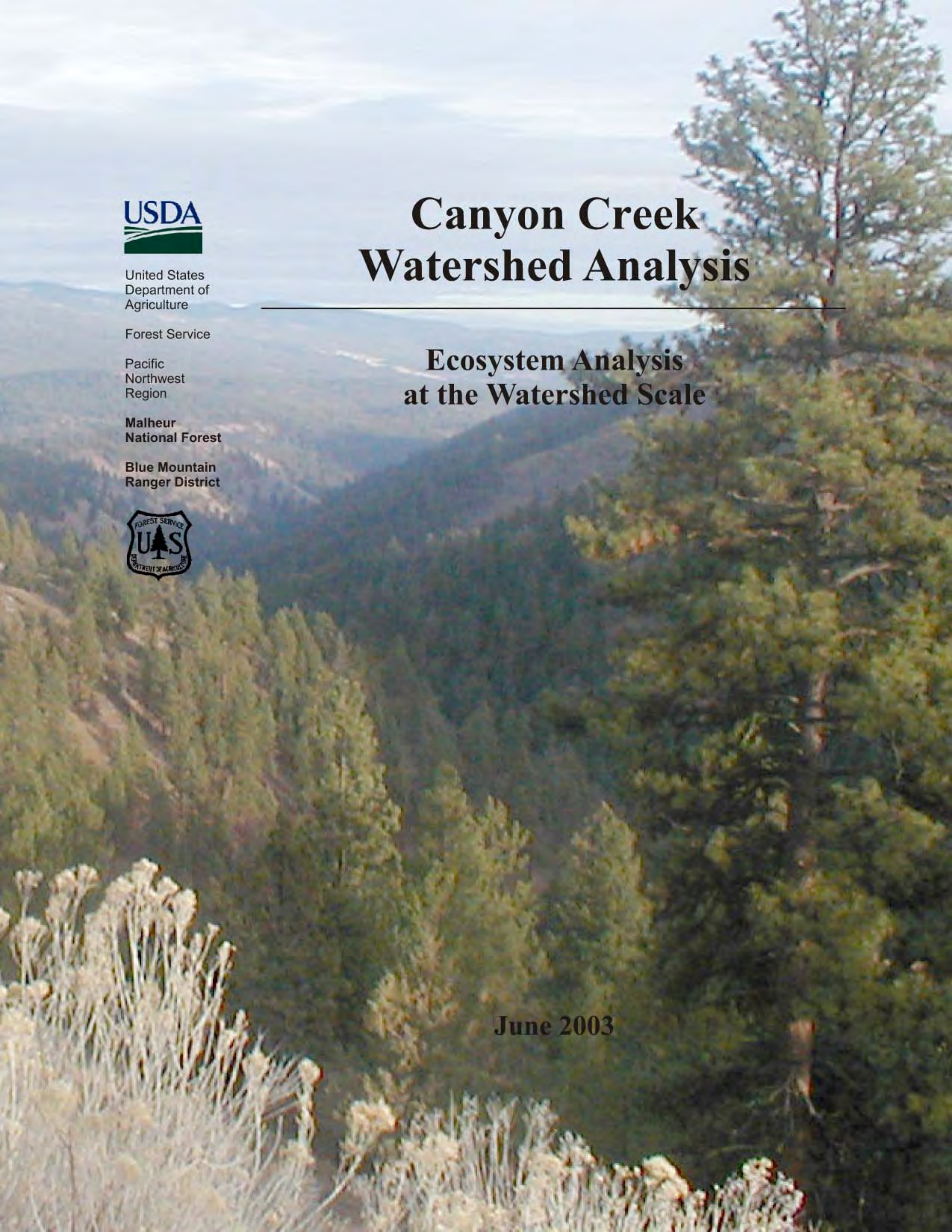

United States
Department of
Agriculture

Forest Service

Pacific
Northwest
Region

**Malheur
National Forest**

**Blue Mountain
Ranger District**

Canyon Creek Watershed Analysis

Ecosystem Analysis at the Watershed Scale

June 2003

United States Department of Agriculture

Forest Service

Malheur National Forest

Blue Mountian Ranger District
P.O. Box 909
John Day, OR 97845
(541) 575-3000

File Code: 1900

Date: June 20, 2003

Dear Forest User

In the fall of 2002, I initiated a project to prepare a watershed analysis (WA) for the Canyon Creek Watershed in the John Day River sub-basin using the process *Ecosystem Analysis at the Watershed Scale - Federal Guide for Watershed Analysis* by David Evans and Associates Incorporated of Portland, Oregon and Duck Creek Associates, Incorporated of Corvallis, Oregon under a professional services contract. I am pleased to announce the WA has been completed. Enclosed, you will find a copy.

The Watershed Analysis (WA) is analyses for implementing the Aquatic Conservation Strategy set forth in PACFISH/INFISH. It provides the watershed context for fisheries protection, restoration and enhancement. In addition the WA will be used to prepare projects under the National Environmental Policy Act (NEPA) based on recommendations from this analysis. There may be several projects analyzed under the NEPA planning procedures to implement recommendations from the WA after a period of public comment and further analysis for each project.

The data used is this analysis, specifically the vegetation information completed via photo interpretation, will undergo field verification during project design. It is not expected that the field verification of the vegetation data will change the basic assumptions and recommendations in this document, but it is important to note that a WA is a dynamic document, which can be updated periodically as new information becomes available.

If you have any further questions, please feel free to contact James Kelly, or Brian Lynch, District Environmental Coordinator at 541-575-3000. Thank you for your continued interest in the Malheur National Forest.

Sincerely,

Michael L. Montgomery

Michael L. Montgomery
District Ranger

Canyon Creek Watershed Analysis

Ecosystem Analysis at the Watershed Scale

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June 2003

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PREFACE

The Canyon Creek Watershed Analysis characterizes ecological and physical processes at multiple spatial scales by systematically uncovering the interactions of biological, physical, and human processes that have created the current conditions in the watershed. The analysis provides the framework to help us understand how the land has changed and to recommend sound management options for the future.

This watershed analysis generally follows the outline described in the *Ecosystem Analysis at the Watershed Scale – Federal Guide for Watershed Analysis* (Federal Guide – Version 2.2, August 1995*)*. Recommendations for maintaining and restoring natural processes within the watershed are made to aid in future project planning.

This watershed analysis is not intended to be a decision-making document but is intended to be useful for future planning. It is recognized, however, that new information, environmental or policy changes, and/or site-specific conditions may alter the current understanding of the watershed and, in turn, may lead to new recommendations. The process is iterative. As new information becomes available, it should be incorporated into the document. The analysis team has attempted to gather all available baseline data and to fill data gaps when feasible. The team will identify existing data gaps to assist further data analysis efforts in understanding watershed processes.

The Canyon Creek Watershed Analysis is driven by the National Fire Plan and the Aquatic Conservation Strategy. The analysis assesses fuels hazard and community vulnerability within the Wildland Urban Interface (WUI) and the potential effects of thinning and prescribed fire. The impacts of fuels treatment on wildlife, soil, water, and other resources were also considered. Special attention will be paid to riparian areas with emphasis given to riparian vegetation communities and habitat condition. The team also evaluated the connectivity of riparian areas throughout the watershed and assess the function of streams as they relate to important aquatic species.

