Local landform and geology dictates channel stability. The A3 channel types, found in the Silver Lake Watershed, are characterized by a moderate-to-high sensitivity to disturbance, moderate-to-high streambank erosion potential, and vegetation having a negligible influence in determining channel stability. Overall, these channels exhibit moderate-to-high sediment supply and transport potential. Large woody debris plays a significant role in determining frequency of step pools, which provides fish habitat and overall channel stability.

Properly functioning Rosgen B stream types are moderately steep (between 2 and 4%) with rapids and riffles common and scour pools irregularly spaced. These stream types are moderately entrenched (1.4-2.2), with moderate width-to-depth ratios (>12) and sinuosity (>1.2). They are found within "V" type valleys, usually in forested systems, with substrates ranging from gravel (B3) to cobble (B4). Vegetation has a moderate influence in determining channel stability. These channel types are characterized by low to moderate sensitivity to disturbance and low streambank erosion. Fish habitat is often associated with large woody debris, which contributes to scour pool formation and cover.

Properly functioning Rosgen C stream types are characterized as low gradient streams which are slightly entrenched (>2.2), have a moderate to high (>12) width-to-depth ratio, high sinuosity values (>1.4), and are characterized by riffle/pool sequences. Streams within the watershed are often found in low gradient alluvial valleys with substrates dominated by gravel (C4). Channels have characteristic point bars and broad, well defined floodplains. Vegetation has a very high influence in determining channel stability, and when vegetation is disturbed and removed, these channel types are highly sensitive to both lateral (bank) and vertical (downcutting) erosion. Natural sediment supply is moderate to high except in those areas where stream banks are well vegetated. These streams are highly sensitive to changes in sediment and stream flow regime.

Properly functioning Rosgen E stream types are low gradient streams (<2%, but can reach 4%) that are slightly entrenched (>2.2), have low width-to-depth ratios (<12) and high sinuosity values (>1.5), and are characterized by riffle/pool sequences and well-developed floodplains. In the Silver Lake Watershed, channel substrate is dominated by gravel (E4) and to a lesser degree cobble (E3). Valleys are usually wide and gently sloped. Vegetation has a very high influence on channel stability. When it is lacking these channel types are highly sensitive to disturbance, which may result in increased levels of streambank erosion and downcutting. These streams are highly sensitive to changes in sediment and stream flow. The E stream type provides excellent fish habitat through cool water temperatures, undercut banks, clean spawning gravels, and numerous deep pools.

Desired Channel Evolution for a Degraded Low-Gradient System: When vegetation is lacking along an E stream type, lateral (bank) and vertical (downcutting) erosion may lead to progressive stages of channel adjustment, resulting in altered channel dimension, pattern, and profile. As a result of the bank erosion and downcutting, the channel becomes wider and shallower, resulting in a higher width/depth ratio (a conversion from an E to C stream type). During downcutting events, the channel becomes an incised gully, straighter and steeper than the original channel—a G stream type. In doing so, the channel abandons its original floodplain, resulting in a lowered water table. Although downcutting subsides, lateral erosion continues because flood energies are confined within the incised channel. As the banks erode, the width-to-depth ratio continues to increase, creating a wide, shallow, and entrenched stream with no floodplain--an F stream type. The lateral erosion will continue until a floodplain is developed and wide enough to dissipate flood energies. The development of a floodplain will only occur with good riparian vegetation that is resistant to flows and able to trap sediments and build banks. This will continue until the stream reaches a condition where it is naturally stable and in balance with the landscape setting. Once at this desired state (an E stream type), the stream is able to accommodate the flow and sediment produced by its watershed while maintaining its dimension, pattern and profile (see Figure 4-x for desired channel evolution).

Functioning Appropriately - stream channel is highly similar to the Rosgen stream type expected for its setting. ***This is the desired (target) condition.***

Functioning Appropriately but-at-Risk - stream channel is highly similar to the Rosgen stream type expected for it's setting, but its bankfull width-to-depth ratio is larger than expected.

Functioning Inappropriately - stream channel is different from the Rosgen stream type expected for its setting (i.e. we expect an E stream type and it is an F stream type).

Data collected from stream surveys in both the Upper Sycan River and Chewaucan River watersheds indicate that E stream types are expected in low gradient meadow reaches with a drainage area of less than 18 square miles, while C Stream Types are expected where drainage areas exceed approximately 18 square miles.

Summary and Synthesis for the entire Silver Lake Watershed Assessment Area

Summary of, and factors contributing to, current conditions for the Silver Creek Watershed: The following tables (Tables 4.19, 4.20, 4.21, and 4.22) summarize current and desired stream types for Silver, West Fork Silver, North Fork Silver and Guyer Creeks. Ratings given within these tables are based on a comparison of current and desired conditions (see desired conditions section for ratings) within each of the surveyed stream reaches. Following each table is a discussion of these ratings and the factors contributing to current conditions, as well as any trends in conditions. When two or more stream types are listed for a reach, the dominant is listed first. For reach locations refer to Figure 5.3 – Silver Creek Watershed Reach and Monitoring Locations.

Silver Creek

Table 4.19 - Silver Creek – Rosgen Stream Types

Reach Information					Condition	Rosgen Stream Type(s) and Associated Bankfull W/D Ratio	
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	Rosgen Stream Type(s)	Bankfull Width/Depth Ratio
1	0.2	USFS	17	1	1 Desired	C	13-25
					1 Current	C	15
					1 Rating	Functioning Appropriately	
2	[illegible]	Private	[illegible]	[illegible]	2 Desired	[illegible]	[illegible]
					2 Current		
					2 Rating		
3	[illegible]	Private	[illegible]	[illegible]	3 Desired	[illegible]	[illegible]
					3 Current		
					3 Rating		
4	[illegible]	BLM	22	[illegible]	4 Desired	C, B	13-25
					4 Current	C, B	18
					4 Rating	Functioning Appropriately	
5	3.9	USFS	22	1	5 Desired	C, B	13-25
					5 Current	C, B	16
					5 Rating	Functioning Appropriately	
6	1.8	USFS	22	[illegible]	6 Desired	C, B	13-25
					6 Current	C, B	17
					6 Rating	Functioning Appropriately	
7	2.3	USFS	25	[illegible]	7 Desired	B, C	13-38
					7 Current	B, C	25
					7 Rating	Functioning Appropriately	
8	[illegible]	USFS	23	[illegible]	8 Desired	B, C	13-38
					8 Current	B, C	23
					8 Rating	Functioning Appropriately	
9	1.3	USFS	23	2	9 Desired	B, B	13-38
					9 Current	B, B	26
					9 Rating	Functioning Appropriately	

All reaches of Silver Creek are **functioning appropriately** in terms of their potential stream type as the shape and size of the stream channel is in balance with its setting. Reaches 1 and 4-6 are a mix of C and B stream types that typically have low gradients (1% or less), gentle sideslopes, gravel/cobble substrates, and some level of floodplain development – although some portions of these reaches are more confined due to the adjacent sideslopes; while reaches 7-9 are primarily B stream types (reaches 7 and 8 have inclusions of C stream types) that are characterized by slightly higher stream gradients (but still less than 2%), more confined floodplains, and higher width-to-depth ratios.

The dominance of sedge, alder, willow and dogwood in these reaches promotes high bank stability and channels that are resistant to the erosive energy associated with high flows. Also, management activities appear to be conducive to maintaining vegetation in the floodplains, which are able to dissipate energy associated with larger flow events.

Although upland vegetation and road density both received functioning appropriately but-at-risk ratings, any modification to the magnitude and timing of stream flows has not shifted channels from their natural potential. The reason for this is primarily associated with Thompson Reservoir, which has modified the flow characteristics in Silver Creek – the reservoir collects the larger early spring runoff events and releases the water later in the year. Accordingly, the channel dimensions of Silver Creek have adjusted (become wider and shallower) to accommodate these regulated flows.

West Fork Silver Creek

Table 4.20 - West Fork Silver Creek – Rosgen Stream Types

Reach Information					Condition	Rosgen Stream Type(s) and Associated Bankfull W/D Ratio	
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	Rosgen Stream Type(s)	Bankfull Width/Depth Ratio
1	0.5	BLM	6	1	1 Desired	C, E	13-25
					1 Current	C, E	7
					1 Rating	Functioning Appropriately	
2	0.3	BLM	10	3	2 Desired	C, E	13-25
					2 Current	C, E	11
					2 Rating	Functioning Appropriately	
3	2.1	BLM	<17	[illegible]	3 Desired	B_c, C	13-18
					3 Current	B_c, C	12
					3 Rating	Functioning Appropriately	
4	3.0	USFS	11	[illegible]	4 Desired	B_c, C, B, E	13-18
					4 Current	B_c, C, B, E	12
					4 Rating	Functioning Appropriately	
5	1.2	USFS	9	<1	5 Desired	C, E	<12
					5 Current	C, E	12
					5 Rating	Functioning Appropriately but-at-Risk	
5a		Private			5a Desired		
					5a Current		
					5a Rating		
6	1.3	USFS	[illegible]	[illegible]	6 Desired	C, E, B_c	13-25
					6 Current	C, E, B_c	14
					6 Rating	Functioning Appropriately	
7	2.6	USFS	8	[illegible]	7 Desired	B, B_c, E, B_c	13-18
					7 Current	B, B_c, E, B_c	13
					7 Rating	Functioning Appropriately	
8	3.2	USFS	8	1-2	8 Desired	E, B	<12
					8 Current	E, B	9
					8 Rating	Functioning Appropriately	
9	1.5	USFS	7	1-2	9 Desired	E, B	<12
					9 Current	E, B	10
					9 Rating	Functioning Appropriately	
10	1.3	USFS	7	<1	10 Desired	E_b, B	<12
					10 Current	E_b, B	7
					10 Rating	Functioning Appropriately	
11	1.2	USFS	5	1-2	11 Desired	E, E_b	<12
					11 Current	E, E_b	5
					11 Rating	Functioning Appropriately	
12	0.7	USFS	5	2-4	12 Desired	B, B_c	12-18
					12 Current	B, B_c	18
					12 Rating	Functioning Appropriately	
13	1.0	USFS	4	>4	13 Desired	A, B_a	<12
					13 Current	A, B_a	8
					13 Rating	Functioning Appropriately	

Reaches 1, 2, 5, 6, 8, 9, 10, and 11 are primarily C and E stream types (with small portions of B stream types intermixed) characterized by low gradients, active floodplains and low width-to-depth ratios. The remaining reaches (reaches 3, 4, 7, 12, and 13) are primarily B and A stream types (with small sections exhibiting E stream types) that have moderately steep gradients, gentle sideslopes, and larger stream substrates that aid in channel stability. All surveyed reaches, except Reach 5, are **functioning appropriately** in terms of their potential stream type as the shape and size of the stream is in balance with its geomorphic setting. Although Reach 5 has stream channels that are similar to the stream type expected, segments of the reach have bankfull width-to-depth ratios that are slightly greater than expected and thus the reach is determined to be **functioning appropriately but-at-risk.**

An abundance of late-seral riparian vegetation is essential for maintaining low-gradient stream types, like those found along a good portion of West Fork Silver Creek. All reaches, with the exception of Reach 5, have an abundance of alder, willow, and sedge that promote high bank stability with channels that are resistant to the erosive energy associated with high flows. Management activities appear to be conducive to maintaining this vegetation within the floodplain – which acts to dissipate energy associated with high flow events, trap sediments, and build banks – allowing the stream to maintain or move towards its desired state. Although conditions in Reach 5 are nearing their desired state, small portions of are still showing signs of recovering stream, one that is still moving along the evolutionary path for degraded low-gradient systems. These areas have less willow and more grass than expected, which are contributing to the unstable stream banks within this reach and the functioning appropriately but-at-risk rating. As late-seral vegetation continues to develop along these reaches, it will act to trap sediment and build banks, causing the channel to continue to narrow and deepen, moving towards its naturally stable and desired state. An additional factor that may be influencing stream channel morphology within the lower reaches of this stream might be the increased drainage network associated with roads throughout the subwatershed, possibly influencing the timing and magnitude of stream flows and their effects on channel scouring.

<u>North Fork Silver Creek</u>

Table 4.21 - North Fork Silver Creek – Rosgen Stream Types

Reach Information					Condition - Reach	Rosgen Stream Type(s) and Associated Bankfull W/D Ratio	
Reach	Reach Length (miles)	Owner	[illegible] Width (?)	Gradient (%)		Rosgen Stream Type(s)	Bankfull Width/Depth Ratio
1	[illegible]	USFS	5	2-4	1 Desired	B, E_b, E	<12
					1 Current	B, E_b, E	10
					1 Rating	Functioning Appropriately	
2	2.6	USFS	5	2-4	2 Desired	B, B, E_b, E	<12
					2 Current	B, B, E_b, E	9
					2 Rating	Functioning Appropriately	

E_b or C_b refers to E and C stream types with steeper gradients (2-4%)

Both reaches of North Fork Silver Creek are **functioning appropriately** in terms of their potential stream type as the shape and size of the stream channel is in balance with its setting. Both reaches comprise a mix of stream types that typically have moderate gradients, gentle sideslopes, gravel/cobble substrates, and some level of floodplain development, although some portions of these reaches are more confined due to the adjacent sideslopes. Small sections of each reach are typical "E" stream types characterized by low gradients, developed floodplains, and low width-to-depth ratios.

The dominance of alder and sedge in these reaches promotes high bank stability and narrow and deep channels that are resistant to the erosive energy associated with high flows. Also, management activities appear to be conducive to maintaining vegetation in floodplains, which are able to dissipate energy associated with high flow events. Any modification to the magnitude and timing of stream flows has not shifted channels from their natural potential, even though upland vegetation and road density both received functioning appropriately but-at-risk ratings.

Guyer Creek

Table 4.22 - Guyer Creek – Rosgen Stream Types

Reach Information					Condition	Rosgen Stream Type(s) and Associated Bankfull W/D Ratio	
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	Rosgen Stream Type(s)	Bankfull Width/Depth Ratio
1		Private			1 Desired		
					1 Current		
					1 Rating		
2	1.9	USFS	8	3	2 Desired	B, E	13-38
					2 Current	B, E_b B_c, E	11
					2 Rating	Functioning Appropriately	
3	2.9	USFS	7	2-4	3 Desired	E, B	<12
					3 Current	E_b, E, B_c, B	7
					3 Rating	Functioning Appropriately	
4	0.7	USFS	5	2-4	4 Desired	E_b, B	<12
					4 Current	E_b, B	5
					4 Rating	Functioning Appropriately	
5	2.0	USFS	5	2-4	5 Desired	E_b, E, B	<12
					5 Current	E_b, E, B	7
					5 Rating	Functioning Appropriately	
6	1.1	USFS	4	>4	6 Desired	B_a, B, A	13-38
					6 Current	B_a, B, A	11
					6 Rating	Functioning Appropriately	

All reaches of Guyer Creek are **functioning appropriately** in terms of their potential stream type as the shape and size of the stream channel is in balance with its setting. Similar to both West Fork Silver and North Fork Silver Creeks, the abundance of late-seral vegetation, primarily alder, willow, and sedge, promotes high bank stability and stable stream channels. Reaches 2-5 are comprised of a mix of stream types that typically have moderate gradients, gentle sideslopes, gravel/cobble substrates, and some level of floodplain development. Portions of each reach are typical "E" stream types characterized by low gradients, developed floodplains, and low width-to-depth ratios. Old beaver ponds/dams in Reach 5 are still functioning, maintaining wetland/riparian habitat. A larger proportion of Reach 2 was classified as a B stream type with larger width-to-depth ratios and more confinement due to the adjacent sideslopes. Reach 6 was found to have higher stream gradients with some level of confinement, leading to a dominance of B and A stream types.

The abundance of alder and sedge in these reaches promotes high bank stability and narrow and deep channels that are resistant to the erosive energy associated with high flows. Also, management activities appear to be conducive to maintaining vegetation in floodplains, which are able to dissipate energy associated with high flow events. Any modification to the magnitude and timing of stream flows has not shifted channels from their natural potential, even though upland vegetation and road density both received functioning appropriately but-at-risk ratings.

Summary of, and factors contributing to, current conditions for Benny, Squaw, and Indian Creeks – Benny, Squaw, and Indian Creek Subwatersheds of the Silver Creek Watershed: No surveys occurred within these subwatersheds, however, past field reconnaissance provides some insight to the current condition of stream channels. Within these subwatersheds, stream channels are typically characterized as Rosgen B stream types, where local geology and large substrate sizes contribute to the channel stability. Inclusions of Rosgen C and F stream types occur in the lower gradient, depositional reaches, which are the main areas within the subwatershed where bank instability occurs. This bank instability, and associated downcutting, are likely the cumulative effect of past grazing practices, extensive logging activities, and the increased drainage network associated with roads throughout these subwatersheds – which is possibly influencing the timing and magnitude of stream flows and their effects on channel scouring. Another contributing factor in the Benny and Squaw Creek subwatersheds is the influence of scabrock flats and other shallow basaltic residual soils along Winter Ridge – flows from these areas are quite flashy producing large runoff volumes to stream channels. For these reasons, and taking into account the rating given for riparian vegetation and associated bank instability, an overall rating of **functioning appropriately but-at-risk** is given for stream channels within these subwatersheds.

Summary of, and factors contributing to, current conditions for the Bridge Creek Watershed: The following table (Table 4.23) summarizes current and desired stream types for Bridge Creek. Ratings given within this table are based on a comparison of current and desired conditions (see desired conditions section for ratings) within each of the surveyed stream reaches. Following the table is a discussion of these ratings and the factors contributing to current conditions, as well as any trends in conditions. When two or more stream types are listed for a reach, the dominant is listed first. For reach locations, refer to Figure 5.3 – Bridge Creek Watershed Reach and Monitoring Locations.

Bridge Creek

Table 4.23 - Bridge Creek – Rosgen Stream Types

Reach Information					Condition	Rosgen Stream Type(s) and Associated Bankfull W/D Ratio	
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	Rosgen Stream Type(s)	Bankfull Width/Depth Ratio
1	0.8	Private		<1	1 Desired	E, C	<12
			8		1 Current	E, C	10
					1 Rating	Functioning Appropriately but-at-Risk	
2	1.7	Private		<1	2 Desired	E, C, B_c	<12
			7		2 Current	E, C, B_c	18
					2 Rating	Functioning Appropriately but-at-Risk	
3	1.2	Private		1	3 Desired	C, E	<12; 13-25
			8		3 Current	C, E	14
					3 Rating	Functioning Appropriately but-at-Risk	
4		Private			4 Desired		
					4 Current		
					4 Rating		
5	0.7	Private		1	5 Desired	C, E	<12; 13-25
			11		5 Current	C, E	13
					5 Rating	Functioning Appropriately but-at-Risk	
6	1.2	BLM/FS	9	1	6 Desired	C, B, E	13-25
			9		6 Current	C, B, E	7
					6 Rating	Functioning Appropriately	
7	2.2	USFS	10	2-4	7 Desired	B, B_c, E_b, E, C	12-18
			10		7 Current	B, B_c, E_b, E, C	10
					7 Rating	Functioning Appropriately	
8	1.0	USFS	10	<2	8 Desired	B, B_c, E, C	12-18
			10		8 Current	B, B_c, E, C	12
					8 Rating	Functioning Appropriately	
9	0.6	Private	9	2-2	9 Desired	B, C	12-18
			9		9 Current	B, C	14
					9 Rating	Functioning Appropriately	
10	1.5	USFS	9	2-4	10 Desired	B, E_b	12-30
			9		10 Current	B, E_b	12
					10 Rating	Functioning Appropriately	
11	1.4	USFS	10	2-4	11 Desired	B, B_c	12-30
			10		11 Current	B, B_c	19
					11 Rating	Functioning Appropriately	
12	0.7	USFS	6	2-8	11 Desired	B, B_c, E	12-30
			6		11 Current	B, B_c, E	8
					11 Rating	Functioning Appropriately	
13	0.5	USFS	7	1	12 Desired	E	<12
			7		12 Current	E	8
					12 Rating	Functioning Appropriately	
14	2.3	USFS	6	2-8	13 Desired	E_b, E, B	<12
			8		13 Current	E_b, E, B	8
					13 Rating	Functioning Appropriately	

Reaches 1, 2, 3, and 5 have stream channels that are similar to the stream type expected for low-gradient, meandering systems, however, these four reaches are **functioning appropriately but-at-risk** because their bankfull width-to-depth ratios are slightly higher than expected. A good portion of these reaches have experienced some level of downcutting in the past, but most areas have substantially recovered, or continue to recover, moving towards their desired state. Reaches 6-12 are **functioning appropriately** in terms of their potential stream type and have channels that are in balance with their geomorphic setting. These reaches are primarily B stream types (Reach 6 is a transitional reach exhibiting both C and B stream types), with low-to-moderate gradients, gentle sideslopes, and cobble/boulder-gravel substrates that aid in channel stability. The shape and size of stream channels in reaches 13 and 14 are similar to E stream types (both E and B stream types for Reach 14) expected for their settings, and thus are determined to be **functioning appropriately**.

In reaches 1-5, the lack of late-seral species, and the abundance of grasses, contributes to the functioning appropriately but-at-risk rating. An additional factor that may be influencing stream channel morphology within these reaches is the cumulative effects of past land management activities – both upland vegetation and road density received functioning appropriately but-at-risk ratings. The increased drainage network associated with roads throughout the watershed has likely modified the timing and magnitude of stream flows in Bridge Creek. This, along with continued livestock grazing, may be influencing the ability of the stream channel to revegetate and form stable banks. Along the B stream types in reaches 7-12, the local geomorphology and larger substrate sizes contribute to the stability of the stream. In the non-meadow, or transitional lower-gradient reaches – those reaches with C and B stream types (Reach 6) – the local geomorphology and larger substrate sizes contribute to stream stability, as well as an abundance of late-seral species such as sedge, alder, and willow. In the remaining lower gradient, meandering stream reaches (reaches 13 and 14), the abundance of late-seral vegetation maintains channel integrity. The dominance of sedge within these two reaches promotes high bank stability, with channels and floodplains that are resistant to the erosive energy of high flows.

Summary of, and factors contributing to, current conditions for the Buck Creek Watershed: The following table (Table 4.24) summarizes current and desired stream types for Buck Creek. Ratings given within this table are based on a comparison of current and desired conditions (see desired conditions section for ratings) within each of the surveyed stream reaches. Following the table is a discussion of these ratings and the factors contributing to current conditions, as well as any trends in conditions. When two or more stream types are listed for a reach, the dominant is listed first. For reach locations, refer to Figure 5.3 – Buck Creek Watershed Reach and Monitoring Locations.

<u>**Buck Creek**</u>

Table 4.24 - Buck Creek – Rosgen Stream Types

Reach Information					Condition	Rosgen Stream Type(s) and Associated Bankfull W/D Ratio	
Reach	Reach Length (miles)	Owner	[illegible]	Gradient (%)	Reach	Rosgen Stream Type(s)	Bankfull W/D Ratio
1	[illegible]	Private	[illegible]	[illegible]	1 Desired	[illegible]	[illegible]
					1 Current		
					1 Rating		
2	2.0	BLM	16	1	2 Desired	C, B	13-25
					2 Current	C, B	16
					2 Rating	Functioning Appropriately but-at-Risk	
3	1.5	Private	14	<1	3 Desired	C	13-25
					3 Current	C	12
					3 Rating	Functioning Appropriately	
4	[illegible]	Private	[illegible]	[illegible]	4 Desired	[illegible]	[illegible]
					4 Current		
					4 Rating		
5	0.6	Private	14	<1	5 Desired	C	13-25
					5 Current	C	14
					5 Rating	Functioning Appropriately but-at-Risk	
6	0.5	Private	15	1-2	6 Desired	C	13-25
					6 Current	C	12
					6 Rating	Functioning Appropriately	
7	2.4	Private	14	<1	7 Desired	C	13-25
					7 Current	C	12
					7 Rating	Functioning Appropriately	
8	0.8	Private	12	<1	8 Desired	C, B	13-25
					8 Current	C, B	12
					8 Rating	Functioning Appropriately	
9	0.6	BLM	12	<1	9 Desired	C, B	13-25
					9 Current	C, B	21
					9 Rating	Functioning Appropriately	
10	0.8	BLM	15	1-2	10 Desired	C, B, B	13-25
					10 Current	C, B, B	16
					10 Rating	Functioning Appropriately	

Table 4.24 - Buck Creek – Rosgen Stream Types (continued)

Reach Information					Condition	Rosgen Stream Type(s) and Associated Bankfull W/D Ratio	
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	Rosgen Stream Type(s)	Bankfull Width/Depth Ratio
11	0.4	Private	15	1	11 Desired	C, B_c, B	13-25
					11 Current	C, B_c, B	14
					11 Rating	Functioning Appropriately but-at-Risk	
12	1.4	Private	15	<2	12 Desired	C, B_c, B, E	13-25
					12 Current	C, B_c, B, E	12
					12 Rating	Functioning Appropriately	
13	1.3	USFS	16	1	13 Desired	C, B_c, B	13-25
					13 Current	C, B_c, B	14
					13 Rating	Functioning Appropriately	
14	1.1	USFS	15	1-4	14 Desired	C, B, B_c	13-25
					14 Current	C, B, B_c	16
					14 Rating	Functioning Appropriately	
15	1.3	USFS	14	1.2	15 Desired	B_c, B	13-38
					15 Current	B_c, B	17
					15 Rating	Functioning Appropriately	
16	2.9	USFS	15	2	16 Desired	B	13-38
					16 Current	B	19
					16 Rating	Functioning Appropriately	
17	3.5	USFS	12	2	17 Desired	B	13-38
					17 Current	B	15
					17 Rating	Functioning Appropriately	
18	2.1	USFS	15	2-9	18 Desired	B, B_c, A	13-38
					18 Current	B, B_c, A	18
					18 Rating	Functioning Appropriately	
19	2.5	USFS	10	1-3	19 Desired	B, C	13-38
					19 Current	B, C	14
					19 Rating	Functioning Appropriately	
20	1.8	USFS	5	1-4	20 Desired	B, E_b, E	13-38
					20 Current	B, E_b, E	9
					20 Rating	Functioning Appropriately	
21	1.0	USFS	5	[illegible]	21 Desired	B, E_b, E, A	13-38
					21 Current	B, E_b, E, A	12
					21 Rating	Functioning Appropriately	

E_b or C_b refers to E and C stream types with steeper gradients (2-4%)

Reaches 2, 5, and 11 have stream channels that are similar to the stream type expected for low-gradient, meandering systems, however, these three reaches are **functioning appropriately but-at-risk** because a portion of their surveyed segments have bankfull width-to-depth ratios that are slightly higher than expected. These conditions can also be found in localized areas of reaches 3 and 6-13, but these reaches have higher bank stability values and a greater abundance of late-seral species leading to **functioning appropriately** ratings. Like the lower reaches of Bridge Creek, portions of each of these reaches have experienced some level of downcutting in the past, but most areas have substantially recovered, or continue to recover, moving towards their desired state. The remaining reaches (reaches 14-21) are **functioning appropriately** in terms of their potential stream type and have channels that are in balance with their geomorphic setting. These reaches occur primarily on steeper slopes, with gentle sideslopes and larger stream substrates that aid in channel stability.

In reaches 2, 5, and 11, the lack of late-seral species and the abundance of grass, as well as bank stability values below or equal to 95%, contributes to the functioning appropriately but-at-risk rating. Reaches 3, and 6-13 are similar but have bank stability values exceeding 95% and a higher abundance of late-seral species. Recently, management practices have been modified along many of these reaches allowing for the recovery of riparian vegetation and stream channels. As late-seral vegetation continues to develop along these reaches, it will act to trap sediment and build banks, causing the channel to narrow and deepen, moving towards its naturally stable and desired state. An additional factor that may be influencing stream channel morphology within these lower reaches is the cumulative effects of past land management activities – both upland vegetation and road density received functioning appropriately but-at-risk ratings. The increased drainage network associated with roads throughout the watershed has likely modified the timing and magnitude of stream flows in Buck Creek. This, along with continued livestock grazing, may be influencing the ability of stream channels within these reaches to re-vegetate and form stable banks. Along the higher gradient B stream types in reaches 14-21, the local geomorphology, larger substrate sizes, and dominance of late-seral species contribute to the stability of the stream.

Summary for the Silver Lake Watershed

Approximately 83 miles of stream were surveyed within the three watersheds and were distributed in the following manner: Silver Creek (42 miles), Bridge Creek (16 miles), and Buck Creek (25 miles). The following is a short summary of riparian and stream channel conditions within the entire Silver Lake Watershed. For reach locations refer to Figures 5.3, 5.4, and 5.5 – Silver Creek, Bridge Creek, and Buck Creek Watershed Reach and Monitoring Locations.

Numerous sites along the surveyed stream reaches were measured to determine Rosgen stream types. Of the 59 reaches surveyed, 51 (86% of the reaches or 89% of the miles surveyed) were found to be **functioning appropriately** in terms of their potential stream type as the shape and size of the stream channel is in balance with its setting. The 8 remaining reaches (14% of the reaches or 11% of the miles surveyed) are **functioning appropriately but-at-risk.** The three dominant stream types within the watershed are B, C, and E, with only small portions of comprised of A, F, and G stream types. Most stream reaches that are functioning appropriately (86%) are the B and E stream types found throughout the watershed, while those which are functioning appropriately but-at-risk (14%) are C and E stream types that have width-to-depth ratios greater than is expected. Most of the C stream types that are functioning appropriately but-at-risk are primarily located along the low gradient meadow reaches of Bridge, Buck, and West Fork Silver Creeks.

The B stream types are inherently stable because of geology and other landscape characteristics, such as large woody debris from forested areas and large streambed substrates. As expected, all of these stream types were in balance with their landscape setting. The majority of stream reaches that are not functioning appropriately are the C and E stream types located along the low gradient meadow reaches of Bridge, Buck, and West Fork Silver Creeks. Because these are areas of high forage production, the meadows have been strongly influenced by grazing practices that have reduced densities of riparian vegetation important for bank stability and low width-to-depth ratios. In addition, early land management activities have influenced the current water table elevations and floodplain widths for the C and E stream types throughout the watershed. Beaver trapping and historical livestock grazing have led to downcut stream channels in low gradient meadows, converting C and E stream types with wide floodplains into F stream types with little to no floodplain. This resulted in lowered water tables with less water storage and lower base flows. As a result of improved livestock grazing strategies promoted within the watershed, E stream types have, or continue to, reclaimed many meadow sites, resulting in the reestablishment of floodplains dominated with late-seral riparian plants. However, the floodplains and areas of water storage are less extensive than they were prior to downcutting. This has likely reduced base flows within the watershed. Furthermore, beaver dams are not present in their historical numbers, further reducing the lateral extent of bank saturation and groundwater storage essential for maintenance of base flows during summer months.

Chapter 5

Habitat for Aquatic Species

Chapter 5
Habitat for Aquatic Species

Key Question #3: Are the channels providing adequate fish habitat?

In order to address Question 3, survey crews and resource professionals gathered and summarized fish habitat condition information on a stream reach basis. In general, a reach is a segment of stream of similar gradient, valley type, etc. For example, a segment of stream flowing through a gentle meadow valley would be a separate reach relative to a segment occurring in a steeper mountain area. Only the primary perennial streams within each watershed were surveyed. The following methods were used to assess current habitat conditions:

During stream surveys conducted in 2000, data was collected on several fish habitat elements within each measured reach. Below is a short summary of the streams, and number of reaches surveyed, within the three watersheds.

Silver Creek Watershed: Four streams were surveyed within this watershed. In Silver Creek, seven of the nine reaches (just over 10 miles) were surveyed; West Fork Silver Creek was divided into fourteen reaches, of which thirteen (over 18 miles) were surveyed; nearly 5 miles of North Fork Silver Creek was divided into two reaches; and Guyer Creek was divided into six reaches, of which five (nearly 9 miles) were surveyed.

It should be mentioned that no surveys occurred within Benny, Squaw, or Indian Creeks -- or any other channels within these three subwatersheds. These streams are intermittent, and due to prioritization--based on funding and time--were not surveyed. However, a general description of streams within these subwatersheds will be given based on field reconnaissance associated with past projects within the area.

Bridge Creek Watershed: Nearly the entire length of Bridge Creek, starting from its headwaters in the Yamsay Mountain Semi-Primitive Non-Motorized Recreation Area to its entrance into Paulina Marsh, was surveyed. This included thirteen of the fourteen reaches, which totaled more than 16 miles.

Buck Creek Watershed: Buck Creek was divided into twenty-one reaches, of which nineteen (over 25 miles) were surveyed. This included reaches near its entrance into Paulina Marsh to its headwaters in the Yamsay Mountain Semi-Primitive Non-Motorized Recreation Area.

Methods used to gather habitat information are summarized based on the following parameters: large woody debris, pools, spawning gravel fines, stream temperature, and fish passage.

a) Large Woody Debris (LWD) - Large wood was counted and classified into two categories. For ponderosa pine and mixed conifer sites, LWD was classified as 35' long with the small end being at least 20" in diameter. In lodgepole pine sites (LP), LWD was classified as 35' long with the small end being at least 12" in diameter. In both cases, LWD had to be within the bankfull dimensions of the channel to be counted.

b) Pools - To be classified as pool, two conditions were required. First, a pool needed to span the entire stream channel. Second, pool length needed to be longer than its width. Using these criteria, pocket pools that occur in the middle of channels were not counted. Large pools are those with depths greater than 2.6 feet.

c) Spawning Gravel Fines – Bulk samples of spawning gravel were acquired through the insertion a cylinder into the streambed and extracting the gravel from the cylinder. Five samples were taken at each site, at pool tail crests or other areas that provided suitable spawning gravels. The samples were then taken to the Fremont National Forest Engineering and Soils Lab where they were dried, and passed through a series of sieves to determine the percent of fines less than 6.4 mm.

d) **Stream Temperature** – Stream temperature information was gathered with continuously recording thermographs, placed in strategic location throughout the watershed. The sensors were placed in moving water, and were calibrated prior to installation.

e) **Fish Passage** – The Region 6 Culvert Inventory Protocol was used to collect information to determine fish passage through culverts. The length, diameter, and slope of culverts within fish-bearing streams were measured. Then, based on the drainage area above the culvert, the average spring flow was calculated. Using the culvert dimensions and flow information, it was determined whether or not the velocities of water flowing through the culvert exceeded the sustained swimming speed of trout. In addition, the presence or absences of jumping pools were documented, and the jump height was measured.

Current Conditions

The summary tables that follow describe current fish habitat conditions in all stream reaches surveyed within the three watersheds. Using methods described in the beginning of this chapter, habitat conditions are summarized based on the following parameters: large woody debris, pools, spawning gravel fines, stream temperature, and fish passage. For reach locations refer to Figures 5.X – Silver Creek Watershed Reach and Monitoring Locations, Figures 5.X – Bridge Creek Watershed Reach and Monitoring Locations, and Figures 5.X – Buck Creek Watershed Reach and Monitoring Locations.

Silver Creek Watershed: The following tables (Tables 5.1, 5.2, and 5.3) are a summary of information collected for several elements that describe fish habitat within Silver, West Fork Silver, North Fork Silver and Guyer Creeks. There were twelve culverts surveyed within this watershed (Refer to Figure 3.1 – Silver Creek Watershed Road Locations).

Table 5.1 - Silver Creek – Fish Habitat Elements

Reach Information					Habitat Elements						
Reach	Reach Length (miles)	Owner	Wetted Width (ft)	Gradient (%)	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Potential Fish Passage (Culvert) Concern
									(°C)	(°F)	
1	0.7	USFS	17	1	**	49	38	NA	NA	NA	No
2		Private									No
3		Private									No
4	1.6	BLM	22	1	1	29	6	NA	NA	NA	No
5	1.5	USFS	22	1	2	42	3	NA	NA	NA	No
6	1.8	USFS	28	1	2	45	6	NA	24.4	75.9	No
7	2.2	USFS	24	1	7	40	3	38	NA	NA	No
8	1.2	USFS	24	1	7	49	3	NA	NA	NA	No
9	1.3	USFS	24	2	9	44	3	NA	22.0	71.6	No

NA – Information Not Available; ** - Habitat element not applicable for this reach
Habitat Abbreviations and Explanations: LWD – Large Woody Debris; Large Pools – Pools > 2.6 feet deep; % Spawning Gravel Fines - <6.4mm

Table 5.2 - West Fork Silver Creek – Fish Habitat Elements

Reach Information					Habitat Elements						
Reach	Reach Length (miles)	Owner	Wetted Width (ft)	Gradient (%)	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Potential Fish Passage (Culvert) Concern
									(°C)	(°F)	
1	0.5	BLM	6	1	**	110	7	NA	NA	NA	No
2	0.3	BLM	10	1	7	109	22	15	23.8	74.9	No
3	1.1	BLM	12	1	8	102	2	NA	NA	NA	No
4	3.0	USFS	11	1	33	116	8	NA	NA	NA	No
5	1.2	USFS	9	<1	21	87	5	25	24.8	76.7	Yes
5a		Private									
6	1.2	USFS	8	<1	7	111	18	NA	NA	NA	No
7	2.0	USFS	8	3	20	115	1	35	15.3	59.5	Yes
8	3.0	USFS	8	1-2	27	96	0	NA	NA	NA	No
9	1.5	USFS	7	1-2	45	108	0	33	13.9	57.0	Yes

Table 5.2 - West Fork Silver Creek – Fish Habitat Elements (continued)

Reach Information					Habitat Elements						
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Potential Fish Passage (Culvert) Concern
									(°C)	(°F)	
10	1.2	USFS	7	<1	21	120	0	NA	NA	NA	Yes
11	1.7	USFS	5	1-2	34	134	0	NA	NA	NA	No
12	0.7	USFS	5	2-4	36	143	0	25	10.9	51.5	No
13	1.0	USFS	4	>4	41	122	0	NA	NA	NA	No

NA – Information Not Available; "" - Habitat element not applicable for this reach
Habitat Abbreviations and Explanations: LWD – Large Woody Debris; Large Pools – Pools > 2.5 feet deep; % Spawning Gravel Fines - <6.4mm

Table 5.3 - North Fork Silver Creek – Fish Habitat Elements

Reach Information					Habitat Elements						
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Potential Fish Passage (Culvert) Concern
									(°C)	(°F)	
1	2.2	USFS	5	1-4	78	108	0	NA	14.3	57.8	No
2	2.4	USFS	5	2-4	74	117	0	52	NA	NA	Yes

NA – Information Not Available; "" - Habitat element not applicable for this reach
Habitat Abbreviations and Explanations: LWD – Large Woody Debris; Large Pools – Pools > 2.5 feet deep; % Spawning Gravel Fines - <6.4mm

Table 5.4 - Guyer Creek – Fish Habitat Elements

Reach Information					Habitat Elements						
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Potential Fish Passage (Culvert) Concern
									(°C)	(°F)	
1		Private									Yes
2	1.9	USFS	8	2	32	107	0	NA	NA	NA	No
3	2.9	USFS	7	2-4	80	137	0	41	16.2	61.1	Yes
4	0.7	USFS	5	2-4	48	155	0	NA	NA	NA	Yes
5	2.0	USFS	5	2-4	52	151	0	45	NA	NA	Yes
6	1.1	USFS	4	>4	36	78	0	NA	NA	NA	No

NA – Information Not Available; "" - Habitat element not applicable for this reach
Habitat Abbreviations and Explanations: LWD – Large Woody Debris; Large Pools – Pools > 2.6 feet deep; % Spawning Gravel Fines - <6.4mm

Benny, Squaw, and Indian Creek Subwatersheds of the Silver Creek Watershed: No surveys occurred within these subwatersheds. The lower portions of Benny and Squaw Creeks are considered to be intermittent fish-bearing streams, but due to prioritization--based on funding and time--these streams were not surveyed. Seasonal potential trout habitat occurs within Benny and Squaw Creeks downstream of Forest Road 2916, however only a few fish have been observed upstream of Forest Road 28. If fish use the portions of stream above this point, it appears the timing of occupation is limited to spring months when sufficient flows exist. Fish, migrating from Thomson Reservoir, do occupy the lower portion of these two streams where riffles, pools, and in-stream large wood are available. However, beyond late spring of early summer, the habitat becomes scarce because of decreased flows. There is a potential barrier to fish passage in Benny Creek at the culvert on Forest Road 28.

Bridge Creek Watershed: The following table (Table 5.5) is a summary of information collected for several elements that describe fish habitat within the surveyed reaches of Bridge Creek. There were seven culverts surveyed within this subwatershed (Refer to Figure 3.3 – Bridge Creek Watershed Road Locations).

Table 5.5 - Bridge Creek – Fish Habitat Elements

Reach Information					Habitat Elements						
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Potential Fish Passage (Culvert) Concern
									(°C)	(°F)	
1	0.8	Private	8	<1	**	57	9	NA	NA	NA	Yes (Weir)
2	1.7	Private	7	<1	**	45	10	NA	NA	NA	No
3	1.2	Private	8	1	**	61	7	NA	NA	NA	Yes (Weir)
4		Private									
5	0.7	Private	11	1	**	123	17	NA	NA	NA	No
6	1.7	BLM/FS	9	1	18	95	2	NA	16.2	61.1	Yes
7	2.2	USFS	10	1-4	29	119	1	NA	NA	NA	No
8	1.0	USFS	10	<2	45	121	0	21	16.4	61.6	Yes
9	0.6	Private	9	1-2	26	64	0	NA	NA	NA	No
10	1.5	USFS	9	2-6	35	105	5	NA	NA	NA	No
11	1.4	USFS	10	2-4	58	132	0	NA	NA	NA	Yes
12	0.7	USFS	6	2-8	31	94	0	19	11.6	52.8	Yes
13	0.5	USFS	7	1	69	178	9	NA	NA	NA	No
14	2.5	USFS	8	2-4	51	183	8	NA	NA	NA	No

NA – Information Not Available; ** - Habitat element not applicable for this reach
Habitat Abbreviations and Explanations: LWD – Large Woody Debris; Large Pools – Pools > 2.8 feet deep; % Spawning Gravel Fines - <6.4mm

Buck Creek Watershed: The following table (Table 3.18) is a summary of information collected for several elements that describe fish habitat within the surveyed reaches of Buck Creek. There were four culverts surveyed within this watershed (Refer to Figure 3.3 – Buck Creek Watershed Road Locations).