The topographically diverse Canyon Creek watershed ranges from the Strawberry Mountain Wilderness to Canyon City and John Day, Oregon. Human uses coincide with diverse ecosystems across this landscape. The Canyon Creek watershed offers the opportunity to strike a balance between pragmatic resource management and necessary resource protection. It is with this in mind that we conduct this analysis.

The interdisciplinary team that has written this document followed the six-step process outlined in the *Ecosystem Analysis at the Watershed Scale – Federal Guide for Watershed Analysis* (Federal Guide – Version 2.2, August 1995). The six steps are:

- Characterization of the watershed – this is a summary of the key parameters and the ecological interactions occurring within the watershed.
- Identification of the key questions and conditions within the watershed.

- Investigation and description into the current conditions in the watershed.
- Description of reference conditions.
- Synthesize and interpret information gathered in the previous chapters, comparative analysis of current conditions and reference conditions.
- Recommendations and management options for future actions within the watershed.

The results of watershed analysis can be used to:

- Assist in developing ecologically sustainable programs to enhance water, timber, recreation, and other commodities.
- Facilitate program and budget development by identifying and setting priorities for social, economic, and ecological needs within and among watersheds.
- Establish a consistent, watershed-wide context for project-level National Environmental Policy Act (NEPA) analyses.
- Establish a watershed context for evaluating management activity and project consistency given existing plan objectives.
- Establish a consistent, watershed-wide context for implementing the Endangered Species Act, including conferencing and consulting under section 7.
- Establish a consistent, watershed-wide context for local government water quality efforts and for the protection of beneficial uses identified by the states and tribes in their water quality standards under the Federal Clean Water Act.

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1.1 INTRODUCTION

1.1.1 Geographic Setting

The Canyon Creek watershed lies within the John Day River sub-basin in the southern Blue Mountains of east-central Oregon, part of the greater Columbia River basin (Mid-Columbia Subregion). The eastern portion of the watershed straddles the Strawberry Mountain Range; the portion of the watershed west of lower Canyon Creek lies in the heart of the Aldrich Mountains. To the south, Canyon Creek watershed is bounded by Bear Valley and the hills north of Bear Creek (Map 1.1).

1.1.2 Geology

Canyon Creek watershed lies within a complicated mix of Paleozoic and Triassic igneous, sedimentary, and a mélange of metamorphic rocks that form a portion of the earth's crust known as the Baker Terrane (Bishop 1984). Evidence suggests that the Baker Terrane started as a fore arc and subduction zone that underwent rapid subduction, high shear stress, and internal mixing (Vallier 1992). Of specific interest to many researchers is the Canyon Mountain Complex, an ophiolite complex formed as an island arc that makes up part of the Aldrich-Strawberry Mountains. The Canyon Mountain ophiolites are a 200 to 250 million-year-old fragment of oceanic crust, a small sample of the upper mantle consisting of gabbro and peridotite that rose to the earth's surface as magma. As this era ended, the solidified rocks emerged from the sea and were subject to intense erosion. About 180 million years ago, the Canyon Mountain Complex was submerged under a shallow sea into which volcanic material flowed; the igneous rocks were then buried under mudstone and shale (Thayer 1990). Periods of volcanism, mountain building, and erosion over the last 60 million years have left andesite and mudflow breccia. Between 10 and 2 million years ago, compressive forces lifted the earth's crust over 1.5 miles and created the Aldrich-Strawberry Mountain Range. Since that time, ice, wind, and water have combined to erode and shape the mountains and valleys present today (Map 1.2).

1.1.3 Topography

The Canyon Creek watershed encompasses a wide band of topographical relief (Map 1.3). Elevations at the north end of Canyon Creek near its confluence with the main stem of the John Day are approximately 3,050 feet (930 meters). Elevation climbs to approximately 8,000 feet (2,440 meters) along the eastern edge of the watershed. Much of the watershed lies on slopes ranging from 35 to 60% (~60% of watershed); some slopes as steep as 150% or greater (~ 8% of watershed area) are found along the eastern boundary in the Strawberry Mountains. Aspects vary widely within the watershed, because Canyon Creek slices the watershed into distinct sections. In general, the terrain to the east of Canyon Creek slopes westward; in contrast, the terrain in the western portion of Canyon Creek slopes eastward. Changes in vegetation are evident along these aspect changes.

Topography interacts with physical and biological factors within the watershed. Rainfall on steep exposed soils is a primary source of surface erosion. Vegetation patterns change as topographical conditions change. The direct altitudinal effect that results in a normal decline in temperature with an increase in elevation causes a corresponding change in plant community composition, structure, and response to fire. Slope angle also contributes to changing vegetation patterns. Slope aspect in relation to the angle of incident solar radiation affects plant communities by impacting temperature and water availability.

1.2 LAND OWNERSHIP

Canyon Creek watershed covers 73,954 acres of federal, private, and state lands. The U.S. Department of Agriculture Forest Service (USFS) and the Bureau of Land Management (BLM) share federal management of the watershed with 59,580 acres and 2,445 acres, respectively. Private landowners hold 11,927 acres; the State of Oregon owns approximately two acres (Map 1.4).

1.2.1 Land Zoning

Land zoning data were obtained from the State of Oregon for Canyon Creek watershed (Map 1.5). There are seven land use zoning classifications in the watershed. Primary forest zoning dominates the watershed and all the Malheur National Forest falls into this category (Table 1.1). A considerable portion of the privately-held land in the watershed falls into the Primary Forest Zone category. The watershed also encompasses two urban growth boundaries and a rural residential zone area.

Table 1.1 Land use zoning within Canyon Creek watershed.

Land use zoning	Acres
Primary Farm Zone	2
Multiple Use Range	437
Dog Creek Marysville Rural Residential	438
John Day Urban Growth Boundaries	520
Canyon City Urban Growth Boundaries	1,088
Canyon Creek Corridor	3,777
Primary Forest Zone	67,694
Total Acrage	**73,954**

Primary Forest Zone occupies the greatest amount of land within watershed. Both the John Day and Canyon Creek Urban Growth Boundaries lie within the watershed.

1.2.2 USDA Forest Service Management Areas

There are seven forest management areas in the Canyon Creek watershed (Table 1.2, Map 1.6). The Strawberry Wilderness Area covers the largest land management area. Big Game Winter Range overlaps the boundaries of the Malheur National Forest boundary. Many of the management areas overlap. For example, much of what is considered visual corridor is also considered Big Game Winter Range.

Table 1.2 Forest Plan Management Areas.

Forest Plan Management Areas	Acres	Percent of watershed	Percent of Malheur National Forest within Canyon Creek watershed
Canyon Creek Watershed	73,954		
National Forest System lands	59,580	81	100
Strawberry Mountain Wilderness	26,216	35	44
Big Game Winter Range (within Malheur National Forest)	19,126	26	32
Visual Coridors (foreground and middleground)	18,212	25	31
Riparian Habitat Conservation Areas	4,069	6	7
Old Growth (dedicated and reserve)	3,514	5	6
Big Game Winter Range (outside of Malheur National Forest)	2,580	3	0
Research Natural Area	1,476	2	2
Wildland Urban Interface (WUI)	34,460	46	58

Acreages do not add up to total National Forest System lands because management areas overlap, and a small percentage of the Big Game Winter Range is outside of the Malheur National Forest. Data supplied by the Malheur National Forest.