Table 5.6 - Buck Creek – Fish Habitat Elements

Reach Information					Habitat Elements						
Reach	Reach Length (miles)	Owner	Wetted Width (')	Gradient (%)	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Potential Fish Passage (Culvert) Concern
									(°C)	(°F)	
1		Private									
2	2.0	BLM	16	1	12	110	28	NA	24.7	76.5	No
3	1.3	Private	14	<1	**	69	14	NA	NA	NA	No
4		Private									Yes (Weir)
5	0.6	Private	14	<1	**	112	46	NA	NA	NA	No
6	0.5	Private	13	1-2	**	96	43	NA	NA	NA	No
7	2.4	Private	14	<1	**	97	35	NA	NA	NA	Yes (Weir)
8	0.8	Private	12	<1	**	92	32	NA	NA	NA	No
9	0.6	BLM	12	<1	3	38	5	NA	NA	NA	No
10	0.8	BLM	15	1-2	6	36	4	NA	NA	NA	No
11	0.8	Private	15	1	2	60	4	NA	NA	NA	No
12	1.4	Private	15	<2	3	82	4	NA	NA	NA	???
13	1.3	USFS	16	1	8	45	1	26	17.3	63.1	No
14	1.1	USFS	17	1-4	8	58	2	NA	NA	NA	Yes
15	1.3	USFS	14	1-2	17	67	8	NA	NA	NA	No
16	2.9	USFS	12	2	21	54	4	NA	NA	NA	No
17	1.5	USFS	12	2	8	51	2	18	14.3	57.8	Yes
18	1.1	USFS	15	2-4	4	55	2	NA	NA	NA	No
19	2.3	USFS	10	1-3	3	85	0	NA	NA	NA	No
20	1.4	USFS	5	1-4	10	115	1	NA	NA	NA	No
21	1.0	USFS	5	>4	47	111	0	NA	NA	NA	No

NA – Information Not Available; ** - Habitat element not applicable for this reach
Habitat Abbreviations and Explanations: LWD – Large Woody Debris; Large Pools – Pools > 2.6 feet deep; % Spawning Gravel Fines - <6.4mm

The tables shown above are a summary of the habitat information collected for those streams and stream reaches where the summer of 2000 stream surveys occurred. Other water quality information (stream temperatures, sediment samples, macroinvertebrates) was, or has been, collected for other sites within these watersheds. For this reason, a summary of the water quality information (including that information already shown above) useful for aquatic habitat discussions within the watershed is summarized below.

Water Quality

The Oregon Department of Environmental Quality has listed two streams within the Watershed on their "303d list" (a list of streams which do not meet the requirements of the Clean Water Act). The streams were placed on this list because they did not meet water quality temperature standards for salmonids. Streams and criteria listed in the 1998 303(d) list are shown in Table 3.19 and on Figure 3.1. The two stream segments are listed due to high summertime stream temperatures. Stream temperatures, as well as fine sediment will be discussed as part of this assessment. State water quality parameters of dissolved oxygen, bacteria, total dissolved solids and toxic pollutants are not addressed as seperate subjects because long-term monitoring data for these parameters are not available.

Table 5.7 - Streams on the 1998 303(d) List

Stream Name	Description	Segment	Parameter/Criteria
West Fork Silver Creek	Mouth to W. Fk. Silver Cr. Marsh	42A-SIWF0	Temperature / Rearing 17.8°C (64°F)
Silver Creek	Mouth to Thompson Valley Res.	42A-SILV0	Temperature / Rearing 17.8°C (64°F)

Stream Temperatures - Stream temperatures are mainly influenced by the amount of stream flows, the amount of topographic and vegetative shading from direct solar radiation, channel morphology, and distance from the watershed divide or groundwater inflow. Reductions in stream shading as a result of land management activities or natural disturbance can increase incoming solar radiation during the summer months and decrease longwave re-radiation during the winter months. This can lead to increasing summertime maximum stream temperatures and diurnal fluctuations, and decreased winter temperatures, which may lead to the formation of anchor ice or the complete freezing of the stream. Small, shallow streams that do not have significant groundwater inflow or vegetative cover show the largest changes in stream temperatures. Stream temperature increases are additive, meaning that a shaded reach will not decrease stream temperatures without cooler groundwater inflow.

Stream temperature data collected during the summer months is available for Silver Creek, West Fork Silver Creek, North Fork Silver Creek, Guyer Creek, Bridge Creek and Buck Creek. Temperature is an important component of these streams as they support native salmonid fish populations. Results of stream temperature monitoring for the above mentioned streams within the watershed are shown in Table 3.17.

Table 5.8 - Maximum stream temperatures within the Silver, Bridge, and Buck Creek Watersheds

	7-Day Average Maximum Stream Temperature (°C)							
Stream and Station #	1993	1994	1995	1996	1997	1998	1999	2000
Silver Creek (SI4530)	22.8				24.1	23.9		24.4
Silver Creek (SIDAM)	20.2							22.0
West Fork Silver Creek (WS4460)		27.0	21.2	21.8	21.4	21.1		23.8
West Fork Silver Creek (WS4740)	21.0	27.0	22.6	22.6	22.0	21.6	20.3	24.8
West Fork Silver Creek (WS4850)			13.7	14.8	14.5			
West Fork Silver Creek (WS5050)	13.1	16.4	12.8	13.8	13.3	13.2	12.4	15.3
West Fork Silver Creek (WS5580)	12.7	18.0	12.9	13.3	12.6	12.3		13.9
West Fork Silver Creek (WS6360)	13.0	17.1	12.5	13.3	12.6			10.9
North Fork Silver Creek (NW3050)	12.7	15.4	12.3	12.9	12.5	12.9	12.4	14.3
Guyer Creek (GY5360)		17.0	15.0	15.6	15.0			16.2
Bridge Creek (BR4800)	14.0	16.9	14.0	15.4	15.0			16.2
Bridge Creek (BR5060)	14.2	18.5	14.5	15.4	15.2		14.3	16.4
Bridge Creek (BR6080)	10.3	12.4	10.7	11.7	11.1		11.1	11.6
Buck Creek (BKBLM)								24.7
Buck Creek (BK4910)	15.2	19.0	15.4	16.1	15.8		14.5	17.3
Buck Creek (BK5760)	11.5	16.0	13.8	14.0	13.5		13.4	14.3

Important stream temperatures associated with Table 5.8:

-INFISH Riparian Management Objective: 7-day maximum of 15.0°C (59°F)
-Current state water quality standard for stream temperature: 7-day maximum of 17.8°C (64°F)
-Stream temperature unfavorable to salmonids: 21°C (70°F)
-Stream temperature for optimum growth of salmonids: 15°C (59°F)

Fine Sediment - Fine sediments in spawning substrates were sampled at nine locations within the watershed. Sediment samples were taken from potential spawning habitat areas or potential redd areas in gravel/cobble portions of pool tail outs. An average of five samples per sampling site were obtained and a summary is shown in Table 5.9.

Table 5.9 - Fine Sediment in Spawning Substrates

Stream	Location	Percent Fines <6.4 mm	Embryo Survival
Silver Creek	Near Augur Creek (SI4720) - 1996	36	31
West Fork Silver Creek	BLM Site (WS4460) - 1996	31	44
West Fork Silver Creek	BLM Site (WS4460) - 2001	15	83
West Fork Silver Creek	Near FS Road 2917 (WS4740) - 1996	26	60
West Fork Silver Creek	Near FS Road 2917 (WS4740) - 2001	25	62
West Fork Silver Creek	Near FS Road 27 (WS4850) - 1996	41	20
West Fork Silver Creek	Near FS Road 27 (WS4850) - 2001	35	34
West Fork Silver Creek	Near FS Road 3380 (WS5580) - 1996	45	14
West Fork Silver Creek	Near FS Road 3380 (WS5580) - 2001	30	47
West Fork Silver Creek	Downstream FS Road 3380 (WS5580) - 2001	47	11
West Fork Silver Creek	Near FS Road 037 (WS6360) - 1996	28	53
Guyer Creek	Near FS Road 3038 (GY5360) - 1996	41	20
Guyer Creek	Near FS Road 3038 (GY5360) - 2001	46	13
Guyer Creek	Near FS Road 024 (GY6000) - 1996	45	14
Guyer Creek	Near FS Road 024 (GY6000) - 2001	46	13
North Fork Silver Creek	Near FS Road 3038 (NW5520) - 1996	60	3
North Fork Silver Creek	Near FS Road 3038 (NW5520) - 2001	52	7
Bridge Creek	Near FS Road 2804 (BR5060) - 1996	31	44
Bridge Creek	Near FS Road 7645 (BR60800 - 1996	19	76
Buck Creek	Near FS Road 013 (BK4910) - 1995	26	60
Buck Creek	Near FS Road 7645 (BK5790) - 1995	19	76

Sieve analysis was performed in the laboratory to determine the percent fines by weight. Literature identifies detrimental fines as those passing the 6.4 mm sieve and smaller (Reiser and Bjornn 1979) in excess of 25-30% of the substrate material. From samples taken in 1995, 1996 and 2001, sediment in potential spawning substrates of perennial streams within the Silver Lake Watershed were found to vary between 15% and 60%, with the highest values being found at the site on North Fork Silver Creek (52 and 60%). According to these percentages, there appears to be some possible negative effects on aquatic macroinvertebrates and embryo survival within the watershed.

Macroinvertebrates

Aquatic macroinvertebrates are an important component of aquatic ecosystems since they process vegetative material that enter streams and are an important food source for fish. Species of macroinvertebrates and macroinvertebrate ratings vary greatly depending on the chemical and biological conditions and amount of sediment in the stream. 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) was determined by the laboratory and is used in evaluation of the stream system. A summary of aquatic macroinvertebrate sampling in West Fork Silver, Bridge, and Buck Creeks is shown in Table 5.10.

Table 5.10 - Macroinvertebrate BCI Rating

Stream	Location	1989 BCI Rating	1990 BCI Rating	1994 BCI Rating
W. Fk. Silver Cr.	Downstream of FS 2917 (WS4740)	94 (Excellent)	75-86 (Fair - Good)	65 (Poor)
Bridge Creek	Upstream of FS Road 2804 (BR5060)	100 (Excellent)	84-98 (Good - Excellent)	86 (Good)
Buck Creek	Near FS Road 013 (BK4910)	82 – 100 (Good – Excellent)	88-98 (Good - Excellent)	77 (Fair)

Conditions in 1994 do not appear as good as those in 1989 or 1990, however, it is worth noting that 1994 was a very dry year with extremely low stream flows (stream flows were approximately 40% of the normal low flow) which likely influenced BCI ratings.

Water Quality Summary

About a third of the sites with stream temperature measurements were higher than recommended by the State, with the higher elevation sites of the three watersheds meeting State stream temperature standards. Fine sediments were found to exceed the recommended 30% level at several locations throughout the assessment area (nearly two-thirds of the sites monitored), limiting embryo survival and thus impairing reproductive success.

Desired Conditions

a) Large Woody Debris (LWD) and its contribution to fish habitat.

Large woody debris in streams is an important roughness element influencing channel morphology, sediment distribution, and water routing (Swanson and Lienkaemper 1978, Bisson et al. 1987). Large wood forms a step gradient, a stair-step effect along the channel. As a result, stream velocity is reduced in the relatively long stretches between debris steps and increases where water falls over the logs. A straight stream will be converted into a more sinuous or meandering stream with the LWD (Swanson 1991). These alterations in flow patterns may either protect or erode banks, but in general, this energy distribution reduces the streams ability to erode banks and enhances sediment storage (Zimmerman et al. 1967). Wood also serves as an important agent in pool formation. For instance, in southeast Alaska streams, LWD accounted for up to 75% of all pools (Robison and Beschta 1990). The resulting effect on fish habitat is significant. Large wood, in the low energy segments; traps organic matter such as leaves, which remains in the stream longer, providing food for aquatic organisms (Speaker et al. 1984). Reeves et al. (1991) notes that low velocity areas required by fish--during floods--increase with additional LWD. Bjornn and Reiser (1991) cited several studies that documented an increase in fish densities with higher levels of LWD. It should be noted that the role of LWD decreases as streams become larger, because greater currents will carry the wood out of the active channel and onto the banks (Murphy and Meehan 1991).

Desired amount of LWD:

Large woody debris is evaluated against the 50th and 75th percentile for natural and near natural streams in the northern Great Basin (ICBEMP 1997).

Functioning Appropriately - Large woody debris numbers are >75th percentile. *This is the desired (target) condition.*

Functioning Appropriately but-at-Risk - Large woody debris numbers are ≥50th and ≤75th percentile.

Functioning Inappropriately - Large woody debris numbers are <50th percentile.

For this assessment, LWD is defined as being 12 inches in diameter on the small end and greater than 35 feet long in ponderosa pine and mixed conifer sites. In lodgepole pine sites, LWD is defined as 6" in diameter and greater than 20 feet long. The natural or near natural frequency is determined using the table below, and the formula for desired numbers per mile = table value x 5280/average riffle width in feet. For example, a stream 10 feet wide with a slope of 2-4% would be expected to have 11 pieces of LWD/mile at the 50th percentile and 45 pieces at the 75th percentile.

Table 5.11 - Natural or Near Natural Frequency of LWD in Northern Great Basin Streams (ICBEMP 1997).

	Large Woody Debris/Mile	
Slope Class	50th Percentile	75th Percentile
All	0.019	0.062
<2%	0.006	0.025
2-4%	0.020	0.085
>4%	0.020	0.067

b) Pools and their contribution to fish habitat.

Pools are considered to be one of the most important fish habitat features, and for most fish, pools are the preferred habitat type (Bestcha and Platts 1986). Reeves et al. (1991) describes some of the reasons why trout use this habitat type: pools offer low velocity refuges, cooler stream temperatures during the summer months, and overwintering habitat. Furthermore, the majority of trout spawning occurs at pool tailouts, where spawning gravel is deposited (Bjornn and Reiser 1991, Reeves et al. 1991). In addition, pools provide rearing habitat for juvenile fish and resting habitat for adult fish (Bjornn and Reiser 1991), and refugia from drought, fire, winter icing and other disturbances (Sedell et. al. 1990). Streams that lack large, deep pools have been documented to freeze during the winter months on the Fremont National Forest (Fremont National Forest, Unpublished Data). When pool numbers, volume, and complexity increases, the stream's capacity to support a diversity of species and life stages/history types increases (Bisson et. al. 1992; Bjornn and Reiser 1991). Further, Decker and Erman (1992) found that rainbow trout numbers were more abundant with an increase in pool habitat. Finally, an increase in pool numbers and complexity produces conditions for increased fish numbers and biomass (Fausch and Northcote 1992).

Desired Pool Numbers:

The number of pools is evaluated against the weighted average of the 50th and 75th percentiles for natural and near natural streams in the northern Great Basin, Blue Mountains, and Central Idaho Mountains (ICBEMP 1997). All three areas were used to simply provide a much larger sample size of streams in a natural condition. The number of large pools (those with depths ≥2.6 feet), however, is only evaluated against the 50th and 75th percentile for natural and near natural streams in the northern Great Basin (ICBEMP 1997). This is based on the fact that large portions of the Blue and Central Idaho Mountain regions receive larger amounts of precipitation, and thus larger streamflow and runoff events (more energy to scour deeper pools).

Functioning Appropriately - Pool numbers are >75th percentile. ***This is the desired (target) condition.***

Functioning Appropriately but-at-Risk - Pool numbers are ≥50th and ≤75th percentile.

Functioning Inappropriately - Pool numbers are <50th percentile.

The natural or near natural frequency is determined using the table below, and the formula for desired numbers per mile = table value x 5280/average riffle width in feet. For example, a stream 10 feet wide with a slope of <2% would be expected to have 14 pools/mile at the 50th percentile and 28 pools/mile of at the 75th percentile.

Table 5.12 - Natural or Near Natural Frequency of Pools in Northern Great Basin Streams*.

Slope Class	Pools/Mile	
	50th Percentile	75th Percentile
All	0.046	0.083
<2%	0.056	0.096
2-4%	0.060	0.101
>4%	0.030	0.058

*Also, includes data from Blue Mountain and Central Idaho Mountain Streams

Table 5.13 - Natural or Near Natural Frequency of Large Pools in Northern Great Basin Streams (ICBEMP 1997).

Slope Class	Pools/Mile	
	50th Percentile	75th Percentile
All	0.000	0.003
<2%	0.000	0.005
2-4%	0.001	0.004
>4%	0.000	0.000

c) Spawning Gravel Fines and their influence on fish habitat and reproductive success.

Willers (1991), describes the effects of spawning gravel size on egg and alevin survival (hatched fish that have not emerged from spawning gravels). In general, he states mortality increases as spawning gravel size decreases because fine sediment impedes the flow of oxygenated water over the eggs or can trap the alevins in the gravel. Likewise, other studies show an inverse relationship between fine sediment and reproductive success (Everest et al. 1987). Bjornn and Reiser (1991) documented rainbow trout embryo survival as it related to substrate fines <6.4 mm: 90% embryo survival with fines at 10%, 75% embryo survival with fines at 20%, and 50% embryo survival with fines at 30%. In general, habitat guidelines for incubation of salmonid embryos require less than 25% volume of fines. Sieve analysis of potential spawning substrate has been conducted forest-wide in a broad range of geologic types. The reference level of fines for a particular geologic type has not been identified; however, analysis shows that a level of less than 30% fines is generally attainable in the top four inches of spawning substrate throughout the Fremont National Forest. The data also shows a high correlation to road density and the presence of valley bottom roads. Based on this information and ICBEMP (1997) recommendations, desired conditions for spawning substrates were determined.

Desired Percentage of fines in Spawning Gravels:

Functioning Appropriately - <20% fines for C and E stream types, and <25% fines for A and B stream types. ***This is the desired (target) condition.***

Functioning Appropriately but-at-Risk - 20-30% fines for C and E stream types, and 25-30% fines for A and B stream types.

Functioning Inappropriately - >30% fines for all stream types.

d) Stream Temperature and Shade, and their influence on fish habitat.

Stream temperature is an important factor regulating aquatic life. Fish are cold blooded, and thus, assume the temperature of the water in which they live. For this reason, a fish's metabolism, and consequently their growth and development, are directly controlled by their thermal environment (Brown 1983). Therefore, the growth and survival of fish can be greatly affected by temperature extremes (Beschta et al. 1987). Because stream temperature affects fish habitat, the Oregon Department of Environmental Quality (DEQ) has established a state water quality temperature criteria (seven-consecutive average daily maximum temperature) to be at or below 17.8°C (64°F) with fish being the primary benefiting resource. Generally, water temperatures in excess of 21°C (70°F) are unfavorable and may cause stress to all age classes (Sigler and Sigler 1991). However, Behnke (1992) states that redband trout possess a hereditary basis to persist at higher water temperatures than other species of trout. Further, Sonski (1985) noted that redband trout raised in a hatchery increased growth until 24°C (75°F) and recommended temperatures ranging from 18.3 to 23.8°C (65 to 75°F) to keep broodstock in good condition. Behnke (1992) has captured (flyfishing) live redband in streams with temperatures of 28.3°C (82.9°F). Finally, temperatures exceeding 29.4°C (84.9°F) can be fatal to rainbow trout (Bjornn and Reiser 1991). Recent studies in southeast Oregon streams (Little Blitzen River and Bridge Creek in the Blitzen River Basin, and North Fork Twelvemile Creek in the Warner Basin) found that redband trout prefer water temperatures of 12.8°C (55°F). At this temperature, metabolic power and swimming ability were some of the highest reported for wild fish (Hammond, in press; Gamperl, in press). Stream shade and proper width-to-depth ratios are the key factors influencing water temperatures within streams of southeastern Oregon.

Desired Stream Temperatures:

Functioning Appropriately - Seven-day maximum stream temperatures are < 17.8°C. *This is the desired (target) condition.*

Functioning Appropriately but-at-Risk - Seven-day maximum stream temperatures are between 17.8°C and 24.0°C.

Functioning Inappropriately - Seven-day maximum stream temperatures are >24.0°C.

e) Fish Passage--Culverts

Fish need to move up and down streams for a variety of reasons, including spawning migration and to seek more suitable habitat as a result of competition or unfavorable stream temperature. It has been documented that redband trout traveled 300 feet on Elder Creek, a major tributary of the Chewaucan River, from June until November (Osborn 1967); however, redband may move even greater distances to seek more suitable water temperatures (Bjornn and Reiser 1991), particularly during the summer months and when seeking spawning habitat during April and May (Kunkel 1976).