1.3 SOILS

Soils are derived from the effects of topography, climate, biological activity, and time on parent material. Most soils found in the Canyon Creek watershed are derived from igneous and sedimentary rocks.

Soils overlying sedimentary rock in the Canyon Creek watershed, particularly in the Vance Creek area and the hills immediately to the south, are the most vulnerable to surface erosion (Map 1.7). Rainfall and overland flow are the primary mechanisms driving erosion in Canyon Creek watershed. Water erodes soil by splash, sheet, rill, gully, or by the undercutting of stream banks (Foth 1990). Erosion occurs when rain directly strikes soil causing the movement of individual soil particles. When soil is exposed and subject to impact by water, soil is transported overland by gravity until it deposits into a watercourse. Exposed soil is the most vulnerable to erosion. Exposed soil can be found throughout the watershed in areas of natural or human caused vegetation removal.

Examples of natural vegetation removal include fire, inner gorge debris sliding, or flooding. Examples of humans directly removing vegetation include road building, land clearing, timber harvesting, or indirectly through livestock grazing. Denuded cut-banks, clear cuts, and roads are sources of fine sediments to streams in the Canyon Creek watershed. Fine sediments may embed larger substrates such as gravels and cobbles leading to degraded fish spawning habitat (see *Aquatic Species and Habitats* in this chapter for further discussion).

Machinery, vehicles, animal hooves, and foot traffic compact soil (Table 1.3). Soil compaction alters soil porosity and soil permeability, which directly affects water infiltration rates. Reductions in permeability increase runoff and surface erosion, which results in lower water table elevations. A lower water table may affect late season flow can result in changes in species composition (i.e., loss of wetland obligate indicator plants). Logging on soils vulnerable to compaction changes bulk density and reduces the pore space of forest soils. Soils affected by mechanical compaction during logging operations may take decades to return to the pre-logging conditions (Froehlich 1979).

Table 1.3 Soil attributes (erosion potential and detrimental compaction hazard) and acres.

Soil erosion potential	***Acres***
Very High	14,601
High	4,196
Moderate - High	6,295
Moderate	20,456
Low - Moderate	13,249
Low - High	1,964
Low	957
Not Rated	1,275
Potential compaction hazard	
Low	761
Low - Moderate	6,678
Moderate	27,561
Moderate - High	8,087
Not Rated	19,906

Data for the Canyon Creek Watershed provided in digital format in the Soil Resource Inventory (SRI) by the Malheur National Forest.

1.4 CLIMATE

The Canyon Creek watershed experiences interior intermountain west climatic conditions typical of east-central Oregon. Climate data from several climate stations in and around the watershed (Map 1.8, Table 1.4) were analyzed to characterize watershed conditions.

1.4.1 Air Temperatures

Air temperatures throughout the area vary with elevation and topography (Figure 1.1). Mean minimum air temperatures occur in the months of December and January and range from 9 degrees Fahrenheit (° F) at Seneca (located south of the analysis area) to 41° F at John Day. Minimum air temperatures within the Canyon Creek watershed may be higher than those at Seneca due to the prevailing westerly winds moving relatively warmer air masses from low elevation areas in the John Day basin. Mean maximum air temperatures occur in the month of July at all stations, and range from 88° F at John Day and Canyon City to 79° F at the Starr Ridge station. The lowest temperatures on record were −24° F at John Day on January 27 and −48° F at Seneca on February 6, 1989. The highest temperatures recorded were 112° F at John Day and 100° F at Seneca on August 4, 1961.

1.4.2 Precipitation

The Oregon Climate Service (1998) has published digital maps of mean annual and monthly precipitation for the State of Oregon, based on available precipitation records for the period 1961-1990. The Oregon Climate Service (OCS) maps were produced using techniques developed by Daly et al. (1994)[1], which use an analytical model that combines point precipitation data and digital elevation model (DEM) data to generate spatial estimates of annual and monthly precipitation. As a result, the precipitation maps available from the OCS incorporate precipitation data from the local stations shown in Map 1.8. Average annual precipitation within the watershed generally increases with increasing elevation (Map 1.9) and ranges from approximately 13 inches near John Day to approximately 39 inches in the higher elevations of the Strawberry Mountains.

Mean monthly precipitation was estimated for each subwatershed using data available from the OCS (1998) (Figure 1.2). Elevation accounts for the variation in mean monthly precipitation among watersheds. Mean monthly precipitation is lowest in the month of July for all subwatersheds, having a value of approximately 0.8 inches in all subwatersheds except for the Canyon City subwatershed where mean July precipitation is approximately 0.5 inches. November and December are the months with the highest values of mean monthly precipitation, ranging from approximately 2.0 inches in the Canyon City subwatershed to 4.3 inches in the Middle Fork Canyon Creek and Upper East Fork subwatersheds.

[1] *For further information on how these maps were produced the reader is referred to Daly et al. (1994), or the on-line overview available at http://www.ocs.orst.edu/prism/overview.html*

Table 1.4 Station information for climate stations in vicinity of Canyon Creek watershed.

Station	Elevation (ft.)	Latitude	Longitude	Parameter	Period of record
Bear Valley near Seneca	4,800	44°13'N	119°01'W	First-of-month snowpack:	1929 – 1935
Canyon City	3,191	44°24'N	118°57'W	Temperature: Snowfall: Precipitation:	1939 – 1953 1939 – 1953 1939 – 1953
East Fork Canyon	5,700	44°13'N	118°45'W	First-of-month snowpack:	1962 – 1969
Indian Creek Butte	6,550	44°15'N	118°45'W	First-of-month snowpack:	1960 – 1978
John Day	3,062	44°25'N	118°58'W	Temperature: Snowfall: Precipitation:	1953 – Present 1953 – Present 1953 – Present
Seneca	4,659	44°08'N	118°59'W	Temperature: Snowfall: Precipitation:	1949 – Present 1949 – Present 1931 – Present
Starr Ridge Snowcourse/SNOTEL	5,150	44°16'N	119°01'W	First-of-month snowpack: Continuous snowpack: Temperature: Precipitation:	1936 – Present 1980 – Present 1988 – Present 1980 – Present
Williams Ranch	4,500	44°14'N	118°46'W	First-of-month snowpack:	1960 – 1974

Data sources: EarthInfo (1996), NRCS (2001).

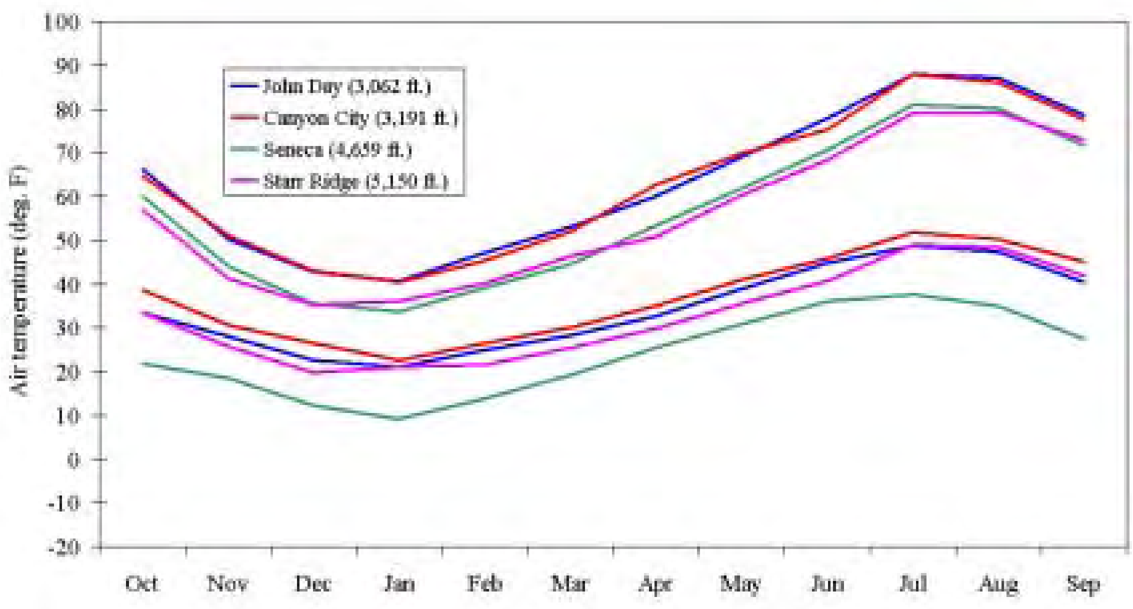
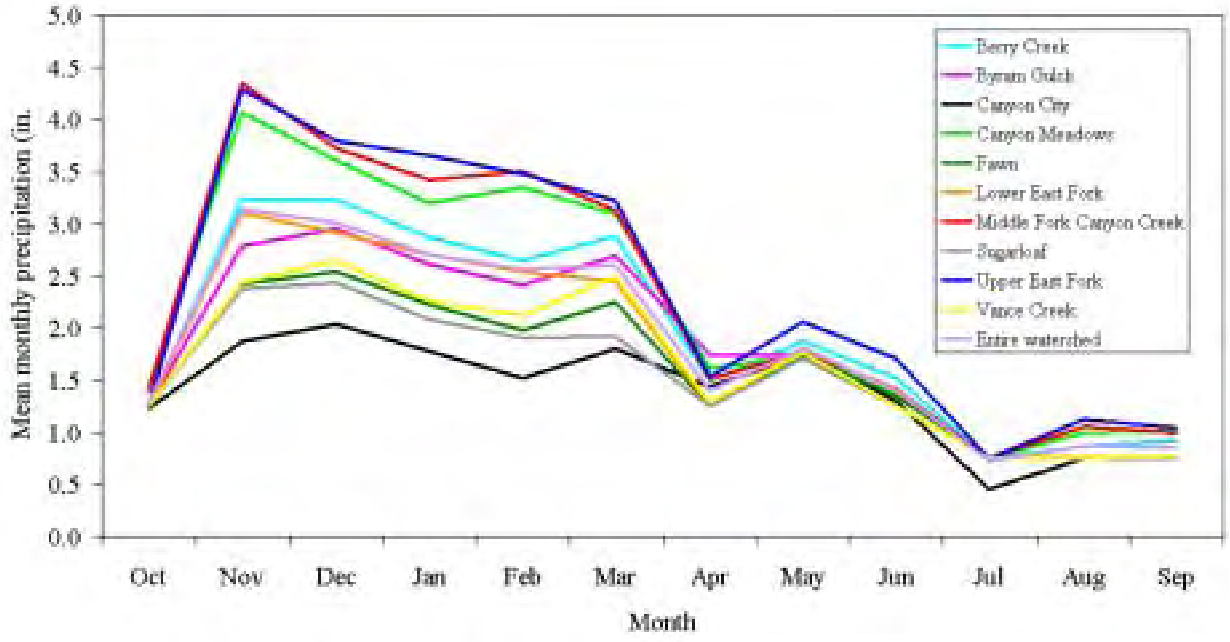


Figure 1.1. Mean minimum and maximum air temperatures for climate stations in the vicinity of the Canyon Creek watershed. Refer to Table 1.4 and Map 1.8 for station location and data availability.



Data source: Oregon Climate Service (1998).

Figure 1.2. Mean monthly precipitation by subwatershed within the Canyon Creek watershed.

1.4.3 Climate Trends

Year-to-year variability in precipitation was assessed using a long-term precipitation record produced by the OCS (2002) for climate region #8, the climate region that completely contains the analysis area. The long-term record produced by the OCS uses mean annual precipitation values from all climate stations within the region and covers the period from 1896 to present (Figure 1.3). Total monthly precipitation data from the OCS data set were used to calculate total precipitation by water year[2]. Also shown in Figure 1.3 are mean annual precipitation values from the John Day station[3]. Inspection of the data in Figure 1.3 suggests that the long-term OCS data set adequately represents precipitation patterns observed in the analysis area. Consequently, the following assessment of long-term precipitation patterns was conducted using the composite OCS data set.

---

[2] *Water year is defined as October 1 through September 30. The water year number comes from the calendar year for the January 1 to September 30 period. For example, Water Year 1990 would begin on October 1, 1989, and continue through September 30, 1990. This definition of water year is recognized by most water resource agencies.*

[3] *Missing data for the John Day station were estimated using data from the Seneca and Starr Ridge climate stations (Map 1.8, Table 1.4). Regression analysis for the two stations are as follows:*

*Monthly precip. @ John Day = 0.743 * monthly precip. @ Seneca + 0.2952; r^2 = 0.64*

*Monthly precip. @ John Day = 0.4537 * monthly precip. @ Starr Ridge + 0.3488; r^2 = 0.52*

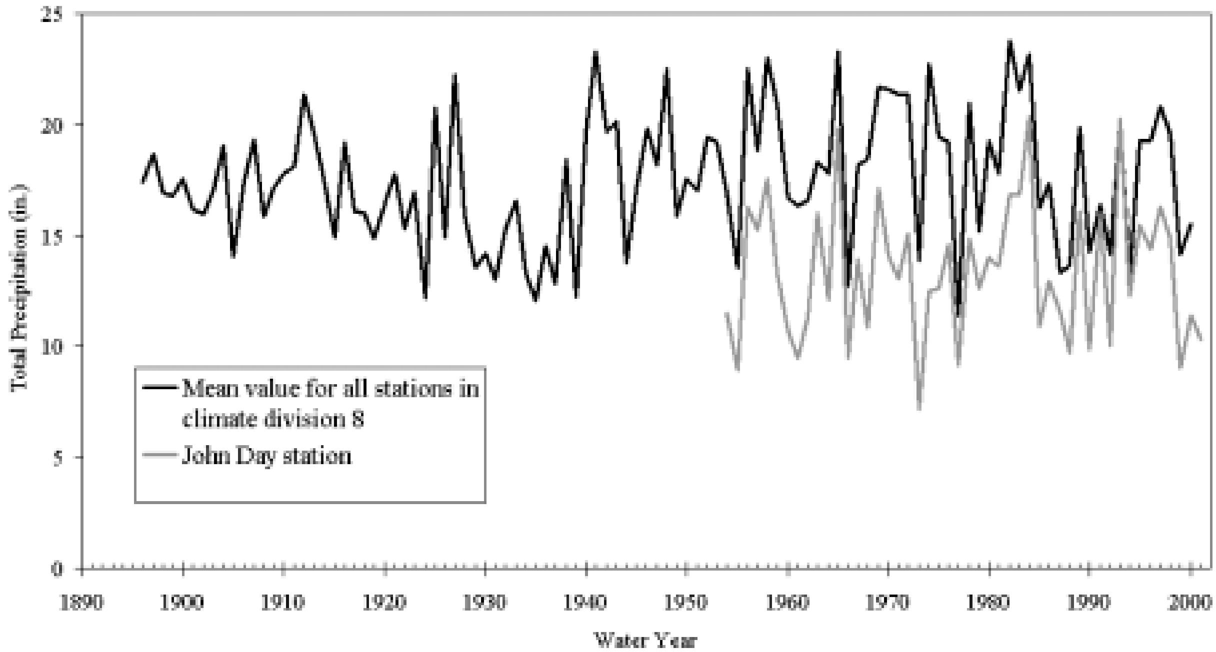


Figure 1.3. Composite annual precipitation record for Oregon climate division #8 (OCS 2002), and annual precipitation from the John Day climate station.