Road culverts can block the movement of fish; the most common access inhibitors being excessive water velocities and associated vertical drops (Baker and Votapka 1990). When assessing culverts for trout passage, the following parameters should be evaluated: (1) jumping pools, (2) vertical jumps of <1 foot, (3) velocities that do not exceed maximum sustained swimming speed, and (4) culvert length (Furniss et al. 1991). Baker and Votapka (1990) document sustained speeds of rainbow trout being 2.0 - 6.6 feet per second. Further, as the water velocity increases, the length of a culvert that a trout can swim through decreases. For example, a trout can maneuver through a 50-foot culvert with water velocities up to 3 feet per second; however, at water velocities of 4 feet per second, a trout can only swim through a 30-foot culvert.

Desired Fish Passage:

Functioning Appropriately - All culverts are passable. *This is the desired (target) condition.*

Functioning Appropriately but-at-Risk - When a culvert is a barrier in the middle to upper reaches of a watershed.

Functioning Inappropriately - When a culvert is a barrier in the lower reaches of a watershed.

Summary and Synthesis for the entire Silver Lake Watershed Assessment Area

Summary of, and factors contributing to, current conditions for the Silver Creek Watershed: The following tables (Tables 5.14, 5.15, 5.16, and 5.17) summarize current and desired fish habitat conditions within Silver, West Fork Silver, North Fork Silver and Guyer Creeks. Ratings given within these tables are based on a comparison of current and desired conditions (see desired conditions in Chapter 4 for ratings) within each of the surveyed stream reaches. Habitat conditions are summarized based on the following parameters: large woody debris, pools, spawning gravel fines, stream temperature, and fish passage. Following each table is a discussion of these ratings and the factors contributing to current conditions, as well as any trends in conditions. For reach locations refer to Figure 5.3 – Silver Creek Watershed Reach and Monitoring Locations.

Silver Creek

Table 5.14 - Silver Creek – Fish Habitat Elements

Reach Information					Condition	Habitat Elements						
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Fish Passage (Culvert)
						50% / 75%	50% / 75%	50% / 75%		(°C)	(°F)	
1	0.7	USFS	17	1	1 Desired	**	17 / 30	3 / 7	< 35	17.8	64.0	Passage
					1 Current	9	49	19	NA	NA	NA	Passage
					1 Rating	FA	FA	FA		FI		FA
2		Private			2 Desired				<20	17.8	64.0	Passage
					2 Current				NA	NA	NA	Passage
					2 Rating					FI		FA
3		Private			3 Desired				<20	17.8	64.0	Passage
					3 Current				NA	NA	NA	Passage
					3 Rating					FI		FA
4	1.6	BLM	22	3	4 Desired	1 / 6	13 / 23	3 / 6	<20	17.8	64.0	Passage
					4 Current	1	29	4	NA	NA	NA	Passage
					4 Rating	FAR	FA	FAR		FI		FA
5	1.5	USFS	22	1	5 Desired	1 / 6	13 / 22	3 / 6	<20	17.8	64.0	Passage
					5 Current	2	42	5	NA	NA	NA	Passage
					5 Rating	FAR	FA	FAR		FI		FA
6	1.5	USFS	23	1	6 Desired	1 / 6	13 / 22	3 / 6	<20	17.8	64.0	Passage
					6 Current	2	43	8	NA	24.4	75.9	Passage
					6 Rating	FAR	FA	FAR		FI		FA
7	2.3	USFS	23	1	7 Desired	1 / 6	13 / 22	3 / 6	<20	17.8	64.0	Passage
					7 Current	7	40	3	36	NA	NA	Passage
					7 Rating	FA	FA	FAR	FI	FAR		FA
8	1.2	USFS	22	1	8 Desired	1 / 6	13 / 22	3 / 6	<25	17.8	64.0	Passage
					8 Current	7	49	5	NA	NA	NA	Passage
					8 Rating	FA	FA	FAR		FAR		FA
9	1.3	USFS	23	2	9 Desired	5 / 20	14 / 23	2 / 6	<25	17.8	64.0	Passage
					9 Current	9	44	3	NA	22.0	71.6	Passage
					9 Rating	FAR	FA	FAR		FAR		FA

FA – Functioning Appropriately; FAR – Functioning Appropriately but-at-Risk; FI – Functioning Inappropriately
NA – Information Not Available; ** - Habitat element not applicable for this reach;
Habitat Abbreviations and Explanations: LWD – Large Woody Debris; Large Pools – Pools > 2.5 feet deep; % Spawning Gravel Fines - <6.4mm

a) Large Woody Debris (LWD).

Reach 1 is primarily a meadow site and thus was not evaluated for LWD. Also, reaches 2 and 3 were not assessed, as these two reaches were not surveyed. Reaches 4-9 are all appropriate sites for LWD, with ponderosa pine being the main source of in-stream wood. Within these reaches, LWD recruitment potential was determined to be adequate, yet LWD loadings were below desired numbers in all but two of the reaches. Thus, reaches 4, 5, 6 and 9 receive **functioning appropriately but-at-risk** ratings while reaches 7 and 8 receive **functioning appropriately** ratings.

In reaches 4-9, even though existing LWD numbers are either below or only slightly above their desired levels, recruitment potential is adequate to meet or exceed these numbers. A possible reason for the slightly reduced LWD numbers within these reaches could be attributed to Silver Creek (at its outflow of Thompson Reservoir) having enough energy during high flow events to move some of the smaller pieces of woody debris, making it more difficult to retain wood within the channel. Existing LWD within these reaches primarily occurs where debris jams have been created, or where pieces have been caught, or locked in place, by boulders.

b) Pools.

All of the reaches surveyed within Silver Creek were found to be **functioning appropriately**, with pool numbers exceeding the 75th percentile. Of these reaches, only Reach 1 is functioning appropriately in terms of the large pool component, while fewer deep (large) pools could be found in the other reaches, all of which received **functioning appropriately but-at-risk** ratings for the large pool habitat element.

Pool frequencies reflect near-natural numbers in part because stream channels and riparian vegetation are highly similar to desired conditions. Reach 1 appears to be providing adequate large pool habitat with pool complexity occurring through depth, structure and undercut banks along meander bends. This same type of complexity does not seem to exist among the pools in the remaining reaches, even though stream channels and riparian vegetation are highly similar to desired conditions. A primary influencing factor is that the channel morphology of Silver Creek has had to adjust to the regulated flows out of Thompson Reservoir, resulting in channels that are fairly wide and shallow. Thus, within many of these reaches, the number of deep pools may remain low until numbers of LWD and beaver (dams) increase within the system.

c) Spawning Gravel Fines.

Thirty-six percent fine sediments were documented at the sampling site located in Reach 7, promoting 31% embryo survival. This element was therefore given a **functioning inappropriately** rating. Sampling did not occur in any of the other reaches.

As mentioned in Chapter 4, section B, the channel morphology of Silver Creek has adjusted to regulated flows out of Thompson Reservoir. Consequently, flushing flows that are able to move sediment out of stream substrates do not occur as often as they did historically (before the construction of the dam), leading to the higher levels of fine sediments that were found in spawning substrates of Reach 7. A report by Reiser and Ramey (1985) identifies that large releases of water from regulated reservoirs are necessary to dislodge fine sediments in downstream reaches. Without these larger flushing flows, and the fact that beaver dams are not playing a significant role in trapping fine sediment within the system, Silver Creek may be unable to meet the recommended sediment levels. Otherwise, the high bank stability, abundance of late-seral vegetation, and appropriate stream types has a positive influence on maintaining lower sediment levels.

d) Stream Temperature.

Based on stream temperature recordings in reaches 6 and 9, it is assumed that reaches 7-9 are **functioning appropriately but-at-risk,** because the 7-day average maximum temperatures were within, or assumed to be within the 17.8-24.0°C range. In contrast, reaches 1-6 are believed to be **functioning inappropriately**, based on the 7-day average maximum temperatures being above 24.0°C.

Although it is assumed that stream temperatures were historically lower than they are today, it is highly unlikely that Silver Creek can meet current state standards since the outflow of Thompson Reservoir is so warm (monitoring shows that temperatures exceed 20°C during the warmest summer period). As mentioned previously, the channel morphology of Silver Creek has adjusted to regulated flows out of Thompson Reservoir with wetted channel widths that are fairly wide, ranging from 17-23 feet. Given these adjusted channel dimensions, shade values (shade information was collected within the surveyed reaches of Silver Creek using a solar pathfinder), however, were still found to be near their desired conditions. Shading values for each reach were compared to data collected for reaches determined to be near their desired or potential condition within the Sprague River system (data from information collected for the Sprague River TMDL – unpublished). Comparisons were made utilizing information from streams of the same width and riparian community group. Shading levels within Silver Creek were found to be within the range of values for similar sites that are at or near their potential condition within the Sprague River System. Shading values for Silver Creek were as follows: (R1) 24%, (R4) 36%, (R5) 30%, (R6) 43%, (R7) 40%, (R8) 44%, and (R9) 39%. For this reason, stream temperatures may be near their potential in part because stream channels and riparian vegetation are near their desired conditions – only slight improvements are expected in riparian (willow communities gain structure in the older age classes) and stream channel conditions (channels may narrow slightly).

e) Fish Passage (Culvert).

There are no known fish passage concerns (culverts) within the reaches that were surveyed, and thus this element receives a **functioning appropriately** rating.

West Fork Silver Creek

Table 5.15 - West Fork Silver Creek – Fish Habitat Elements

Reach Information					Condition	Habitat Elements						
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Fish Passage (Culvert)
						50% / 75%	50% / 75%	50% / 75%		(°C)	(°F)	
1	0.5	BLM	8	1	1 Desired	**	49 / 84	0 / 4	<20	17.8	64.0	Passage
					1 Current	0	110	*	NA	NA	NA	Passage
					1 Rating	FA	FA	FA		FAR		FA
2	0.5	BLM	10	1	2 Desired	3 / 15	30 / 51	0 / 3	<25	17.8	64.0	Passage
					2 Current	7	109	22	15	21.6	74.9	Passage
					2 Rating	FA+	FA	FA	FA	FAR		FA
3	1.1	BLM	12	1	3 Desired	3 / 11	25 / 42	0 / 2	<25	17.8	64.0	Passage
					3 Current	5	102	2	NA	NA	NA	Passage
					3 Rating	FAR	FA	FAR		FAR		FA
4	3.0	USFS	15	1	4 Desired	3 / 12	27 / 46	0 / 2	<25	17.8	64.0	Passage
					4 Current	33	118	6	NA	NA	NA	Passage
					4 Rating	FA	FA	FA		FAR		FA
5	1.2	USFS	9	<1	5 Desired	4 / 15	33 / 56	0 / 3	<25	17.8	64.0	Passage
					5 Current	21	37	5	25	24.9	76.7	Barrier
					5 Rating	FA	FA	FA	FAR	FAR		FI
5a		Private			6 Desired				<20	17.8	64.0	Passage
					6 Current				NA	NA	NA	Passage
					6 Rating					FAR		FA
6	1.2	USFS	8	<1	7 Desired	4 / 17	37 / 63	0 / 2	<20	17.8	64.0	Passage
					7 Current	7	111	18	NA	NA	NA	Passage
					7 Rating	FA+	FA	FA		FAR		FA
7	2.9	USFS	8	7	8 Desired	13 / 58	40 / 67	1 / 5	<25	17.8	64.0	Passage
					8 Current	20	115	1	35	15.3	59.5	Passage
					8 Rating	FAR	FA	FAR	FI	FA		FA
8	3.0	USFS	8	1-2	9 Desired	4 / 17	37 / 63	0 / 3	<25	17.8	64.0	Passage
					9 Current	27	98	0	NA	NA	NA	Passage
					9 Rating	FA	FA	FAR		FA		FA
9	1.5	USFS	7	1-2	10 Desired	5 / 19	42 / 72	0 / 4	<20	17.8	64.0	Passage
					10 Current	45	108	0	30	13.9	57.0	Barrier
					10 Rating	FA	FA	FAR	FI	FA		FAR
10	1.3	USFS	7	<1	11 Desired	5 / 19	42 / 72	0 / 4	<20	17.8	64.0	Passage
					11 Current	21	120	0	NA	NA	NA	Barrier
					11 Rating	FA	FA	FAR		FA		FAR
11	1.7	USFS	5	1-2	12 Desired	6 / 26	59 / 101	0 / 5	<20	17.8	64.0	Passage
					12 Current	34	134	0	NA	NA	NA	Passage
					12 Rating	FA	FA	FAR		FA		FA
12	0.7	USFS	5	2-4	12 Desired	21 / 90	63 / 107	0 / 5	<20	17.8	64.0	Passage
					12 Current	58	143	0	28	10.9	51.5	Passage
					12 Rating	FA–	FA	FAR	FAR	FA		FA
13	1.0	USFS	4	>4	13 Desired	24 / 48	40 / 77	0 / 0	<20	17.8	64.0	Passage
					13 Current	41	122	0	NA	NA	NA	Passage
					13 Rating	FA–	FA	FA		FA		FA

FA – Functioning Appropriately; FAR – Functioning Appropriately but-at-Risk; FI – Functioning Inappropriately
NA – Information Not Available; ** - Habitat element not applicable for this reach; +- - Rating modified based on reach characteristics (i.e. meadow/forest)
Habitat Abbreviations and Explanations: LWD – Large Woody Debris; Large Pools – Pools > 2.8 feet deep; % Spawning Gravel Fines - <6.4mm

a) Large Woody Debris (LWD).

Reach 1 is primarily a meadow site, where LWD in not expected. Reaches 2-7 are all appropriate sites for LWD, with ponderosa pine being the main source of in-stream wood. Within these reaches, LWD recruitment potential was determined to be adequate in reaches 3, 4, 5, and 7. Of these, only reaches 4 and 5 were determined to **functioning appropriately**, while reaches 3 and 7 had LWD loadings below desired numbers and thus received **functioning appropriately but-at-risk** ratings. Reaches 2 and 6 occur within areas of limited LWD recruitment potential, and for this reason, both were determined to be **functioning appropriately** for this element. In reaches 8-13, lodgepole pine is the main source of LWD, with levels in each reach determined to be **functioning appropriately**. Of these six reaches, reaches 12 and 13 have a larger portion exhibiting meadow/forest characteristics, which slightly limits LWD recruitment potential. Also, there were pieces of LWD found to be just above the bankfull dimensions and thus were not counted in the current condition numbers shown in the table above. Taking this into consideration, as well as the nature and setting of the stream, both of these reaches were determined to be **functioning appropriately** for this element.

As mentioned above, Reaches 2 and 6 occur in areas of limited LWD recruitment potential where only a portion of the channel is lined with conifers and/or tree densities are low within the stream corridor. In reaches 12 and 13, West Fork Silver Creek flows through both lodgepole forests and meadow-shrub/forested areas, which helps to explain the slightly reduced numbers of LWD found within these reaches. For this reason, LWD ratings within these reaches are questionable since calculations that lead to desired numbers of LWD assume that nearly all areas along the stream are forested. Professional judgment, based primarily on adequate LWD recruitment potential was used to determine that these reaches have appropriate levels of LWD.

b) Pools.

All of the reaches surveyed within West Fork Silver Creek were found to be **functioning appropriately**, with pool numbers exceeding the 75th percentile. It should be noted that Reach 5 received functioning appropriately ratings even though riparian vegetation and channel morphology received functioning appropriately but-at-risk ratings. Of the reaches surveyed, reaches 1, 2, 4, 5, 6 and 13 are **functioning appropriately** in terms of the large pool component, while fewer deep (large) pools were found in the other reaches, all of which received **functioning appropriately but-at-risk** ratings for large pools.

In the thirteen surveyed reaches of West Fork Silver Creek, pool frequencies reflect near-natural numbers in part because stream channels and riparian vegetation are similar to desired conditions. Reaches 1, 2, 4, 5, 6 and 13 appear to be providing adequate large pool habitat, with pool complexity occurring through depth, structure and undercut banks. An important insight for both Reach 6 and the rest of the watershed is the role beaver dams play in creating many of the deep pools within the reach. This same type of complexity does not seem to exist among the pools in the remaining reaches, even though stream channels and riparian vegetation are similar to desired conditions. Thus, the number of deep pools within many of these reaches is likely to remain low with the absence of beaver dams.

c) Spawning Gravel Fines.

Fine sediment in spawning substrates has been sampled at five locations within West Fork Silver Creek. At the lowermost sampling station, located in Reach 2 (a C/E stream type), the percent fines were measured to be 15%, the lowest recorded at any sampling site within the Silver Lake watershed, promoting 83% embryo survival. In Reach 5, also a C/E stream type, the percent fines were higher at 25%, promoting 62% embryo survival. Thus Reach 2 is **functioning appropriately**, while Reach 5 is **functioning appropriately but-at-risk.** In reaches 7 and 9, which are primarily B/E stream types, sampling results showed 35% and 30% fine sediment, respectively, promoting 34% and 47% embryo survival, resulting in a **functioning inappropriately** rating for Reach 7 and a **functioning appropriately but-at-risk** rating for Reach 9. Associated with the sampling location that was above the road in Reach 9, samples were also taken below the road during the 2001 sampling, with results showing 47% fine sediments – 17% higher than the sampling results that were found upstream of the road crossing. At the uppermost sampling station, located in Reach 12 (also a B/E stream type) the percent fines were measured to be 28% in 1996 (no measurement were taken in 2001), promoting 53% embryo survival and resulting in a **functioning appropriately but-at-risk** rating.

Results of monitoring fine sediments in spawning substrates within West Fork Silver Creek indicates that levels of fine sediment are typically higher than recommended. Mean values of fine sediment and embryo survival for the five reaches sampled in 2001 are 26% and 60%, respectively. These levels of fines are not only limiting embryo survival, but are likely influencing the food supply and habitat for adult fish. Species of macroinvertebrates and macroinvertebrate ratings vary greatly depending on the chemical and biological conditions and amount of sediment in the stream. Aquatic macroinvertebrate sampling in West Fork Silver Creek during 1989, 1990 and 1994, shows an overall decline in habitat conditions since monitoring began. Overall habitat condition ratings have gone from an excellent rating (BCI 94) in 1989, to good and fair ratings (BCI 86 & 75) in 1990, to a poor rating (BCI 65) in 1994. It is worth noting, however, that 1994 was a very dry year, with extremely low stream flows, which likely influenced BCI ratings.

Sediment in potential spawning substrates of West Fork Silver Creek varies between 15% and 35% (26% and 45% in 1996). One of the reasons for these relatively high reported sediment values is likely associated with the naturally high erosion rates associated with soils (located in the pumice zone) and geomorphology of the area. Monitoring in this system shows that in the upper portions of the drainage, where impacts from logging activities are minimal, sediment levels are about 28% (measured only in 1996). Below West Fork Silver Creek Marsh, which is influenced by beaver activity, sediment levels were measured at 25% (26% in 1996). Between these two areas, substrate fines were measured at 35 and 30% (41 and 45% in 1996). Review of aerial photographs of the area reveals impacts from logging in the adjacent uplands, which, along with associated roading may be influencing sediment levels. It should be noted, however, that potential natural erosion rates are high in the areas where the highest sediment levels occur (also the area where harvesting and roading have occurred), possibly influencing localized sediment levels. Thus, the stream system may be unable to meet the recommended sediment levels in the absence of beaver. The connection between beaver dams and the lower levels of sediment measured below the marsh, indicates the importance of maintaining beaver habitat and beaver populations in the stream system. Beaver dams are important for trapping sediment and providing cool water refugia for fish. The decrease in beaver dams has resulted in an even distribution of sediment throughout the entire length of the stream channel and higher levels of fines in spawning substrates than existed historically. Under reference conditions, sediment would be trapped behind beaver dams and cleaner spawning substrate would be found below these beaver dams. The relatively low sediment levels found in Reach 2 are most likely attributed to the upstream beaver dams that act as a sediment trap, high stream bank stability, the abundance of late-seral vegetation, and appropriate stream types. A note of interest from the sediment sampling that has occurred within this stream is the overall average decrease in values (10%) between 2001 (average of 26%) and 1996 (average of 36%). This difference is likely attributed to the flushing of fine sediments out of the system associated with the flood of 1997, one of the largest on record.

d) Stream Temperature.

Based on stream temperature recordings in reaches 7, 9, and 12, it is assumed that reaches 7-13 are all **functioning appropriately**, because the 7-day average maximum temperatures were all below 17.8°C. In contrast, reaches 1-6 are believed to be **functioning appropriately but-at-risk**, based on the 7-day average maximum temperatures that were within, or assumed to be within, the 17.8-24.0°C range (data from all years of record was taken into consideration, see Table 5.8).