The two major patterns of climatic variability that occur in the Pacific Northwest are the El Niño/Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). The two climate oscillations have similar spatial climatic patterns, but very different temporal behavior (Mantua 2001). One difference is that PDO events persist for 20-to-30-year periods, while ENSO events typically persist for 6 to 18 months (Mantua 2001). Several studies (Mantua et al. 1997, Minobe 1997, and Mote et al. 1999) suggest that there have been five distinct PDO cycles since the late 1800's (Table 1.5). Changes in Pacific Northwest marine ecosystems have been correlated with PDO phase changes. Warm/dry phases have been correlated with enhanced coastal ocean productivity in Alaska and with decreased productivity off the west coast of the lower 48 states, and cold/wet phases have resulted in opposite patterns of ocean productivity (Mantua 2001).

Table 1.5. Recent Pacific Decadal Oscillation (PDO) cycles in the Pacific Northwest.

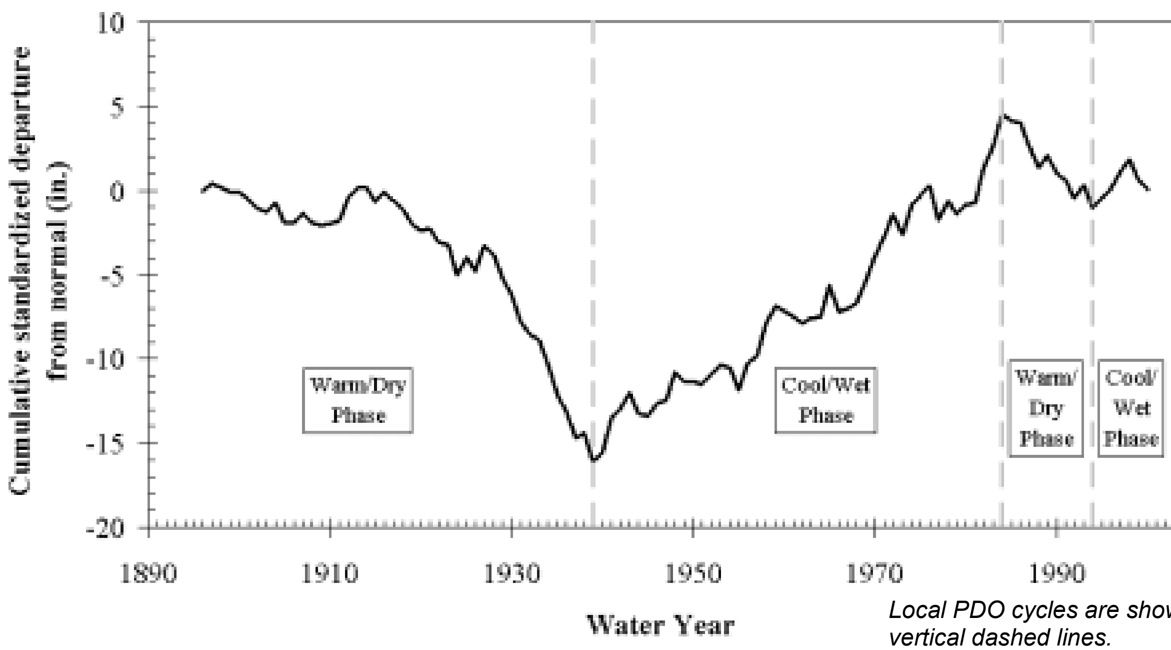
PDO cycle	***Time period***
Cool/wet	1890-1924
Warm/dry	1925-1946
Cool/wet	1947-1976
Warm/dry	1977 –1995
Cool/wet	1995 – present (estimated)

Source: Mantua et al. 1997; Minobe 1997; Mote et al, 1999.

Statistical techniques used by Envirovision Corporation (2000) were applied to the composite annual precipitation record for Oregon climate division #8 in order to investigate if local precipitation trends follow the documented PDO cycles. Data from this station were processed in the following manner:

1. Mean and standard deviation was calculated for annual precipitation over the period of record.
2. A standardized departure from normal was calculated for each year by subtracting mean annual precipitation from annual precipitation for a given year and dividing by the standard deviation.
3. A cumulative standardized departure from normal was then calculated by adding the standardized departure from normal for a given year to the cumulative standardized departure from the previous year (the cumulative standardized departure from normal for the first year in a station record was set to zero).

This approach of using the cumulative standardized departure from normal better illustrates patterns of increasing or decreasing precipitation over time by reducing year-to-year variations in precipitation, thus compensating for the irregular nature of the data set. Values for the cumulative standardized departure from normal increase during wet periods and decrease during dry periods. Results for the composite annual precipitation record for Oregon climate division #8 are given in Figure 1.4.



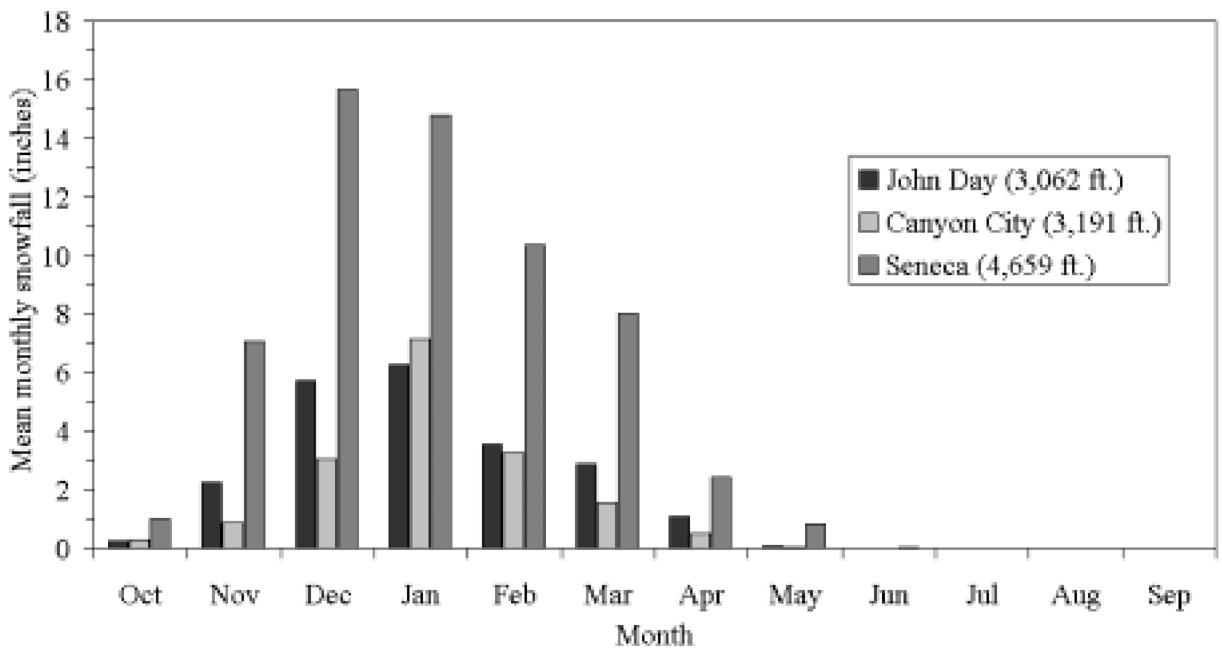
Local PDO cycles are shown as vertical dashed lines.

Figure 1.4. Cumulative standardized departure from normal for the composite annual precipitation record for Oregon climate division #8.

Precipitation patterns for the composite annual precipitation record for Oregon climate division #8 (Figure 1.4) do not follow very closely the documented regional trends (Table 1.5). The cool/dry phase that is regionally reported to have lasted from 1890 – 1924 does not appear to have occurred locally. The transition from warm/dry to cool/wet phase that occurred regionally in 1946 – 1947 appears to have occurred locally around 1939, and the cool/wet phase appears to have persisted locally until approximately 1984 rather than ending in 1976. The transition from warm/dry to cool/wet phase in 1994 – 1995 follows the regional pattern.

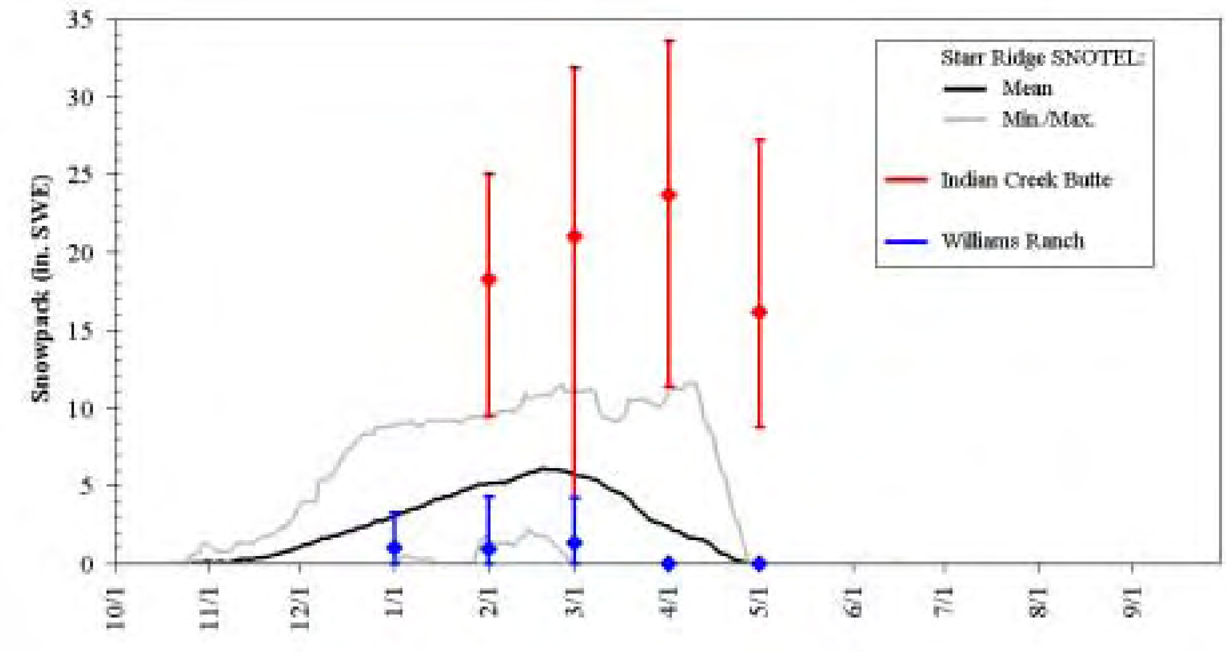
1.4.4 Snowfall and Snowpack

Data on snowfall (i.e., depth of snow independent of snow density) and snowpack (i.e., depth of snow on the ground, expressed in terms of snow water equivalent [SWE]) are available from several stations in the vicinity of the Canyon Creek watershed (Map 1.8, Table 1.4). Mean monthly snowfall is shown in Figure 1.5, and snowpack is shown in Figure 1.6. Snowfall generally occurs in the months of October through April at all elevations, and snowpack is generally gone by the beginning of May at all but the highest elevations. Maximum snowfall occurs in the months of December and January, and snowpack appears to reach the greatest depths in late February at the lower elevations and in early April at the higher elevations.



Refer to Map 1.8 and Table 1.4 for station location and data availability.

Figure 1.5. Mean monthly snowfall at climate stations in vicinity of Canyon Creek watershed.



Data for the Indian Creek and Williams Ranch sites are shown as minimum, maximum, and mean values. Data for the Starr Ridge SNOTEL site is recorded continuously, while data at the Indian Creek and Williams Ranch stations are measured on or about the first of each month. Refer to Map 1.8 and Table 1.4 for station location and data availability.

Figure 1.6. Snowpack (in inches of snow-water equivalent) at climate stations in vicinity of Canyon Creek watershed.

1.5 HYDROLOGY

1.5.1 Subwatersheds

The Malheur National Forest identifies nine sixth-field subwatersheds within the Canyon Creek watershed. Concerns about the Canyon City municipal water supply within Byram Gulch (within the Canyon City sixth-field subwatershed) (Welby, pers. comm. 2002) led to the delineation of a tenth subwatershed that encompasses Byram Gulch (Map 1.10). Elevations in the watershed range from over 8,000 feet in the headwaters of the Berry Creek subwatershed to 3,050 feet where Canyon Creek joins the John Day River (Table 1.6). Mean subwatershed elevation and slope generally increase moving upstream throughout the subwatersheds (Table 1.6); the exceptions are the Berry Creek and Byram Gulch subwatersheds, which contain some of the higher elevation areas of the Strawberry Mountains in their headwaters. All the subwatersheds contain areas of steep slopes and are moderately steep overall (Table 1.6). Lower East Fork and Fawn subwatersheds have the gentlest slopes within the watershed; Upper East Fork, Berry Creek, and Byram Gulch have the steepest.

Table 1.6. Characteristics of subwatersheds within the Canyon Creek watershed.