The relatively low stream temperatures found throughout the upper seven reaches of West Fork Silver Creek are a result, in part, of upstream riparian vegetation and stream channels being near their desired state. For this reason, stream temperatures may also be near their potential. In contrast, the relatively open forest/meadow and meadow reaches found throughout the rest of the system allow temperatures to increase, being close to 24.0°C. As discussed in previous watershed evaluations, several sections of the low-gradient reaches in West Fork Silver Creek have been affected by at least one factor influencing stream temperatures – stream channels that are slightly wider than desired, loss of riparian shade, lower stream flows caused by increased evapotranspiration, etc. Although this has occurred, current shade values (shade information was collected within the surveyed reaches of West Fork Silver Creek using a solar pathfinder) were still found to be near their desired conditions. Shading values for each reach were compared to data collected for reaches determined to be near their desired or potential condition within the Sprague River system (data from information collected for the Sprague River TMDL – unpublished). Comparisons were made utilizing information from streams of the same width and riparian community group. Shading levels within West Fork Silver Creek were found to be within the range of values for similar sites that are at or near their potential condition within the Sprague River System. Shading values for West Fork Silver Creek were as follows: (R1) 33%, (R2) 25%, (R3) 60%, (R4) 65%, (R5) 35%, (R6) 51%, (R7) 77%, (R8) 77%, (R9) 64%, (R10) 64%, (R11) 54%, (R12) 60%, and (R13) 73%. For this reason, stream temperatures may be near their potential in part because stream channels and riparian vegetation are near their desired conditions – only slight improvements are expected in riparian (willow communities gain structure in the older age classes) and stream channel conditions (channels may narrow slightly).

Beaver ponds do occur in localized areas, such as West Fork Silver Creek Marsh, where State of Oregon standards for stream temperatures were exceeded, however, beaver ponds can provide deep-water habitat with cool refugia areas. It is assumed that the loss of beaver dams throughout the stream system has created streams that are less complex with fewer cool water refugia areas.

e) Fish Passage (Culvert).

Three of the four culverts surveyed along West Fork Silver Creek were found to be barriers, or at least partial barriers, to fish passage. The culverts surveyed are located in reaches 5, 7, 9, and 10. Refer to Figure 5.2 – Silver Creek Watershed Road Locations. The culverts in reaches 5 and 9 were found to have a vertical jump (water surface to culvert outlet) of around one foot and have flow velocities that exceed sustained swimming speeds for trout. The culvert in Reach 7 was found to be passable for fish with beaver dams located both upstream and downstream of the pipe. Although the culvert in Reach 10 is an open-bottom arch pipe, the survey identified it as a barrier, or partial barrier, due to a perch at the inlet. Because the culvert in Reach 5 is considered a barrier, and is located in the lower part of the stream, making upstream reaches inaccessible, this element receives a **functioning inappropriately** rating.

The slope of the culverts in reaches 5 and 9 is steep enough that, when based on their size and length, contribute to flow velocities in the pipes that are higher than sustainable for fish. For this reason, these culverts are considered barriers to fish passage (these culverts also have perch at their outlet, about a one foot jump height). The culvert in Reach 10 is considered a barrier due the perch at the culvert inlet – it is likely this problem could be easily fixed without replacement of this culvert.

<u>North Fork Silver Creek</u>

Table 5.16 - North Fork Silver Creek – Fish Habitat Elements

Reach Information					Condition	Habitat Elements						
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Fish Passage (Culvert)
						50% / 75%	50% / 75%	50% / 75%		(°C)	(°F)	
1	7.5	USFS	3	1-4	1 Desired	21 / 90	63 / 107	1 / 4	<20	17.8	64.0	Passage
					1 Current	78	108	0	NA	14.3	57.8	Passage
					1 Rating	FA+	FA	FI		FA		FA
2	2.6	USFS	5	2-4	2 Desired	21 / 90	63 / 107	1 / 4	<20	17.8	64.0	Passage
					2 Current	34	117	0	52	NA	NA	Barrier
					2 Rating	FA+	FA	FI	FI	FA		FI

FA – Functioning Appropriately; FAR – Functioning Appropriately but-at-Risk; FI – Functioning Inappropriately
NA – Information Not Available; ** - Habitat element not applicable for this reach; + - Rating modified based on reach characteristics (i.e. meadow/forest)
Habitat Abbreviations and Explanations: LWD – Large Woody Debris; Large Pools – Pools > 2.6 feet deep; % Spawning Gravel Fines - <6.4mm

a) Large Woody Debris (LWD).

Similar to many the upper reaches of West Fork Silver Creek, both reaches of North Fork Silver Creek occur within lodgepole pine vegetation types, with some areas exhibiting meadow/forest characteristics. Ample large woody debris, as well as large woody debris potential, was noted during stream surveys, but numerous pieces were found to be just above the bankfull dimensions and thus were not counted in the current condition numbers shown in the table above. Considering this, as well as the nature and setting of the stream, both of these reaches were determined to be **functioning appropriately** for this element.

As mentioned above, North Fork Silver Creek flows through both lodgepole forests and meadow/forested areas, which helps to explain the slightly reduced numbers of LWD found within the two reaches. For this reason, LWD ratings within these reaches are questionable since calculations that lead to desired numbers of LWD assume that nearly all areas along the stream are forested. Professional judgment, based primarily on LWD recruitment potential including the numerous pieces lying just above the bankfull dimensions, was used to determine that all reaches have appropriate levels of LWD.

b) Pools.

Both of the reaches surveyed were found to be **functioning appropriately**, with pool numbers exceeding the 75th percentile. In terms of the large pool component, however, no deep (large) pools could be found in either reach, and thus both received **functioning inappropriately** ratings for the large pool habitat element.

Pool frequencies reflect near-natural numbers in part because stream channels and riparian vegetation are highly similar to desired conditions. Of particular importance for this stream is that large woody debris numbers are at desired levels – LWD is such an important structural agent in forming pools in small streams like North Fork Silver Creek. However, complexity of these pools, with reference to depth, appears to be lacking. This may simply be a function of the size of the stream, or as with other smaller streams in the Silver Lake Watershed, the number of deep pools within North Fork Silver Creek may remain low with the absence of beaver dams.

c) Spawning Gravel Fines.

Fifty-two percent fine sediments (60% recorded in 1996) were documented at the sampling site located in Reach 2, promoting only 7% (3% based on 1996 sample) embryo survival. This element was therefore given a **functioning inappropriately** rating.

The relatively high sediment levels recorded in Reach 2 are most likely attributed to the depositional nature of the sampling site – it is likely that the sample was taken within the depositional influence zone of a large road fill/crossing. Also, natural high erosion rates associated with soils and geomorphology of this area could be another reason for the high sediment in spawning substrates. A note of interest from the sediment sampling that has occurred within this stream is the lower values found in 2000. This difference is likely attributed to the flushing of fine sediments out of the system associated with the flood of 1997, one of the largest on record.

d) Stream Temperature.

Based on stream temperature recordings at the lower end of Reach 1 (7-day average maximum temperatures of 14.3°C) it is assumed that both reaches are below 17.8°C, and thus are **functioning appropriately**.

The low stream temperatures found throughout North Fork Silver Creek are a function of upstream riparian vegetation and stream channels being at their desired state. This has led to shading-levels (shade information was collected within both reaches of North Fork Silver Creek using a solar pathfinder) also being at or near their desired conditions. Shading values for each reach were compared to data collected for reaches determined to be near their desired or potential condition within the Sprague River system (data from information collected for the Sprague River TMDL – unpublished). Comparisons were made utilizing information from streams of the same width and riparian community group. Shading levels within North Fork Silver Creek were found to be within the range of values for similar sites that are at or near their potential condition within the Sprague River System. Shading values for North Fork Silver Creek were as follows: (R1) 76%, and (R2) 82%. For this reason, stream temperatures may be near their potential in part because stream channels and riparian vegetation are near or at their desired conditions.

e) Fish Passage (Culvert).

Based on the information gathered during culvert inventories, the one culvert surveyed along North Fork Silver Creek, which is located in reach 2, is considered to be barrier to fish passage. Refer to Figure 5.2 – Silver Creek Watershed Road Locations. This culvert has an acceptable jump height and pool at the outlet of the culvert, but velocities were determined to exceed the sustainable swimming speeds of trout. Because this culvert occurs in the lower portion of this reach, this assessment element receives a **functioning inappropriately** rating.

The culvert has a fairly steep slope (4%), which, based on the size and length of the culvert, contribute to flow velocities in the pipe that are higher than sustainable for fish. This is the reason this culvert is considered a barrier to fish passage.

Guyer Creek

Table 5.17 - Guyer Creek – Fish Habitat Elements

Reach Information					Condition	Habitat Elements						
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Fish Passage (Culvert)
						50% / 75%	50% / 75%	50% / 75%		(°C)	(°F)	
1		Private			1 Desired				<20	17.8	64.0	Passage
					1 Current				NA	NA	NA	Barrier
					1 Rating							FI
2	1.9	USFS	8	2	2 Desired	13 / 56	40 / 67	1 / 2	<20	17.8	64.0	Passage
					2 Current	52	107	0	NA	16.2	61.1	Passage
					2 Rating	FA~	FA	FI		FA		FA
3	2.9	USFS	7	2-4	3 Desired	15 / 64	45 / 76	1 / 3	<20	17.8	64.0	Passage
					3 Current	90	137	0	46	NA	NA	Barrier
					3 Rating	FA~	FA	FI	FI	FA		FI
4	0.7	USFS	5	2-4	4 Desired	21 / 90	63 / 107	1 / 4	<20	17.8	64.0	Passage
					4 Current	48	155	0	NA	NA	NA	Passage
					4 Rating	FA~	FA	FI		FA		FA
5	2.0	USFS	5	2-4	5 Desired	21 / 90	63 / 107	1 / 4	<20	17.8	64.0	Passage
					5 Current	52	151	0	46	NA	NA	Barrier
					5 Rating	FA~	FA	FI	FI	FA		FAR
6	1.1	USFS	4	>4	6 Desired	26 / 88	40 / 77	0 / 0	<25	17.8	64.0	Passage
					6 Current	76	78	0	NA	NA	NA	Passage
					6 Rating	FA~	FA	FA		FA		FA

FA – Functioning Appropriately, FAR – Functioning Appropriately but-at-Risk, FI – Functioning Inappropriately
NA – Information Not Available; ** - Habitat element not applicable for this reach; ~ - Rating modified based on reach characteristics (i.e. meadow/forest)
Habitat Abbreviations and Explanations: LWD – Large Woody Debris; Large Pools – Pools > 2.6 feet deep; % Spawning Gravel Fines - <6.4mm

a) Large Woody Debris (LWD).

Like the upper reaches of West Fork Silver Creek and both reaches of North Fork Silver Creek, all five surveyed reaches of Guyer Creek occur within lodgepole pine vegetation types, with some segments exhibiting meadow/forest characteristics. Ample large woody debris, as well as large woody debris potential, was noted during stream surveys, but numerous pieces were found to be just above the bankfull dimensions and thus were not counted in the current condition numbers shown in the table above. Taking this into consideration, as well as the nature and setting of the stream, all five of these reaches were determined to be **functioning appropriately** for this element.

As mentioned above, Guyer Creek flows through both lodgepole forests and meadow-shrub/forested areas, which helps to explain the slightly reduced numbers of LWD found within these reaches. For this reason, LWD ratings within these reaches are questionable since calculations that lead to desired numbers of LWD assume that nearly all areas along the stream are forested. Professional judgment, based primarily on adequate LWD recruitment potential including the numerous pieces lying just above the bankfull dimensions, was used to determine that all reaches have appropriate levels of LWD.

b) Pools.

All of the reaches surveyed were found to be **functioning appropriately**, with pool numbers exceeding the 75[th] percentile. In terms of the large pool component, however, no deep (large) pools could be found in any of the reaches. Thus, reaches 2-5 received **functioning inappropriately** ratings for the large pool habitat element, while Reach 6 received a **functioning appropriately** rating (gradient of Reach 6 is steeper than in reaches 2-5, thus a different formula was used to calculate desired condition numbers – see desired conditions section).

Pool frequencies reflect near-natural numbers in part because stream channels and riparian vegetation are highly similar to desired conditions. As with West Fork Silver and North Fork Silver Creeks, of particular importance for this stream is that large woody debris numbers are at desired levels – LWD is such an important structural agent in forming pools in small streams like Guyer Creek. However, complexity of these pools, with reference to depth, appears to be lacking. This may simply be a function of the size of the stream, or as with other smaller streams in the Silver Lake Watershed, the number of deep pools within Guyer Creek may remain low with the absence of large beaver dams. Although old beaver ponds/dams are still maintaining important pool habitat and refugia in Reach 5, pools are not deep enough to meet the large pool criteria. The likely reason for this is associated with the fact that these structures have been around long enough that the deeper parts of the original pond have since filled in with sediment.

c) Spawning Gravel Fines.

Forty-six percent fine sediments were documented at the sampling sites located in reaches 3 and 5, promoting only 13% embryo survival and resulting in **functioning inappropriately** ratings.

The relatively high sediment levels reported within these two reaches are somewhat unexpected as road crossings and bank instability are both minimal upstream from the sampling locations. One possible explanation is that the samples were taken at the lower end of a low gradient meadow reach, which may act as a natural settling point for fine sediment. In addition, reported values are likely associated with the naturally high erosion rates associated with soils and geomorphology of the area.

d) Stream Temperature.

Seven-day average maximum temperatures in Reach 2 were 22.9°C and 22.2°C, respectively. Based on these numbers, which are within the 17.8-24.0°C range, these two reaches are determined to be **functioning appropriately but-at-risk.**

Based on the stream temperature sensor located at Reach 2 (7-day average maximum temperatures of 16.2°C), it is assumed that reaches 2-6 are below 17.8°C, and thus are **functioning appropriately.** No data was collected in Reach 1, nor were any assumptions made as to whether this reach is functioning appropriately or functioning appropriately but-at-risk.

The relatively low stream temperatures found throughout Guyer Creek are a function of upstream riparian vegetation and stream channels being near or at their desired state. This has led to shading levels (shade information was collected within all reaches of Guyer Creek using a solar pathfinder) that are also close to their desired conditions. For each surveyed reach, measured shading values were compared to data collected for reaches determined to be near their desired or potential condition within the Sprague River system (data from information collected for the Sprague River TMDL – unpublished). Comparisons were made utilizing information from streams of the same width and riparian community group. Shading levels within Guyer Creek were found to be within the range of values for similar sites that are at or near their potential condition within the Sprague River System. Shading values for Guyer Creek were as follows: (R2) 80%, (R3) 61%, (R4) 63%, (R5) 54%, and (R6) 68%. For this reason, stream temperatures may be near their potential in part because stream channels and riparian vegetation are near their desired conditions.

e) Fish Passage (Culvert).

Three of the four culverts surveyed along Guyer Creek were found to be barriers to fish passage. The culverts surveyed are located in reaches 1, 3, 4, and 5. Refer to Figure 5.2 – Silver Creek Watershed Road Locations. The culvert in Reach 1 was identified as a barrier, or partial barrier, due to a perch at the inlet. The culvert in Reach 3 has a vertical jump (water surface to culvert outlet) of greater than 1 foot and has flow velocities that exceed sustained swimming speeds for trout. The culvert in Reach 4 was found to be passable for fish. The culvert in Reach 5 has an acceptable jumping height and pool at its outlet, but the water velocities during spawning periods were calculated to exceed sustained swimming speeds. Because the culverts in reaches 1 and 3 are considered barriers, and are located in the lower part of the stream, making upstream reaches inaccessible, this element receives a **functioning inappropriately** rating.

The slope (just over 4%) of the culverts in reaches 3 and 5, which produces flow velocities in the pipe that exceed sustained swimming speeds for fish, is the reason these culverts (also jump height in Reach 3) are considered barriers. The culvert in Reach 1 is considered a barrier due the perch at the culvert inlet – it is likely this problem could be easily fixed without replacement of this culvert.

Summary of, and factors contributing to, current conditions for Benny, Squaw, and Indian Creeks – Benny, Squaw, and Indian Creek Subwatersheds of the Silver Creek Watershed: No surveys occurred within these subwatersheds. The lower portions of Benny and Squaw Creeks are considered to be intermittent fish-bearing streams with seasonal potential trout habitat occurring downstream of Forest Road 2916, however only a few fish have been observed upstream of Forest Road 28. If fish use the portions of streams above this culvert, it appears the timing of occupation is limited to spring months when sufficient flows exist. Fish, migrating from Thompson Reservoir, do occupy the lower portion of these two streams where riffles, pools, and in-stream large wood are available, however, no stream survey information exists to be able to quantify habitat conditions. Also, beyond early summer, the available habitat becomes scarce due to decreased flows. Where Benny Creek crosses Forest Road 28, redband trout have been documented in the pool at the culvert outlet. This culvert is considered to be a potential barrier to fish passage based on velocities (during the spring months – spawning period) that exceed the sustained swimming speeds of trout. For these reasons, this subwatershed is **functioning appropriately but-at-risk** in terms of fish habitat conditions.

Summary of, and factors contributing to, current conditions for the Bridge Creek Watershed: The following table (Table 5.18) summarizes current and desired fish habitat conditions within Bridge Creek. Ratings given within this table are based on a comparison of current and desired conditions (see desired conditions in Chapter 4 for ratings) within each of the surveyed stream reaches. Habitat conditions are summarized based on the following parameters: large woody debris, pools, spawning gravel fines, stream temperature, and fish passage. For reach locations refer to Figure 5.3 – Bridge Creek Watershed Reach and Monitoring Locations.

Bridge Creek

Table 5.18 - Bridge Creek – Fish Habitat Elements

Reach Information					Condition	Habitat Elements						
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Fish Passage (Culvert)
						50%/75%	50%/75%	50%/75%		(C)	(F)	
1	0.8	Private	6	<1	1 Desired	**	49 / 84	0 / 4	<20	17.8	64.0	Passage
					1 Current	0	83	9	NA	NA	NA	Barrier (weir)
					1 Rating	FA	FAR	FA		FAR		FI
2	1.7	Private	7	<1	2 Desired	**	42 / 72	0 / 4	<20	17.8	64.0	Passage
					2 Current	2	45	10	NA	NA	NA	Passage
					2 Rating	FA	FAR	FA		FAR		FA
3	1.2	Private	8	1	3 Desired	**	37 / 63	0 / 3	<20	17.8	64.0	Passage
					3 Current	6	61	3	NA	NA	NA	Barrier (weir)
					3 Rating	FA	FAR	FAR		FAR		FI
4		Private			4 Desired				<20	17.8	64.0	Passage
					4 Current				NA	NA	NA	
					4 Rating					FAR		
5	0.7	Private	8	1	5 Desired	**	37 / 63	0 / 3	<20	17.8	64.0	Passage
			11		5 Current	4	123	17	NA	NA	NA	Passage
					5 Rating	FA	FA	FA		FA		FA
6	1.7	BLM/FS	9	1	6 Desired	4 / 15	33 / 56	0 / 3	<20	17.8	64.0	Passage
					6 Current	18	93	2	NA	16.2	61.1	Barrier
					6 Rating	FA	FA	FAR		FA		FI
7	2.2	USFS	10	1-4	7 Desired	21 / 45	32 / 53	1 / 2	<25	17.8	64.0	Passage
					7 Current	29	119	1	NA	NA	NA	Passage
					7 Rating	FAR	FA	FAR		FA		FA
8	1.0	USFS	10	<2	8 Desired	21 / 45	32 / 53	1 / 2	<25	17.8	64.0	Passage
					8 Current	47	121	0	31	16.4	61.6	Barrier
					8 Rating	FAR	FA	FI	FI	FA		FI
9	0.6	Private	9	1-2	9 Desired	12 / 50	35 / 59	1 / 2	<25	17.8	64.0	Passage
					9 Current	26	84	0	NA	NA	NA	Passage
					9 Rating	FAR	FA	FI		FA		FA
10	1.5	USFS	9	2-4	10 Desired	12 / 50	35 / 59	1 / 2	<25	17.8	64.0	Passage
					10 Current	33	105	5	NA	NA	NA	Passage
					10 Rating	FA -	FA	FA		FA		FA
11	1.4	USFS	10	2-4	11 Desired	11 / 45	32 / 53	1 / 2	<25	17.8	64.0	Passage
					11 Current	58	132	0	NA	NA	NA	Passage
					11 Rating	FA	FA	FI		FA		FA

Table 5.18 - Bridge Creek – Fish Habitat Elements (continued)

Reach Information					Condition	Habitat Elements						
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Fish Passage (Culvert)
						50% / 75%	50% / 75%	50% / 75%		(°C)	(°F)	
12	0.7	USFS	6	2-8	12 Desired	18 / 59	26 / 51	0 / 0	<25	17.8	64.0	Passage
					12 Current	71	94	0	19	11.6	52.9	Barrier
					12 Rating	FA~	FA	FA	FA	FA		FAR
13	0.5	USFS	7	1	13 Desired	5 / 38	42 / 72	0 / 4	<20	17.8	64.0	Passage
					13 Current	69	178	9	NA	NA	NA	Passage
					13 Rating	FA	FA	FA		FA		FA
14	2.3	USFS	6	2-8	14 Desired	18 / 59	26 / 51	0 / 0	<25	17.8	64.0	Passage
					14 Current	51	167	0	NA	NA	NA	Passage
					14 Rating	FA~	FA	FA		FA		FA

FA – Functioning Appropriately; FAR – Functioning Appropriately but-at-Risk; FI – Functioning Inappropriately
NA – Information Not Available; ** - Habitat element not applicable for this reach; ~ - Rating modified based on reach characteristics (i.e. meadow/forest)
Habitat Abbreviations and Explanations: LWD – Large Woody Debris; Large Pools – Pools > 2.6 feet deep; % Spawning Gravel Fines - <6.4mm

a) Large Woody Debris (LWD).