Subwatershed	Area (mi^2)	Elevation (ft): Mean	Elevation (ft): Min	Elevation (ft): Max	Slope (%): Mean	Slope (%): Min	Slope (%): Max
Berry Creek	15.1	5,170	3,527	8,012	47	0	259
Upper East Fork	12.6	6,180	4,744	7,966	47	0	140
Fawn	21.9	4,734	3,753	6,286	31	0	147
Vance Creek	7.4	4,949	3,868	5,929	41	0	182
Lower East Fork	12.1	5,308	4,062	6,972	31	0	152
Middle Fork Canyon Creek	11.1	5,829	4,311	7,917	38	0	179
Canyon Meadows	13.5	5,507	4,311	7,645	36	0	220
Sugarloaf	11.6	4,852	4,082	6,198	34	0	129
Byram Gulch	1.4	5,121	3,524	7,251	53	0	120
Canyon City	8.8	3,914	3,051	5,771	32	0	124

Data sources: USFS (2001)

1.5.2 Characteristics of Primary Streams

The Canyon Creek watershed contains a diversity of stream channel types that reflect the geologic and geomorphic processes that have been active in the region. Stream gradient and valley development are mostly a function of position within the watershed; upstream reaches tend to be the steepest and most confined. However, the wide variety in the underlying geology of Canyon Creek provides some anomalous situations.

The lowest-gradient streams and the streams having the largest amount of floodplain development are the mainstem of Canyon Creek from the confluence with Berry Creek upstream to the confluence with the Middle Fork of Canyon Creek and the lower portions of Vance, East Fork Canyon, and Middle Fork Canyon Creeks (Map 1.10, Figure 1.7). These stream characteristics reflect not only position within the watershed but also underlying shale and mudstone rock, which is relatively easily eroded (Walker and MacLeod 1991).

Moderate-gradient streams, some having developed flood plains, are located within areas underlain by the Strawberry Volcanics, and include the middle portions of the East Fork and Middle Fork Canyon Creek, Wall Creek and Crazy Creek (Map 1.10, Figure 1.7).

The steepest streams are located within the more resistant rock, including partly-metamorphosed sedimentary and volcanics, clastic rocks and andesite flows, and in ultramafic intrusive rocks. These areas include the mainstem of Canyon Creek from upstream of Canyon City to upstream of Byram Gulch, Byram Gulch, Berry Creek, upper Vance Creek, and the headwater tributaries to the East Fork Canyon Creek (Map 1.10, Figure 1.7).

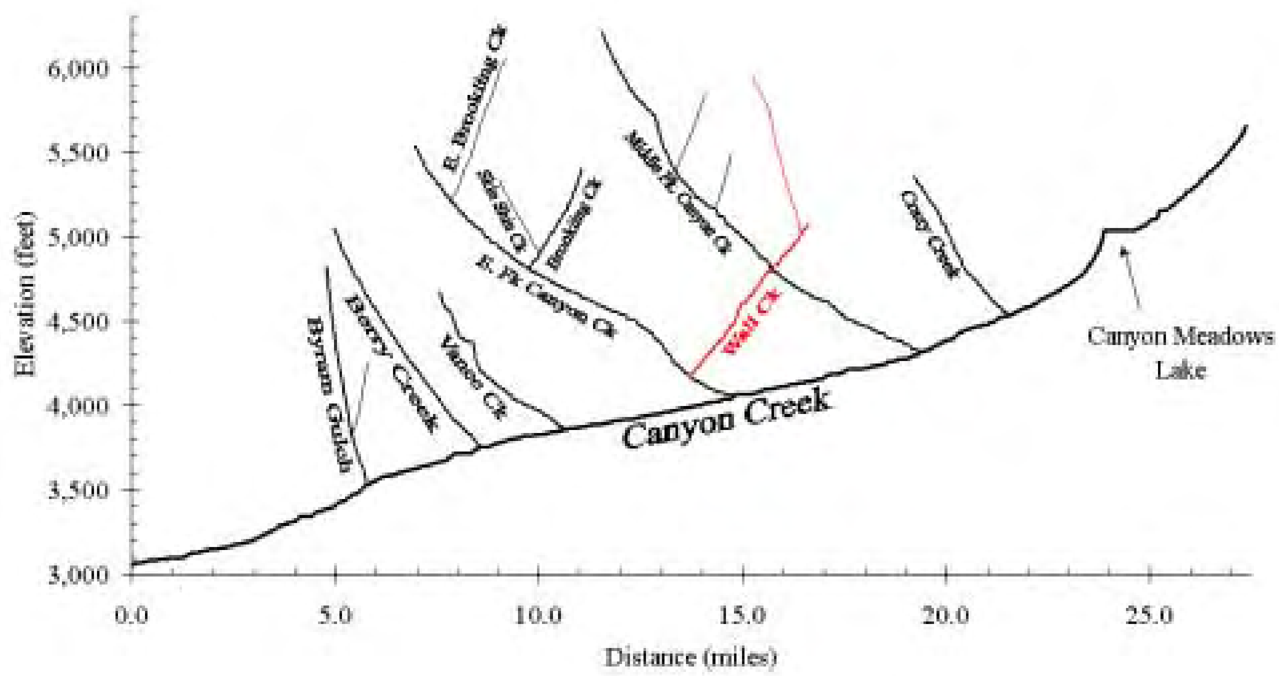


Figure shows relative channel gradients of the principal streams in the watershed.

Figure 1.7. Channel Profiles (end view) of Canyon Creek and primary tributaries.

1.5.3 Streamflow Data

Little data are available to characterize streamflow within the Canyon Creek watershed. Because continuous stream flow records are of short duration, an additional stream gage, located in Strawberry Creek immediately east of the analysis area, was included in this analysis. The locations of available stream flow data from within the watershed are shown in Map 1.11 and summarized in Table 1.7. The Strawberry Creek above Slide Creek near Prairie City gage (#14037500) drains an area of 7.0 square miles [mi^2] and has a mean basin elevation of 6,919 feet (range 4,908 to 9,052 feet), which is slightly higher than the Canyon Creek subwatersheds (Table 1.6), although mean basin slope (45%) is similar. The Strawberry Creek gage has one of the longest periods of record for any tributary stream in the upper John Day and is similar enough with respect to basin characteristics to be considered when evaluating the long-term peak flow record for the area. Stations included in Map 1.11 and Table 1.7 have little or no upstream regulation or diversion. None of the gages included here are currently active.

Table 1.7. Stream gages within the Canyon Creek watershed.

Map ID	Gage number: name	Drainage area (mi2)	Gage elev. (ft)	Period of record: mean daily flow	Period of record: peak flows	Responsible agency / current status
A	14038550: East Fork Canyon Ck near Canyon City	24.8	4,080	n/a	10/1/1964 – 9/30/1979	USGS / Discontinued
B	14038560: Canyon Ck at Thissel's Ranch near Canyon City	70.3*	3,970*	4/22/1925 – 9/30/1926	n/a	OWRD / Discontinued
C	14038600: Vance Ck near Canyon City	6.54	4,000	n/a	10/1/1963 – 9/30/1979	USGS / Discontinued
D	14038602: Canyon Ck near Canyon City	86.3	4,000	10/1/1980 – 9/30/1991	10/01/1980 – 09/30/1991	OWRD / Discontinued
E	14038630: Canyon Ck at John Day	115.4*	3,080*	4/13/1925 – 9/30/1925	n/a	OWRD / Discontinued
F	14037500: Strawberry Ck above Slide Ck near Prairie City	7.0	4,910	4/28/1925 – 9/30/1997	10/1/1930 – 9/30/1997	OWRD / Discontinued