Reaches 1, 2, 3, and 5 were not rated for LWD because they are primarily low gradient meadow sites where little LWD is expected. Although a few pieces of LWD do occur within each of these reaches, recruitment of LWD is quite limited. On the other hand, LWD recruitment potential was much greater within the remaining reaching. In reaches 6-9, both ponderosa pine and lodgepole pine were the primary sources of in-stream wood, but only Reach 6 was determined to be **functioning appropriately**, while reaches 7-9 had LWD loadings below desired numbers and thus received **functioning appropriately but-at-risk** ratings. In reaches 10-14, lodgepole pine is the main source of LWD, with levels in each reach determined to be **functioning appropriately**.

Even though reaches 7-9 received functioning appropriately but-at-risk ratings, LWD levels are likely near their potential since these reaches, like nearly all of the other forested reaches of Bridge Creek, have had little influence from past timber harvesting. However, ratings within these reaches were not adjusted based on the fact that the addition of correctly placed LWD within these reaches would improve overall pool complexity within the stream and create important large pool habitat.
On the other hand, although LWD numbers in reaches 10, 12, and 14 were also found to be slightly below desired levels, they were rated as functioning appropriately due to the nature and setting of the stream – some areas exhibiting meadow/forest characteristics and two of the reaches (12 and 14) being within the Yamsay Mountain Semi-Primitive Non-Motorized Recreation Area – as well as numerous pieces found just above bankfull dimensions.

b) Pools.

Reaches 1, 2, and 3 were found to be **functioning appropriately but-at-risk**, with pool numbers slightly lower than the 75th percentile, while reaches 5-14 all received **functioning appropriately** ratings. For large pools, reaches 1, 2, 5, 10, 12, 13, and 14 were found to have numbers exceeding the 75th percentile, resulting in **functioning appropriately** ratings. On the other hand, reaches 3, 6, and 7 were lacking large pools and received **functioning appropriately but-at-risk** ratings, while reaches 8, 9, and 11 had no large pools and were found to be **functioning inappropriately**.

The lower pool frequencies found in reaches 1, 2, and 3 reflect the lack of late-seral riparian vegetation and stream channels that are wider than desired. As previously mentioned, C and E stream types require an abundance of late-seral vegetation to promote and maintain channel integrity. In portions of these reaches, riparian vegetation and stream channels conditions are still on the path of recovery towards their desired state, with stream channels being a little wider than their potential. With late-seral riparian vegetation promoting continued recovery, improved channel integrity and lower width-to-depth ratios should result – conditions that promote high quality pool habitat (deep and complex pools) and desired pool frequencies. Also, as riparian conditions improve within these reaches, habitat for beaver will also improve, promoting the presence of beaver dams and their associated deep and complex pools. In the remaining reaches, pool frequencies reflect near-natural numbers in part because stream channels and riparian vegetation are highly similar to desired conditions.

c) Spawning Gravel Fines.

Fine sediment in spawning substrates was sampled at two locations within Bridge Creek. The site in Reach 8, a B stream type, has 31% fine sediments, promoting 44% embryo survival. In Reach 12, also a B stream type, the percent fines were lower at 19, promoting 76% embryo survival. Thus, Reach 8 is determined to be **functioning inappropriately**, while Reach 12 is **functioning appropriately**.

One of the reasons for the relatively high reported sediment values within Bridge Creek is likely attributed to the naturally high erosion rates associated with the soils (located in the pumice zone) and geomorphology of the area. Monitoring in this system shows that in the upper portions of the drainage, where impacts from roading and harvesting are minimal, sediment levels are about 19%. Below this area, where the watershed has been influenced by logging and associated roading, substrate fines were found to be higher than recommended levels. Reach 8 occurs within this area and had values of fine sediment and embryo survival of 31% and 44%, respectively. These levels of fines may not only limit embryo survival, but could also be influencing the food supply and habitat for adult trout and other aquatic species. Species of macroinvertebrates, and macroinvertebrate ratings, vary greatly depending on the chemical and biological conditions and amount of sediment in the stream. Although sediment levels are fairly high (water quality – temperature, pH, etc. – is excellent) within this reach of Bridge Creek, past aquatic macroinvertebrate sampling shows a "good" overall habitat condition rating. Overall habitat condition ratings have gone from an excellent rating (BCI 100) in 1989, to good and excellent ratings (BCI 84 & 98) in 1990, to a good rating (BCI 86) in 1994. It is worth noting that 1994 was a very dry year, with extremely low stream flows, which likely influenced BCI ratings.

d) Stream Temperature.

Based on stream temperature recordings in reaches 6, 8, and 12, it is assumed that reaches 5-14 are **functioning appropriately**, because the 7-day average maximum temperatures were below, or assumed to be below 17.8°C. In contrast, reaches 1-4 are believed to be **functioning appropriately but-at-risk,** with 7-day average maximum temperatures assumed to be within the 17.8-24.0°C range – this assumption if based on data from the lower reaches of Buck Creek and West Fork Silver Creek, which have similar stream characteristics as Bridge Creek.

The relatively low stream temperatures found within the upper ten reaches of Bridge Creek are a result, in part, of upstream riparian vegetation and stream channels being near their desired state. For this reason, stream temperatures may also be near their potential. In contrast, the relatively open forest/meadow and meadow reaches found throughout the lower portion of the system allow temperatures to increase, likely towards the upper end of the 17.8-24.0°C range. As discussed in previous watershed evaluations, several sections of the low-gradient reaches in Bridge Creek have been affected by at least one factor influencing stream temperatures – stream channels that are slightly wider than desired, loss of riparian shade, lower stream flows caused by increased evapotranspiration, etc. Although this has occurred, current shade values (shade information was collected within the surveyed reaches of Bridge Creek using a solar pathfinder) were still found to be near their desired conditions, with the exception of Reach 2. Shading values for each reach were compared to data collected for reaches determined to be near their desired or potential condition within the Sprague River system (data from information collected for the Sprague River TMDL – unpublished). Comparisons were made utilizing information from streams of the same width and riparian community group. Shading levels for all reaches within Bridge Creek, except for Reach 2, were found to be within the range of values for similar sites that are at or near their potential condition within the Sprague River System. Shading values for Bridge Creek were as follows: (R1) 27%, (R2) 13%, (R3) 56%, (R5) 37%, (R6) 64%, (R7) 80%, (R8) 69%, (R9) 68%, (R10) 77%, (R11) 83%, (R12) 55%, (R13) 58%, and (R14) 49%. For this reason, stream temperatures may be near their potential in part because stream channels and riparian vegetation are near their desired conditions – only slight improvements are expected in riparian (willow communities gain structure in the older age classes) and stream channel conditions (channels may narrow slightly) in reaches 1-3. Managing for beaver within these reaches would likely have beneficial effects to fish habitat. Beaver dams and their associated ponds would act to store water, which could augment late season flows, and provide deep-water habitat and cool-water refugia areas.

e) Fish Passage (Culvert).

Three of the four culverts surveyed along Bridge Creek were found to be barriers to fish passage. These culverts are located in reaches 6, 8, and 12. All three culverts have a vertical jump of approximately 1 foot and have flow velocities that exceed sustained swimming speeds for trout. The culvert in Reach 11 is an open-bottom arch that is passable for fish. Refer to Figure 3.2 – Bridge Creek Watershed Road Locations. Also, two weirs – one in Reach 1 and the other in Reach 3 – were noted during surveys as potential barriers to fish passage. Due to the fact that both the weirs (reaches 1 and 3) and culvert barriers (reaches 6 and 8) occur in the lower to middle reaches of the watershed, making upstream reaches inaccessible, this element receives a **functioning inappropriately** rating. Furthermore, three other culverts were surveyed within the watershed – all of which are located in the headwater tributaries of Bridge Creek (see Figure 3.2 – Bridge Creek Watershed Road Locations) and were documented as barriers to fish passage.

The slope (2% for Reach 6 and 6% for reaches 8 and 12) of the culverts surveyed is steep enough that, when based on their size and length, contribute to flow velocities in the pipes that are higher than sustainable for fish. For this reason, and the fact that all three pipes have 1-foot vertical jump out their outlets, these culverts are considered barriers to fish passage.

Summary of, and factors contributing to, current conditions for the Buck Creek Watershed: The following table (Table 5.19) summarizes current and desired fish habitat conditions within Buck Creek. Ratings given within this table are based on a comparison of current and desired conditions (see desired conditions in Chapter 4 for ratings) within each of the surveyed stream reaches. Habitat conditions are summarized based on the following parameters: large woody debris, pools, spawning gravel fines, stream temperature, and fish passage. Following each table is a discussion of these ratings and the factors contributing to current conditions, as well as any trends in conditions. For reach locations refer to Figure 5.3 – Buck Creek Watershed Reach and Monitoring Locations.

__Buck Creek__

Table 5.19 - Buck Creek – Fish Habitat Elements

Reach Information					Condition	Habitat Elements						
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Fish Passage (Culvert)
						50%/75%	50%/75%	50%/75%		(°C)	(°F)	
1		Private			1 Desired				<20	17.8	64.0	Passage
					1 Current				NA	NA	NA	
					1 Rating					FI		
2	2.0	BLM	16	1	2 Desired	2/9	18/32	0/2	<20	17.8	64.0	Passage
					2 Current	13	110	28	NA	24.7	76.5	Passage
					2 Rating	FA	FA	FA		FI		FA
3	1.5	Private	14	<1	3 Desired	**	21/36	0/2	<20	17.8	64.0	Passage
					3 Current	0	89	14	NA	NA	NA	Passage
					3 Rating	FA	FA	FA		FAR		FA
4		Private			4 Desired				<20	17.8	64.0	Passage
					4 Current				NA	NA	NA	Barrier (weir)
					4 Rating					FAR		FI
5	0.6	Private	14	<1	5 Desired	**	21 / 36	0 / 2	<20	17.8	64.0	Passage
					5 Current	2	117	46	NA	NA	NA	Passage
					5 Rating	FA	FA	FA		FAR		FA
6	0.5	Private	15	1-2	6 Desired	**	20 / 34	0 / 2	<20	17.8	64.0	Passage
					6 Current	2	96	43	NA	NA	NA	Passage
					6 Rating	FA	FA	FA		FAR		FA
7	2.4	Private	14	<1	7 Desired	**	21 / 36	0 / 2	<20	17.8	64.0	Passage
					7 Current	0	97	35	NA	NA	NA	(culvert)
					7 Rating	FA	FA	FA		FAR		FA
8	0.8	Private	12	<1	8 Desired	**	25 / 42	0 / 2	<20	17.8	64.0	Passage
					8 Current	0	92	32	NA	NA	NA	Passage
					8 Rating	FA	FA	FA		FAR		FA
9	0.6	BLM	12	<1	9 Desired	3 / 11	25 / 42	0 / 2	<20	17.8	64.0	Passage
					9 Current	3	38	5	NA	NA	NA	Passage
					9 Rating	FA+	FA	FA		FAR		FA
10	0.8	BLM	15	1-2	10 Desired	2 / 9	20 / 34	0 / 2	<20	17.8	64.0	Passage
					10 Current	6	38	4	NA	NA	NA	Passage
					10 Rating	FA+	FA	FA		FAR		FA
11	0.8	Private	15	1	11 Desired	2 / 9	20 / 34	0 / 2	<20	17.8	64.0	Passage
					11 Current	2	61	4	NA	NA	NA	Passage
					11 Rating	FA +	FA	FA		FAR		FA

Table 5.19 - Buck Creek – Fish Habitat Elements (continued)

Reach Information					Condition	Habitat Elements						
Reach	Reach Length (miles)	Owner	Desired Wetted Width (')	Gradient (%)	Reach	LWD/ Mile	Pools/ Mile	Large Pools/ Mile	Spawning Gravel Fines (%)	Stream Temperature		Fish Passage (Culvert)
						50% / 75%	50% / 75%	50% / 75%		(°C)	(°F)	
12	1.4	Private	15	<2	12 Desired	2 / 9	20 / 34	0 / 2	<20	17.8	64.0	Passage
					12 Current	3	42	4	NA	NA	NA	Passage
					12 Rating	FA-	FA	FA		FAR		FA
13	1.2	USFS	16	1	13 Desired	2 / 8	18 / 32	0 / 2	<20	17.8	64.0	Passage
					13 Current	8	45	1	28	17.5	47.1	Passage
					13 Rating	FAR	FA	FAR	FAR	FA		FA
14	1.1	USFS	13	1-4	14 Desired	2 / 10	23 / 39	0 / 2	<20	17.8	64.0	Passage
					14 Current	8	38	2	NA	NA	NA	Passage
					14 Rating	FAR	FA	FAR		FA		FA
15	1.3	USFS	14	1-2	15 Desired	2 / 9	21 / 36	0 / 2	<25	17.8	64.0	Passage
					15 Current	17	85	8	NA	NA	NA	Passage
					15 Rating	FA	FA	FA		FA		FA
16	2.9	USFS	12	1-3	16 Desired	2 / 10	24 / 41	0 / 2	<25	17.8	64.0	Passage
					16 Current	21	54	4	NA	NA	NA	Passage
					16 Rating	FA	FA	FA		FA		FA
17	1.5	USFS	12	1-3	17 Desired	3 / 11	26 / 44	0 / 2	<25	17.8	64.0	Passage
					17 Current	8	31	2	19	14.2	57.8	Barrier
					17 Rating	FA-	FA	FAR	FA	FA		FAR
18	1.1	USFS	13	2-8	18 Desired	8 / 35	24 / 41	0 / 2	<25	17.8	64.0	Passage
					18 Current	8	55	2	NA	NA	NA	Passage
					18 Rating	FA-	FA	FAR		FA		FA
19	2.2	USFS	10	1-3	19 Desired	3 / 13	30 / 51	0 / 3	<25	17.8	64.0	Passage
					19 Current	3	85	0	NA	NA	NA	Passage
					19 Rating	FA-	FA	FAR		FA		FA
20	1.4	USFS	5	1-4	20 Desired	6 / 26	59 / 101	0 / 3	<25	17.8	64.0	Passage
					20 Current	10	115	1	NA	NA	NA	Passage
					20 Rating	FA-	FA	FAR		FA		FA
21	1.0	USFS	5	2-8	21 Desired	21 / 65	63 / 107	0 / 3	<25	17.8	64.0	Passage
					21 Current	47	111	0	NA	NA	NA	Passage
					21 Rating	FA-	FA	FAR		FA		FA

FA – Functioning Appropriately, FAR – Functioning Appropriately but-at-Risk, FI – Functioning Inappropriately
NA – Information Not Available; ** - Habitat element not applicable for this reach
Habitat Abbreviations and Explanations: LWD – Large Woody Debris; Large Pools – Pools > 2.6 feet deep; % Spawning Gravel Fines - <6.4mm

a) Large Woody Debris (LWD).

Reaches 3, 5, 6, 7, and 8 were not rated for LWD because they are primarily low gradient meadow sites where little LWD is expected. Although a few pieces of LWD do occur within a few of these reaches, recruitment of LWD is quite limited. On the other hand, LWD recruitment potential was much greater within the remaining reaching. In reaches 13 and 14, both lodgepole pine and ponderosa pine were the primary sources of in-stream wood with LWD loadings slightly below desired numbers, thus these reaches received **functioning appropriately but-at-risk** ratings. The remaining reaches were all determined to be **functioning appropriately**. These reaches either occur within a mix of forest and meadow areas, which limited LWD recruitment, and/or had lodgepole pine as the main source of LWD.

Even though reaches 13 and 14 received functioning appropriately but-at-risk ratings, LWD levels are likely near their potential since these reaches, like nearly all of the other forested reaches of Buck Creek, have had little influence from past timber harvesting. However, ratings within these reaches were not adjusted based on the fact that the addition of correctly placed LWD within these reaches would improve overall pool complexity within the stream and create important large pool habitat. On the other hand, although LWD numbers in reaches 9, 10, 11, 12, and 17-21 were also found to be slightly below desired levels, they were rated as functioning appropriately due to the nature and setting of the stream – portions of these reaches occur within a mix of forest and meadow areas, with limited LWD recruitment, and/or had lodgepole pine as the main source of LWD, with numerous pieces found just above bankfull dimensions. Also, five of the reaches (reaches 17-21) are within the Yamsay Mountain Semi-Primitive Non-Motorized Recreation Area, an area that would be considered near natural in terms of LWD.

b) Pools.

All of the reaches surveyed within Buck Creek were found to be **functioning appropriately**, with pool numbers exceeding the 75th percentile. In addition, twelve of the reaches (reaches 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 15, and 16) are also **functioning appropriately** in terms of the large pool component, while the remaining seven reaches (reaches 13, 14, 17, 18, 19, 20, and 21) received **functioning appropriately but-at-risk** ratings as fewer deep pools could be found.

Pool frequencies reflect near-natural numbers in part because stream channels and riparian vegetation are highly similar to desired conditions. The quality of pools within Buck Creek appears to be quite high, with pool complexity occurring through depth, structure and undercut banks. This is revealed by the abundance of large pools noted in the majority of the lower reaches. This same type of complexity, with reference to depth, appears to be lacking in many of the reaches in the upper part of the watershed. The reason for this is most likely associated with the smaller size of the stream within these reaches, where less energy is available to scour deep pools.

Also, for those portions of the lower reaches where riparian vegetation and stream channels conditions are still on the path of recovery towards their desired state, late-seral riparian vegetation will continue to promote recovery with improved channel integrity and lower width-to-depth ratios – conditions that promote high quality pool habitat (deep and complex pools). Also, as riparian conditions improve within these reaches, habitat for beaver will also improve, promoting the presence of beaver dams and their associated deep and complex pools.

c) Spawning Gravel Fines.

Twenty-six percent fine sediments were documented in spawning substrates of Reach 13, a C/B stream type, promoting 60% embryo survival and resulting in a **functioning appropriately but-at-risk** rating. In Reach 17, a B stream type, the percent fines were lower at 19%, resulting in a **functioning appropriately** rating and an embryo survival rate of around 76%.

Unsurprisingly, results of sediment sampling within the Buck Creek watershed are essentially the same as those found in the adjacent Bridge Creek watershed. Like Bridge Creek, one of the main reasons for the relatively high reported sediment values within Buck Creek can be attributed to the naturally high erosion rates associated with the soils (located in the pumice zone) and geomorphology of the area. Monitoring results from the upper portions of the Buck Creek drainage, where impacts from roading and harvesting are minimal (Yamsay Mountain Semi-Primitive Non-Motorized Recreation Area), show the exact same sediment levels, about 19%, as those found in the upper portions of Bridge Creek. Below this area, where the watershed has been influenced by logging and associated roading, substrate fines were found to be 26% (31% for a similar location in Bridge Creek), higher than recommended levels. These levels of fines may not only limit embryo survival, but could also be influencing the food supply and habitat for adult trout and other aquatic species. Species of macroinvertebrates, and macroinvertebrate ratings, vary greatly depending on the chemical and biological conditions and amount of sediment in the stream. Although sediment levels are fairly high (water quality – temperature, pH, etc. – is excellent) within this reach of Buck Creek, past aquatic macroinvertebrate sampling shows a "fair to excellent" overall habitat condition rating. Overall habitat condition ratings have gone from good to excellent ratings in 1989 (BCI 82 & 100) and 1990 (BCI 88 & 98), to a fair rating (BCI 77) in 1994. It is worth noting that 1994 was a very dry year, with extremely low stream flows, which likely influenced BCI ratings.

d) Stream Temperature.

Seven-day average maximum temperatures in reaches 13 and 17 were 17.3°C and 14.3°C, respectively. Based on these numbers, which are below 17.8°C, reaches 13-21 are determined to be **functioning appropriately**. In contrast, reaches 1 and 2 are assumed to be **functioning inappropriately**, based on the 7-day average maximum temperature of 24.7°C at the lower end of Reach 2. The remaining reaches, reaches 3-12, are believed to be **functioning appropriately but-at-risk**, with 7-day average maximum temperatures assumed to be within the 17.8-24.7°C range.

Like Bridge Creek, the relatively low stream temperatures found within the upper nine reaches of Buck Creek are a result, in part, of upstream riparian vegetation and stream channels being near their desired state. For this reason, stream temperatures may also be near their potential. In contrast, the relatively open meadow and forest/meadow reaches found throughout the lower portion of the system provide for lower shading levels the allow temperatures to increase, exceeding 24.0°C in Reach 2. As discussed in previous watershed evaluations, several sections of the low-gradient reaches in Buck Creek have been affected by at least one factor influencing stream temperatures – stream channels that are slightly wider than desired, loss of riparian shade, lower stream flows caused by increased evapotranspiration, etc. Although this has occurred, current shade values (shade information was collected within the surveyed reaches of Buck Creek using a solar pathfinder) were still found to be near their desired conditions, with a potential exception being Reach 11. Shading values for each reach were compared to data collected for reaches determined to be near their desired or potential condition within the Sprague River system (data from information collected for the Sprague River TMDL – unpublished). Comparisons were made utilizing information from streams of the same width and riparian community group. Shading levels for all reaches within Buck Creek, except for Reach 11, were found to be within the range of values for similar sites that are at or near their potential condition within the Sprague River System. Shading values for Buck Creek were as follows: (R2) 26%, (R3) 28%, (R5) 21%, (R6) 33%, (R7) 23%, (R8) 40%, (R9) 49%, (R10) 50%, (R11) 17%, (R12) 44%, (R13) 62%, (R14) 66%, (R15) 61%, (R16) 71%, (R17) 70%, (R18) 58%, (R19) 34%, (R20) 52%, and (R21) 53%. For this reason, stream temperatures may be near their potential in part because stream channels and riparian vegetation are near their desired conditions – only slight improvements are expected in riparian (willow communities gain structure in the older age classes) and stream channel conditions (channels may narrow slightly) in portion of reaches 2-11. Also, managing for beaver within these reaches would likely have beneficial effects to fish habitat. Beaver dams and their associated ponds would act to store water, which could augment late season flows, and provide deep-water habitat and cool-water refugia areas.

e) Fish Passage (Culvert).

Two culverts were surveyed along Buck Creek, one located in Reach 14 and the other in Reach 17. For culvert locations refer to Figure 3.3 – Buck Creek Watershed Road Locations. The culvert in Reach 14, which is actually 2 open-bottom arches, is passable for fish, while the culvert in Reach 17 is considered to be a barrier. Also, a weir located at the break between reaches 3 and 4 was noted as a potential barrier to fish passage during surveys. Considering the likelihood this weir is hindering fish passage, either seasonally or for specific age classes, and is located in the lower portion of the watershed, this assessment element receives a **functioning inappropriately** rating (if the rating were based only on inventoried culverts, this element would be rated as functioning appropriately but-at-risk). Furthermore, two other culverts were surveyed within the watershed and both were documented as barriers to fish passage – although it is unlikely fish occupy these sites with upstream habitat being very limited (see Figure 3.3 – Buck Creek Watershed Road Locations)

The culvert in Reach 17 is considered a barrier to fish passage due to a 2-foot jump height, with essentially no pool at its outlet (an existing rock ledge exists at the culvert outlet preventing pool formation), and water velocities in the culvert determined to exceed the sustainable swimming speeds of trout.

<u>Summary for the Silver Lake Watershed</u>

Approximately 83 miles of stream were surveyed within the three watersheds and were distributed in the following manner: Silver Creek (42 miles), Bridge Creek (16 miles), and Buck Creek (25 miles). The following is a short summary of riparian and stream channel conditions within the entire Silver Lake Watershed. For reach locations refer to Figures 5.3, 5.4, and 5.5 – Silver Creek, Bridge Creek, and Buck Creek Watershed Reach and Monitoring Locations.

a) Large Woody Debris (LWD).

Of the 59 reaches surveyed, 48 are appropriate sites for LWD, while the remaining 11 are primarily meadow sites where LWD in not expected. Of the 48 reaches that were determined appropriate for LWD ratings, 25 are in forested areas where calculated numbers were used to determine ratings, while the other 23 occurred in a mix of meadow and forest areas (or in lodgepole pine areas where numerous pieces were found just above bankfull dimensions) where professional judgment was used to determine if reaches had appropriate levels of LWD. Of the 25 reaches that are forested, 14 (56% of the reaches or 62% of the miles surveyed) are **functioning appropriately**, while the remaining 11 (44% of the reaches or 38% of the miles surveyed) are **functioning appropriately but-at-risk.** The meadow/forest reaches, or those lodgepole pine areas where numerous pieces were found just above bankfull dimensions, were all determined to be **functioning appropriately**. The majority of the forested reaches are B stream types, with a few C and E stream types. The meadow/forest reaches were primarily E and C stream types.

As mentioned in the individual stream summaries, many of the surveyed reaches within the watershed flow through a mixture of both meadow and forested areas that have a limited LWD recruitment, and/or have lodgepole pine as the main source of LWD, with numerous pieces found just above bankfull dimensions. This helps to explain why LWD numbers within these reaches are slightly below desired levels. For these reasons, LWD ratings within these reaches were questionable, since calculations that lead to desired numbers of LWD assume that nearly all areas along the stream are forested. Professional judgment, based primarily on LWD recruitment potential and nature/setting of the stream, was used to determine that all reaches have appropriate levels of LWD. Most of the forested reaches within the watershed have adequate numbers of LWD, in part, due to the low levels of harvesting that has occurred near stream channels.

b) Pools.

Of the 59 reaches surveyed, 56 (95% of the reaches or 95% of the miles surveyed) are **functioning appropriately** for pool numbers, while the remaining reaches are **functioning appropriately but-at-risk**. All of the stream reaches surveyed within Silver Creek, West Fork Silver Creek, North Fork Silver Creek, and Buck Creek are functioning appropriately, with only three reaches of Bridge Creek **functioning appropriately but-at-risk**. Of the reaches surveyed, 27 (46% of the reaches or 39% of the miles surveyed) are **functioning appropriately** in terms of the large pool component, with fewer pools found in the other 32 reaches, 23 (39% of the reaches or 43% of the miles surveyed) of which received **functioning appropriately but-at-risk** ratings while the remaining 9 reaches (15% of the reaches or 18% of the miles surveyed) receiving **functioning inappropriately** ratings. The percent of stream miles, for each stream surveyed, that meet desired large pool numbers include the following: Silver Creek (7%), West Fork Silver Creek (39%), North Fork Silver Creek (0%), Guyer Creek (13%), Bridge Creek (50%), and Buck Creek (62%).

Pool frequencies reflect near-natural numbers, for the most part, because stream channels and riparian vegetation are highly similar to desired conditions throughout the watershed. In other words, the majority of the stream reaches surveyed are lined with late-seral vegetation that contribute to appropriate stream types and width-to-depth ratios, factors that contribute to desired pool numbers. The 3 reaches that were not determined to be functioning appropriately have riparian vegetation and stream types that are not at desired conditions.

The quality of pools within the lower reaches of West Fork Silver Creek and Buck Creek, the lower reach of Silver Creek, and several reaches of Bridge Creek is high with pool complexity occurring through depth, structure, and undercut banks (C and E stream types). This is revealed by the abundance of large pools noted in many of the reaches. Beaver dams are considered the primary reason for the high number of large pools found in Reach 6 of West Fork Silver Creek. This same type of complexity appears to be lacking in some of the other streams or stream reaches within the watershed. This may simply be a function of the small size of many of the streams and/or the fact that in portions of these streams, riparian vegetation and stream channel conditions are still on the path of recovery towards their desired state, with the stream channels being a little wider than their potential. With late-seral riparian vegetation promoting continued recovery, improved channel integrity and lower width-to-depth ratios should result – conditions that promote deep and complex pools. A primary factor influencing the number of large pools in Silver Creek is likely associated with the fact that its channel morphology has had to adjust to the regulated flows out of Thompson Reservoir, resulting in channels that are fairly wide and shallow. Thus, within many of these reaches, the number of deep pools may remain low until numbers of LWD and beaver (dams) increase within the system. One additional note for the smaller streams within the watershed, is that deep pools may be uncommon in the absence of beaver dams – Reach 6 of West Fork Silver Creek serves as an example of how beaver dams can influence the number of large pools in small streams.

c) Spawning Gravel Fines.

Of the 13 sites measured for spawning gravel fines, 3 (23%) are **functioning appropriately**, 3 (23%) are **functioning appropriately but-at-risk**, while 7 were found to be **functioning inappropriately**.

One of the main reasons for the relatively high reported sediment values found throughout the assessment area can be attributed to the naturally high erosion rates associated with the soils and geomorphology of the area. Results of sediment sampling within the three watersheds were quite similar, with the exception of Silver Creek, which has had to adjust to the regulated flows out of Thompson Reservoir. Monitoring results from the upper portions of West Fork Silver Creek, Bridge Creek, and Buck Creek drainages, where impacts from roading and harvesting are minimal (Yamsay Mountain Semi-Primitive Non-Motorized Recreation Area), show an average of about 22% (based on 1995/1996 numbers) fine sediment. Below this area, where the watersheds have been influenced by logging and associated roading, substrate fines were found to average 36% (based on 1995/1996 numbers), higher than recommended levels. These higher sediment values are likely a function of the cumulative effects from sedimentation associated with roads and increased drainage network throughout the watershed. The high values reported in Reach 2 of North Fork Silver Creek, the highest within the watersheds, were unexpected as road crossings and bank instability are minimal upstream from the sampling location. This is most likely attributed to the depositional nature of the sampling site – it is likely that the sample was taken within the depositional influence zone of a large road fill/crossing.

The connection between beaver dams and the lower levels of sediment measured below the marsh in West Fork Silver Creek, indicates the importance of maintaining beaver habitat and beaver populations within the stream systems of the watershed. Beaver dams are important for trapping sediment and providing cool water refugia for fish. The decrease in beaver dams throughout the watershed has likely resulted in an even distribution of sediment throughout a stream with higher levels of fines in spawning substrates than existed historically. Under reference conditions, sediment would be trapped behind beaver dams and cleaner spawning substrate would be found below these beaver dams.

A note of interest from the sediment sampling that has occurred within West Fork Silver Creek is the overall average decrease in values (10%) between 2001 (average of 26%) and 1996 (average of 36%). This difference is likely attributed to the flushing of fine sediments out of the system associated with the flood of 1997, one of the largest on record.

d) Stream Temperature.

All of the 59 reaches surveyed were evaluated for stream temperature. Of these reaches, 33 (56% of the reaches or 61% of the miles surveyed) are **functioning appropriately**, 21 (36% of the reaches or 31% of the miles surveyed) are **functioning appropriately but-at-risk,** while the remaining 5 (8% of the reaches or 8% of the miles surveyed) are **functioning inappropriately**.

For nearly all of the stream reaches surveyed that are functioning appropriately, water temperatures may be near their potential because stream channels and riparian vegetation are near their desired state. Several of the stream reaches that are functioning appropriately but-at-risk or functioning inappropriately, occur in, or downstream of, low gradient meadow reaches (Silver Creek receives warm water outflow from Thompson Reservoir). In these reaches, the relatively open meadow and forest/meadow setting provides fairly low shade levels that ascribe to higher stream temperatures. In addition, large willows are lacking along some of these meadow reaches – late season grazing is probably a major contributor to the lack of willow in these meadow environments – and a number of these reaches have width-to-depth ratios that are slightly higher than desired, which increases the water surface area exposed to solar radiation.

Overall, shading values for 97% of the reaches and stream miles surveyed within the Silver Creek Watershed were found to be within the range of values for similar sites (same width and riparian community group) that are at or near their potential conditions within the Sprague River system (data from information collected for the Sprague River TMDL – unpublished). These shading levels are a function of riparian vegetation and stream channels being near their desired state – 89% of the miles surveyed were found to be functioning appropriately. For this reason, stream temperatures may also be near their potential with only slight improvements expected in riparian (willow communities gain structure in the older age classes) and stream channel conditions (channels may narrow slightly). As discussed in previous watershed evaluations, several of the low-gradient reaches within the watersheds have been affected by at least one factor influencing stream temperatures – stream channels that are slightly wider than desired, loss of riparian and upland shade, lower stream flows caused by increased evapotranspiration, etc. With continued improvement in riparian and stream channel conditions, shading and a narrowing of stream channels could result in slightly lower stream temperatures. However, even though it is assumed that stream temperatures were historically lower than they are today, it is highly questionable as to whether or not current state standards can be achieved in all streams. Also, managing for beaver within these watersheds would likely have beneficial effects to fish habitat. Beaver dams and their associated ponds would act to store water, which could augment late season flows, and provide deep-water habitat and cool-water refugia areas.

e) Fish Passage (Culvert).

Only one of the streams surveyed – Silver Creek – is **functioning appropriately** for fish passage (although the watershed as a whole is rated **functioning inappropriately**). The other five streams surveyed are **functioning inappropriately**, because culverts in the lower reaches of the stream are determined to be barriers to fish passage.

Of the 23 culverts surveyed within the assessment area, 19 or 83% were found to be barriers, or partial barriers to fish passage. In most cases, culverts are barriers due to the steeper slopes at which the culverts were installed, which, based on the size and length of the culverts, contributes to flow velocities in the pipe that are higher than sustainable for fish. Also, in several cases, culverts were also found to have vertical jumps (water surface to culvert outlet) of 1 foot or greater.

Chapter 6

Viability of Native Aquatic Species (Redband Trout)

Chapter 6
Viability of Native Aquatic Species (Redband Trout)

Key Question #4: How are the previously mentioned watershed conditions influencing native trout viability?

As stated in Chapter 2, this chapter of the document serves as a summary of the previous elements, or questions, and their cumulative effects on the watershed's ability to serve as a reserve for native trout. A brief description of fish populations and distribution within the watershed is provided in current conditions section below.

Current Conditions

Fish Populations and Distribution – The three main streams within the assessment area, as well as their major tributaries, contain redband trout (*Oncorhynchus mykiss*) and introduced brook trout (*Salvelinus fontinalis*), and are the streams responsible for supporting the native Fort Rock Basin redband trout – one of six inland basin populations making up the larger Great Basin redband trout population. The Great Basin redband trout were recently petitioned for listing under the Endangered Species Act, but in March of 2000, the Fish and Wildlife Service found that the listing was not warranted at that time. Within the assessment area, redband trout inhabit the entire length of all surveyed streams but are primarily found in the mid-to-lower, or warmer, reaches. In many of the upper/cooler reaches and tributaries, brook trout become the dominant species, nearly replacing redband trout in some of the upper headwater areas. Specific inventories and stream surveys conducted by the Oregon Department of Fish and Wildlife in 1999 (Dambacher 1999) determined redband trout densities in the Fort Rock Basin to be 0.171 fish/m^2. Dambacher and Jones (in press) have analyzed numerous redband trout densities within the Great Basin over the past 30 years enabling them to make qualitative ranges (low, moderate, and high) for population densities. From this information, they have concluded that a low-density population of redband has less than 0.059 fish/m^2, a moderate-density has 0.06 to 0.19 fish/m^2, and a high-density population has more than 0.2 fish/m^2. Based on this analysis, the Fort Rock Basin redband trout population abundance estimates are considered moderate as compared to other streams in the Great Basin of Oregon.

Introduced species (brook trout) seem to be an influencing factor on the distribution and abundance of native redband trout within the basin. Literature shows that when there are life history differences between introduced and native species, the introduced species can often displace the native species, especially when combined with habitat degradation and higher reproductive potential (Leary et al. 1991). This seems to be occurring within the assessment area, as it appears that brook trout have been able to out-compete redband trout for food and habitat in many of the cooler/upper reaches and headwater areas, forcing redband into the lower/warmer stream reaches.

Desired Conditions

Population viability addresses the continued existence of well-distributed populations or subpopulations over specific time periods (Marcot and Murphy 1996). High genetic variability will help ensure the viability of populations. Meffe (1996) states that genetic variability of a population determines its fitness or ability to respond and adapt to environmental changes, and low genetic variability may result in decreased adaptability. This variability, Meffe continues, can be maintained by managing for a hierarchy of habitat types across a geographical area and uses stream order as an example for stratification. Salmonids within first order streams may contain subtle genetic differences from fish in the second and third order streams of the watershed. Movement patterns of redband trout within the Basin are not well known, but movement is probably limited due to the presence of manmade and natural barriers. These barriers include culverts, dams, waterfalls, and low water levels in Paulina Marsh on most years. Applying this concept to the Silver Lake Community Watershed, native redband trout occupying the upper reaches of the West Fork Silver Creek subwatershed may possess subtle genetic differences from redband in the upper reaches of Guyer Creek. It is important to manage for a diversity of high-quality habitat types and connectivity between watersheds to maintain genetic diversity (Meffe 1996).

Meffe's concept fits within the context of metapopulation theory. Noss et al. (1997) defines a metapopulation as a group of subpopulations, spatially distinct but connected by at least occasional dispersal. Because the redband within the watershed are part of the larger Fort Rock Basin populations, they are considered a part of this metapopulation. Applying the metapopulation concept to the Silver Lake Community Watershed, each of the three watersheds may host a separate subpopulation.

A reserve is an area of high-quality habitat that can sustain a viable subpopulation. In this document, reserves in the context of a subwatershed will be assessed. Several principals should be considered when evaluating an individual reserve or network of reserves. First, reserves should be well distributed across the landscape, the idea being that widely distributed subpopulations will not experience a catastrophe or adverse impact across its entire range. Some subpopulations will escape the impact, eventually recolonize the affected area, and sustain the population as a whole. Second, large reserves are better than small ones, because there is a greater opportunity for habitat diversity and larger population size. As a result, genetic variability within the subpopulation will be optimized, promoting increased adaptability to environmental change. Thirdly, reserves that are close together are better than those far apart. A short travel distance between reserves promotes dispersion and genetic interchange. If enough interchange occurs between reserves, fish are functionally united into a larger population that can better avoid extinction. In other words, connectivity between reserves is required. Finally, the above three principles can be achieved by managing at the landscape level, managing for watershed conditions which are within the natural range of variability (Noss et al. 1997).

Desired native trout viability:

Functioning Appropriately - Uplands are producing hydrological conditions (water and sediment outputs) that contribute to properly functioning riparian areas and stream channels. In-channel habitat is of high quality (functional) and is connected throughout the watershed allowing the expression of all life stages. Population density is moderate-to-high as compared to statewide averages. Habitat conditions are able to recover from one short-term disturbance (i.e. flood or small scale wildfire) within one or two generations (3-5 years). ***This is the desired (target) condition.***

Functioning Appropriately but-at-Risk - Uplands are producing hydrological conditions (water and sediment outputs) that are adversely affecting – or have the potential for adversely affecting – the functioning of riparian areas and stream channels, contributing to reduced habitat quality and connectivity over a portion of the subwatershed/watershed which leads to a reduced, or moderate-density, population of native redband trout, as compared to statewide averages. Altered habitat conditions will not recover to pre-disturbance conditions within one or two generations (3-5 years).

Functioning Inappropriately - Uplands are producing hydrological conditions (water and sediment outputs) that are adversely affecting the functioning of riparian areas and stream channels, resulting in low quality habitat and connectivity over much of the subwatershed/watershed that supports only a low-density population of redband trout, as compared to statewide averages. Habitat conditions are not expected to improve to pre-disturbance conditions within two to four generations (5-10 years).

Summary and Synthesis for the entire Silver Lake Watershed Assessment Area

For this assessment, native trout viability is used as an indicator for watershed health, being linked to upland, riparian, and channel conditions. If watershed conditions are conducive to long-term native trout viability, then the desired watershed attributes should occur across the landscape. Those attributes include good water quality, high forage production, and good fish and wildlife habitat.

Under current conditions described in this document, all of the streams and watersheds are functioning appropriately but-at-risk for the long-term viability of native trout populations. Thus, the entire Silver Creek Watershed also receives a **functioning appropriately but-at-risk** rating for native trout viability. Recognizing the connection between uplands, riparian areas, stream channels, and habitat for native trout, the following reasons support this rating.

Dense forest stands are one factor contributing to the watersheds functioning appropriately but-at-risk. A portion of the watershed's forest stands have fairly dense understories resulting from nearly 100 years of fire exclusion. Prior to the early 1900's, the natural fire return interval maintained relatively open forest stands with little understory fuels to carry a fire from the ground to the canopy layers. Once intensive timber harvest began in the 1950's, old growth trees within these stands were usually removed through clearcutting or selective harvest, converting slower growing stands into faster growing wood producing sites. This left the landscape in a matrix of dense and early-to-mid-seral stands, leaving the dense canopies at high risk of catastrophic fire which could result in added sediment and altered flow regimes in watershed streams. If stands remain in their current condition, the question is not "Will these dense forests burn?" but "When and how hot will they burn?"

In addition, fire exclusion has permitted conifers to expand into meadows and other riparian areas, promoting competition with riparian plants (sedge, rush, willows, aspen, cottonwood, and alder) necessary to maintain bank stability and proper stream types. In addition, junipers are slowly expanding into the drier, deeper-soil pine sites in the northern portion of the watershed. This continued expansion could lead to more areas in juniper woodlands, replacing other native vegetation types, leaving the soils prone to erosion, and probably reducing late summer stream flows.

High road densities are a major reason why the watershed(s) is functioning appropriately but-at-risk for native trout viability. Most of the roads within the watershed were constructed to provide access for recreation and the vast timber resources within the area, with many that parallel and/or cross, stream channels. Additionally, the effects of management activities on soil resources has been fairly extensive throughout the watershed, a result of past timber harvest activities. The resulting road network and detrimental soil compaction have likely modified the timing, magnitude, and frequency of peak flows, flows that can prevent natural healing of unstable banks, as well as influencing the amount of sediment reaching stream channels, sediment that can fill spawning gravels and pools.

Both vegetation/bank stability and Rosgen stream types support favorable conditions for native trout viability throughout the watershed. Survey results documented that about 89% of the riparian vegetation and associated bank stability is functioning appropriately throughout the watershed, suggesting that most current management practices promote late-seral vegetation required for high bank stability. Further, the predominance of late-seral riparian vegetation in the watershed appears strongly correlated to the abundance (about 89%) of Rosgen stream types that are functioning appropriately. As previously mentioned in this chapter, Rosgen B stream types are abundant across the watershed and are anchored by alder, willow, sedge, and conifers. The abundance of E and C stream types throughout the watershed is directly tied to sedge, rush, and to a lesser degree, willow. In a few locations within the watershed, such as small localized sections of the lower reaches of Bridge, Buck and Silver Creeks, the cumulative effects of past land management activities – mainly the effects of roads along with continued livestock grazing – may be negatively influencing the ability of the stream channel to revegetate and form stable banks.

The predominance of late-seral riparian vegetation and appropriate stream types has led to high pool numbers throughout the watershed streams. Pool frequencies reflect near-natural numbers, for the most part, because stream channels and riparian vegetation are highly similar to desired conditions throughout the watershed. In other words, the majority of the stream reaches surveyed are lined with late-seral vegetation that contribute to appropriate stream types and width-to-depth ratios, factors that contribute to desired pool numbers. The quality of pools within the larger streams (Silver, Bridge, and Buck Creeks) is high, with pool complexity occurring through depth, structure, and undercut banks (C and E stream types). Within the E and healthy C stream types, pools are complex – relatively deep with undercut banks. However, in the C stream types that lack sedge and willow, and have higher width-to-depth ratios, pools are lacking undercut banks that provide fish cover. In the B stream types throughout the watershed, LWD levels play an important role in enhancing pool complexity, increasing the ability of watershed streams to capture and store sediment, especially in the event of a catastrophic fire, which can place spawning habitat at risk of sedimentation.

This same type of complexity appears to be lacking in many of the other streams or stream reaches within the watershed. This may simply be a function of the small size of many of the streams within the watershed and/or the fact that in portions of these streams, riparian vegetation and stream channel conditions are still on the path of recovery towards their desired state, with the stream channels being a little wider than their potential. With late-seral riparian vegetation promoting continued recovery, improved channel integrity and lower width-to-depth ratios should result – conditions that promote deep and complex pools. One additional note, for the smaller streams within the watershed, is that deep pools may be uncommon in the absence of beaver dams – Reach 6 of West Fork Silver Creek serves as an example of how beaver dams can influence the number of large pools in small streams.

An additional reason for placing native trout viability in the functioning appropriately but-at-risk category are the higher stream temperatures found in the mid to lower portions of Silver, West Fork Silver, Bridge and Buck Creeks. These temperatures can be stressful to native fish, negatively affecting growth and development. Areas where these temperatures occur are within, or downstream of, low gradient meadow or forest/meadow reaches, which have fairly low shade levels that ascribe to higher stream temperatures. Within some of these meadow reaches, the abundance of large willows that could provide shade is lacking, with historic late season grazing being the likely contributor. Also, a number of these reaches have width-to-depth ratios that are slightly higher than desired, which increases the water surface area exposed to solar radiation. Although these conditions exist, shade values were found to be similar to their potential (based on data from the Sprague River Watershed) in 97% of the reaches.

Finally, culvert barriers exist throughout the watershed, disrupting connectivity and inhibiting free movement of native trout within and amongst streams within each of the watersheds, movement necessary for spawning, access to cool water refuges, and immigration from lower quality habitat into higher quality habitat.

In conclusion, riparian vegetation/bank stability, Rosgen stream types, and pool numbers have good overall ratings. The remaining elements, however, need improvement: high canopy closure in forested sites, expansion of juniper, moderate road densities, moderate stream temperatures, moderate to high spawning gravel fines, and culvert barriers. Currently, the less than desired conditions of these remaining elements inhibit the Silver Lake Watershed from functioning appropriately as a native trout reserve and as a result, the watershed is **functioning appropriately but-at-risk.**

As stated in the current conditions, fish surveys conducted by the Oregon Department of Fish and Wildlife in 1999 determined redband trout densities in the Fort Rock Basin to be 0.171 fish/m^2. When comparing this to desired conditions, the Fort Rock Basin redband trout population abundance estimates are considered moderate as compared to other streams in the Great Basin of Oregon. This coincides with the functioning appropriately but-at-risk rating given based on watershed conditions.

Chapter 7

Recommendations

Chapter 7
Recommendations

Chapter 7 provides recommendations based on the analysis presented in the previous 6 chapters. This chapter also identifies monitoring activities that are needed in association with these recommendations. Data gaps are also documented. Recommendations are designed to identify restoration and management activities that are responsive to needs identified in this watershed assessment. Specifically, restoration and management actions which address differences between current and reference conditions, where there is a need to provide restoration, maintenance, or protection of ecosystem components in order to sustain the health and productivity of natural resources. Any actions or projects on federal lands, which utilize the information presented in this watershed assessment, will be analyzed on a site-specific basis by an interdisciplinary team and will include both public involvement and disclosure of decision as prescribed in the National Environmental Policy Act (NEPA).

The overall goal of these recommendations is to guide the general type, location, and sequence of appropriate restoration activities within these watersheds based on the results of this assessment. The objectives of these recommendations are to:

1. Reduce soil erosion and improve water quality and soil productivity
2. Increase the overall vigor of forest 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.
5. Improve riparian ecosystems.
6. Improve hydrologic function and channel conditions.
7. Maintain and/or improve terrestrial and aquatic species and their habitats.
8. Provide for human needs.

The following recommendations are grouped into four primary categories. The categories are uplands, riparian vegetation and stream channels, habitat for aquatic species, and aquatic species viability. In addition, the Silver Lake Watershed Council has identified and prioritized projects and they are presented at the end of this chapter.

Uplands

Key Question #1: Is the upland portion of the watershed producing hydrologic conditions (water and sediment outputs) that contribute to properly functioning riparian areas and stream channels?

A) Upland plant communities and their effect on the amount of water and sediment reaching riparian areas

To reduce the risk of catastrophic fire and associated soil erosion, sedimentation, and increased flows, forest understories should be thinned to move them closer to HRV, especially in the ponderosa pine and mixed conifer sites (refer to Figures 3.1, 3.2, and 3.3 for locations of these areas). This will promote conditions for low intensity fires to re-occur, either naturally or controlled, throughout these watersheds and reduce the potential for epidemic insect and disease outbreaks. Concentrating efforts around old growth and old growth core, as well as connectivity corridors, will help to provide a future reconnection of these stands into a functional old seral stage system – examination of maps of the current old growth shows that the West Fork Silver Creek subwatershed and the adjacent Bridge Creek watershed contain one of the largest remaining blocks of old growth left on the Silver Lake Ranger District and indeed the Fremont National Forest.

In the dry meadows, aspen stands, and other non-forested areas, conifers, including juniper, that became established after the advent of fire suppression should also be considered for thinning. Aspen stands will continue to decline across these watersheds with the absence of fire. Thus, the use of prescribed fire, as well as thinning of conifers, is recommended to restore these sites (when thinning conifers within these stands, fall the trees in an array that provides a barrier to livestock grazing within the aspen stand which enhances the likelihood for sprout reproduction to regenerate).

In juniper woodlands and other areas where junipers have encroached, thinning may be required to promote the growth of native grasses, forbs, and shrubs. In these areas, trees should be selectively cut (and it is preferred to scatter the limbs) and left on the ground to prevent erosion and provide a better environment for the growth of ground vegetation. If this juniper encroachment is not curtailed, these trees will eventually dominate a much larger portion of the analysis area leading to even more adverse effects on water quality and quantity. Where possible, skid trails and landings should be eliminated throughout the watershed to alleviate past soil impacts, beginning with those areas where understory treatments will occur.

It is also recommended to enhance and manage watershed conditions that maintain a desirable hydrologic regime (snowmelt hydrograph). For example, desired conditions for uplands state that openings (early-seral condition) can account for approximately 5-20% of the forest lands within a watershed, based on research which has shown detectable changes in stream flow when 20-30% of a watershed is in a cutover condition (Troendle 1982). This leaves approximately 35-50% of the forested stands in a late-seral condition (mature and old) and roughly 35-50% being in a mid-seral condition (young and mid-aged), which corresponds with management recommendation for Northern Goshawk, an indicator wildlife species within the watershed (Reynolds et al. 1991). Reynolds et al. (1991) also states that the areas in openings/early-seral condition (5-20% of the watershed) should be less than 4 acres in size. Again, these recommendations correspond with those for maintaining a desirable hydrological regime. When the objective is to reduce the highest flows and spread runoff over a longer period of time delaying snowmelt is desirable as it may help offset the modified/desynchronized flow regime (earlier and higher peak flows) resulting from roads and detrimental soil compaction (see part B of Question 1). Small openings (2-8 tree heights across) on low energy slopes tend to deposit snow in concentrations where melt is delayed (Satterlund and Adams 1992).

B) Roads (Density, Location, and Drainage Network)

To reduce the adverse effects of roads on aquatic resources, road miles should be progressively decreased through decommissioning (obliteration or permanent closure). In the Silver Lake Watershed, reaching the desired road density of 1.7 mi/mi² and a functioning appropriately rating will require decommissioning approximately 316 miles of road. Within the three watersheds, meeting these same desired conditions would mean decommissioning roughly 264, 44, and 8 miles of road in the Silver Creek, Bridge Creek, and Buck Creek watersheds, respectively.

During the summer of 2000, an inventory of roads within the analysis area was completed to determine which roads were necessary for recreation, access, and a sustainable flow of goods and services, as well as to identify those unneeded or substandard roads for decommissioning. From this information, numerous roads (approximately 78 miles) were identified as unneeded or causing environmental damage. These are shown in Figures 3.4, 3.5, and 3.6 as "Roads Recommended for Decommissioning" in the Silver, Bridge, and Buck Creek Watersheds, respectively. The following table, Table 7.1 – Road Density, Location and Drainage Network in the Silver Lake Watershed, shows a comparison of current road density, location, and drainage network information with the same parameters if these recommendations were implemented.

Emphasis for decommissioning should be placed on those roads within 300 feet of streams or which have numerous stream crossings. The remaining roads, primarily those roads within 600 feet of streams, should be properly drained to reduce the hydrological connection to stream channels, resulting in less water and sediment flowing down roads and their ditches. This promotes better infiltration of water into forest soils to be slowly released into stream channels.

Table 7.1 - Road Density, Location and Drainage Network in the Silver Lake Watershed

Watershed	Road Density (mi/mi^2)	Road Miles	# of Crossings / Crossings per Mile of Stream^	Road Impact Index (RII)	Road Miles within 300 feet of Streams*	Road Density (mi/mi^2) within 300 feet of Streams*	Increase In Drainage Network (%)
Current Conditions							
Silver Creek	3.3	551	274 / 1.02	0.49wa	70.0	3.1	123
Bridge Creek	2.3	113	51 / 0.77	0.48	20.0	3.2	103
Buck Creek	1.9	96	50 / 0.63	0.32	16.9	2.1	72
Silver Lake Watershed	2.9	760	375 / 0.90	0.46wa	106.9	2.9	110
If Recommendations Are Implemented							
Silver Creek	3.0	502	256 / 0.95	0.42wa	63.7	2.8	112
Bridge Creek	2.3	92	40 / 0.61	0.31	15.6	2.5	84
Buck Creek	1.7	88	46 / 0.58	0.27	14.4	1.8	66
Silver Lake Watershed	2.6	682	342 / 0.82	0.37wa	93.7	2.6	99

^ includes perennial, intermittent and ephemeral channels

* perennial and intermittent stream only

wa – weighted average of the subwatersheds

Riparian Vegetation and Stream Channels

Key Question #2: Is vegetation in riparian areas contributing to the appropriate stream channel types and hydrologic regime?

In all reaches where conifer encroachment is common, mechanically thin encroaching conifers and/or allow prescribed fire to creep into riparian areas. This will reduce conifer densities and maintain growth of riparian grasses, shrubs, and trees. Implement grazing management that promote the growth of willow and improve width-to-depth ratios along C and E stream types. Continue deferred rotation grazing strategies, or other types of grazing strategies that maintain or promote late-seral riparian plant communities and their associated high bank stability. Also, the implementation of INFISH – Aquatic Conservation Strategy – guidelines will direct management activities so they will not adversely affect riparian vegetation.

Along Reach 5 of West Fork Silver Creek, reaches 1-5 of Bridge Creek, and reaches 2 and 5-12 of Buck Creek, grazing management should be adjusted to promote additional growth of sedge and willow. Furthermore, it may be necessary to develop water sources away from these stream reaches, most of which have been determined to be functioning appropriately but-at-risk, or implement other grazing strategy changes in order to improve livestock distribution and restrict the amount of trailing and bank trampling along riparian areas. Specifically, finish constructing the new pasture fence from Thirteen Mile Spring to Buck Creek, and west of Buck Creek to the Buck Creek/Little Antelope division fence. This will complete the fencing for the lower portion of the Coshaw pasture and will create positive divisions between the Buck Creek and Coshaw pastures and the new Bridge pasture. This should greatly enhance livestock management within this area and prevent livestock from re-grazing the lower portions of Buck and Bridge Creek. Along meadow reaches, conifers that have become established after fire exclusion should be extensively thinned.

On a limited basis, place sedge mats or root wads (or other structures designed to relieve stress on stream banks) as described by Rosgen (1996) in areas of high bank instability along fully developed meander bends (geometry). This would occur primarily in those reaches found to be functioning appropriately but-at-risk – Reach 5 of West Fork Silver Creek, reaches 1-5 of Bridge Creek, and reaches 2, 5, and 11 of Buck Creek. Smaller areas of bank instability should also be monitored and considered for treatment, such as those found in Reach 3 of West Fork Silver Creek, Reach 6 of Bridge Creek, and reaches 7-12 of Buck Creek. Also, treat all headcuts within the watershed, such as the one at

Coshaw Creek (a tributary of Bridge Creek), to prevent a lowering of the water table, loss of riparian vegetation, and encroachment of conifers.

Implement recommendations in the upland and riparian vegetation sections described in this document. Emphasis should be placed on implementing grazing practices that promote the growth of sedge, rush, and willow – plants required for high bank stability and low width-to-depth ratios in low gradient systems. If structures are utilized along the eroding meanders, they should only be placed when meander geometry (lateral erosion) is fully developed or when there is a risk of losing sinuosity. These actions will aid in maintaining or producing the desired stream types.

Habitat for Aquatic Species

Key Question #3: Are stream channels providing adequate fish habitat?

a) Large Woody Debris (LWD).

In the short-term, add LWD in those reaches of the watershed where numbers are below the functioning appropriately category. Emphasis should be placed on the following stream reaches: reaches 4-9 of Silver Creek, reaches 3 and 7 of West Fork Silver Creek, reaches 7-9 of Bridge Creek, and reaches 13 and 14 of Buck Creek. Additional large wood in the channel will enhance sediment retention, especially in the event of a catastrophic fire, and help improve water quality and aquatic habitat. Long-term solutions to LWD recruitment can be achieved by leaving buffers along forest reaches (buffer widths are prescribed in the INFISH Aquatic Conservation Strategy).

b) Pools.

Even though pool numbers are at desired levels in all but three of the stream reaches surveyed, additional large pools are needed – in many of these reaches – to meet desired conditions. Although the small size of most of these streams may be limiting the amount of large pools, the abundance of late seral vegetation is promoting continued recovery. This recovery will improve channel integrity and lower width-to-depth ratios, conditions that promote deep and complex pools that have an abundance of undercut banks for fish cover. To accomplish this, grazing strategies that promote the growth of late-seral vegetation will need to be maintained or promoted. Also, managing for beaver and their dams would increase deep pool habitat and cool water refugia (Reach 6 of West Fork Silver Creek serves as an example of how beaver dams can influence the number of large pools).

In those reaches where LWD additions are recommended, which occur mainly in B and C stream types, the added pieces of LWD will help create additional pool habitat. Large wood will also make pools more complex, increasing cover, depth, rearing habitat, cool water refugia, and over-wintering habitat. For LWD to effectively create a pool, the added pieces must be within the bankfull dimensions – preferably within the wetted channel. Consult with a hydrologist and fishery biologist when implementing these habitat improvement projects.

c) Spawning Gravel Fines.

Decommission roads, emphasizing those within 300' of streams and/or those that have numerous stream crossings. The remaining roads should be properly drained to help reduce the amount of sediment reaching streams. Based on the Road Impact Index numbers listed in Chapter 3, the Silver Creek and Bridge Creek watersheds should receive priority when considering road obliteration projects. Maintain, or improve, the existing riparian vegetation and associated bank stability by implementing recommendations in the riparian vegetation and Rosgen stream type sections. Restore LWD to desired levels where needed for additional bank stability and sediment storage. Manage for increased beaver colonies throughout the watersheds to enhance sediment storage, improved hydrologic function, and diverse aquatic habitats.

d) Stream Temperature.

Higher stream temperatures can be found in the mid to lower portions of Silver Creek, West Fork Silver Creek, Bridge Creek, and Buck Creek, most of which are located within, or downstream of, low gradient meadow or forest/meadow reaches (Silver Creek receives warm water outflow from Thompson Reservoir). These are the areas that require the most attention within the watershed, because they have been affected by at least one factor influencing stream temperatures – stream channels that are slightly wider than desired, loss of riparian and upland shade, lower stream flows caused by increased evapotranspiration, etc. With continued improvement in riparian and stream channel conditions, shading and a narrowing of stream channels could result in slightly lower stream temperatures. However, it is questionable as to whether or not current state standards can be achieved in all streams given hydrologic regimes, water diversions for agricultural needs, and the operation of irrigation reservoirs.

Implement recommendations found in the riparian vegetation and Rosgen stream type sections of this chapter. These recommendations will promote late-seral vegetation, which results in narrow stream channels and decreased surface areas exposed to solar radiation.

e) Fish Passage (Culvert).

Replace those existing culverts identified as barriers with ones that allow for fish passage. Ensure that culverts are properly sized and installed at the appropriate location and slope by working with a hydrologist, fisheries biologist and engineer. Survey all weirs, as well as the remaining stream crossings within the watershed, to determine if any other barriers exist.

Aquatic Species Viability

Key Question #4: How are the previously mentioned watershed conditions influencing native trout viability?

By implementing the recommendations listed in the previous three chapters, each of the assessment elements will move closer to, or meet, its desired conditions, all of which will bring native trout viability towards the functioning appropriately category. In doing so, desirable watershed attributes should occur across the landscape, including those that provide for high water quality, an abundance of high-quality fish and wildlife habitat, and high forage production.

Project Priorities

The Silver Lake Watershed Council, after reviewing the final draft of the watershed assessment, has determined that all of the recommended projects were of a high priority. Since several types of projects were identified within the watershed assessment, the council decided to group the projects into four categories: 1) thinning/removal, 2) noxious weeds, 3) riparian and instream, and 4) roads. The groupings were then ranked in order of priority for implementation.

1. Thinning/removal: Thinning or removal of juniper and conifers would be implemented to further the promotion of natural vegetative communities and stand conditions. A variety of treatments methods could be used and may include thinning with lop and scatter, use of a slash buster, prescribed fire or various combinations.

2. Noxious weeds: Although noxious weeds are currently not a significant problem in the watershed, the potential exists for weed spread and infestation. Therefore, a proposal for control and elimination of noxious weeds will be developed and implemented. The Silver Lake Watershed Council feels that it is important to stay on top of this potentially damaging problem.

3. Riparian/Instream: The focus of riparian and instream restoration projects will include protection and establishment of riparian vegetation, addition of large woody debris to stream channels and floodplains, improved culverts for fish passage, development of off-site water sources, and changes in grazing management. The watershed council will determine types of projects and locations.

4. Road closures/obliterations: Roads identified for treatment, closure, or obliteration on Forest Service lands will be treated and implemented as projects are identified and the NEPA process is completed. Roads on BLM and private lands will undergo additional analysis.

Data Gaps

The following data should be collected in order to further refine the types and locations of watershed improvement projects:

- Further stream temperature and sediment monitoring information within the watershed is needed, with emphasis on those areas that provide quality habitat for native redband trout.
- Further site-specific data is needed on the level of soil impacts that have occurred within the watershed.
- Further site-specific analysis of roads on BLM, USFS, and private lands should be completed to identify which roads are the highest priorities for treatment.
- Further data collection on riparian vegetation and soils should be conducted in order to tie in with current work on riparian classification and scorecards.
- Identification and assessement of water diversions and their impacts to aquatic resources needs to be completed.

Monitoring Activities

Although bull trout and suckers do not occur within the Silver Lake watershed, it is recommended that the monitoring strategies and Best Management Practices identified below be implemented to provide consistency across the landscape.

- Implement monitoring strategies described in the "Formal Consultation and Conference on Grazing and Associated Activities Affecting Listed Suckers and Bull Trout within the Four Watersheds on the Fremont National Forest" and/or those described in the new R1/R4/R6 Grazing Implementation Module.
- Implement Best Management Practices (BMPs) described in the "Formal Consultation on Road Construction and Maintenance Activities Affects Listed Suckers and Bull Trout within the Four Basins on the Fremont National Forest" (this document covers road decommissioning, erosion control, culvert installation, road maintenance, etc.).

Appendix A

Literature Cited

Appendix A

Literature Cited

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