*Notes: * Estimated from USGS quad maps*

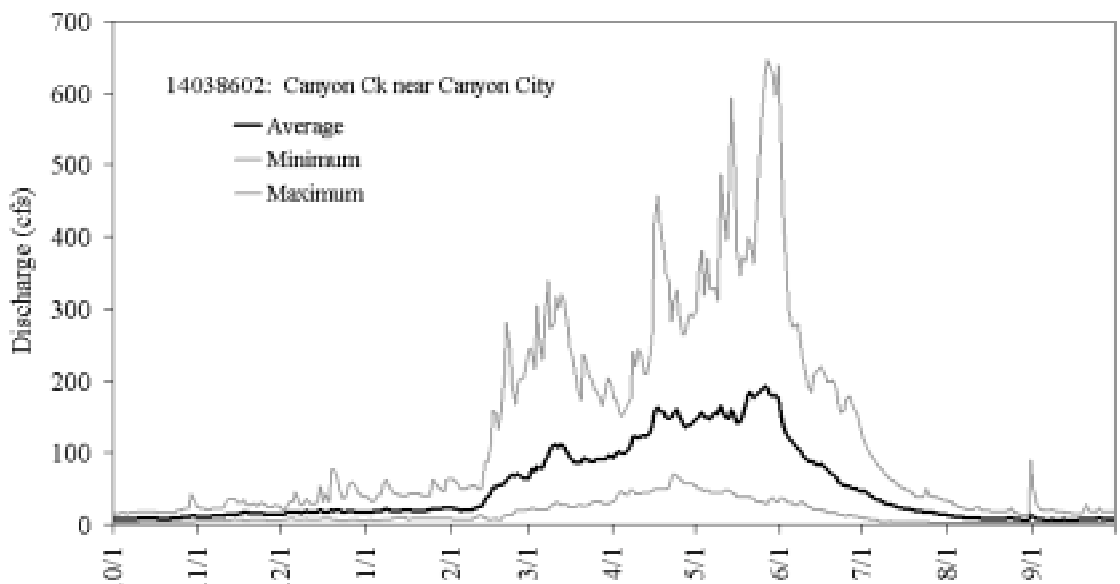
Refer to Map 1.11 for gage locations. Data source: OWRD (2002a), USGS (2002).

1.5.4 Hydrologic Regime

The primary peak-flow-generating processes active in Oregon are rainfall, snowmelt, and rain-on-snow (ROS). Rain-on-snow is the common term used to describe wintertime conditions when relatively warm wind and rain combine to produce rapid snowmelt. Appendix A of the Oregon Watershed Assessment Manual (WPN 2001) identifies the dominant peak flow generating processes by EPA level IV ecoregion. The majority (89%) of the Canyon Creek watershed falls within "Mélange" level IV ecoregion. The remaining portions of the watershed fall within the Subalpine Zone level IV ecoregion (approximately 8% of the watershed area in the headwaters of the Berry Creek, Upper East Fork, Middle Fork Canyon Creek, Canyon Meadows, and Byram Gulch subwatersheds) and the John Day/Clarno Uplands ecoregion (approximately 3% of the watershed at the mouth of the Canyon City subwatershed). Within the Mélange and Subalpine Zone ecoregions, the primary peak flow generating processes are identified as spring rain, spring rain-on-snow, and snowmelt (WPN 2001). Within the John Day/Clarno Uplands ecoregion the primary peak flow generating processes are identified as primarily winter rainstorms and winter rain-on-snow.

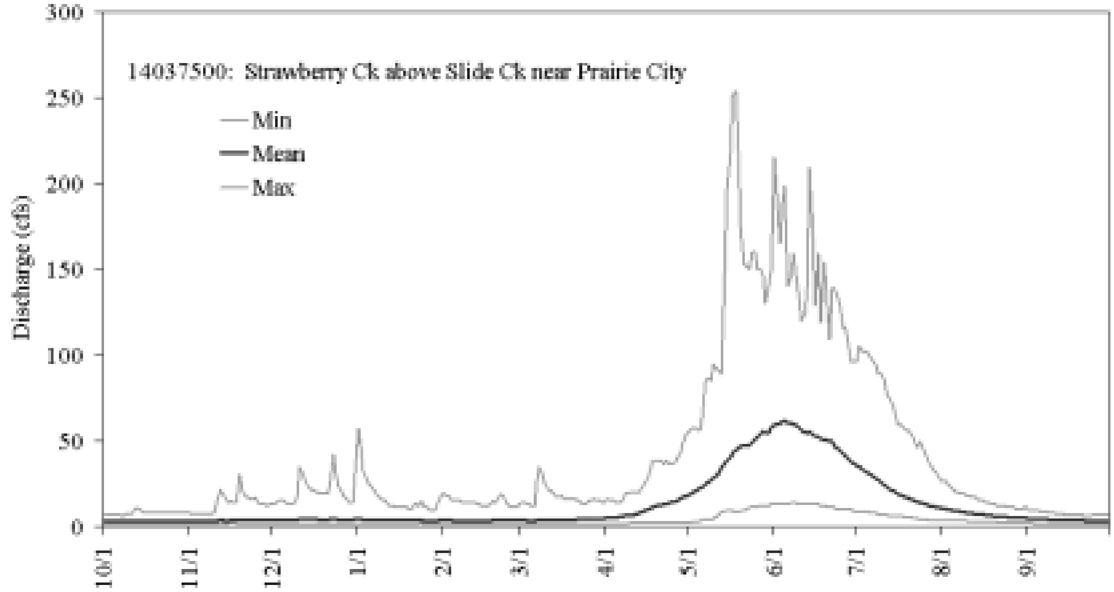
The average, minimum and maximum mean daily discharge at the Canyon Creek near Canyon City stream gage (#14038602) are shown in Figure 1.8. Inspection of the hydrograph for the Canyon Creek gage shows that the highest flows occur during the late spring / early summer snowmelt season; however, high flows also occur during the winter months, probably in response to winter rain-on-snow conditions. In contrast, the hydrograph for the Strawberry Creek gage (Figure 1.9) represents a purely snow-melt-dominated hydrologic regime. This is not surprising considering that the contributing area to the Strawberry Creek gage is approximately 80% within the Subalpine ecoregion; only the lower 20% is in the Mélange ecoregion. The frequency distribution of peak flows by month (Figure 1.10) further supports the conclusion that the majority of annual peak flows occur in response to spring snowmelt, but that winter rain-on-snow events also occur. Indeed, the largest peak-flow events recorded at the Vance Creek and East Fork Canyon Creek gages were for the December 21, 1964, rain-on-snow event.

The lowest base flows at the Canyon Creek near Canyon City stream gage (Figure 1.8) occur primarily in late August and early September. Base flow for the month of August ranges from 1.3 to 90 cfs with a mean value of 9 cfs (0.02 cfs/mi^2 to 1.04 cfs/mi^2 with a mean value of 0.10 cfs/mi^2). In contrast, the minimum flow recorded at the Strawberry Creek gage (Figure 1.9), 1.2 cfs (0.17 cfs/mi^2), have been recorded in the months of February and March. Flows are generally lowest at the Strawberry Creek gage in the month of October, ranging from 1.4 cfs to 11 cfs with a mean value of 3.2 cfs (0.20 cfs/mi^2 to 1.57 cfs/mi^2 with a mean value of 0.46 cfs/mi^2). The occurrence of low stream flows later in the season at the Strawberry Creek gage reflects the higher elevation, snowmelt-dominated characteristics of the contributing area.



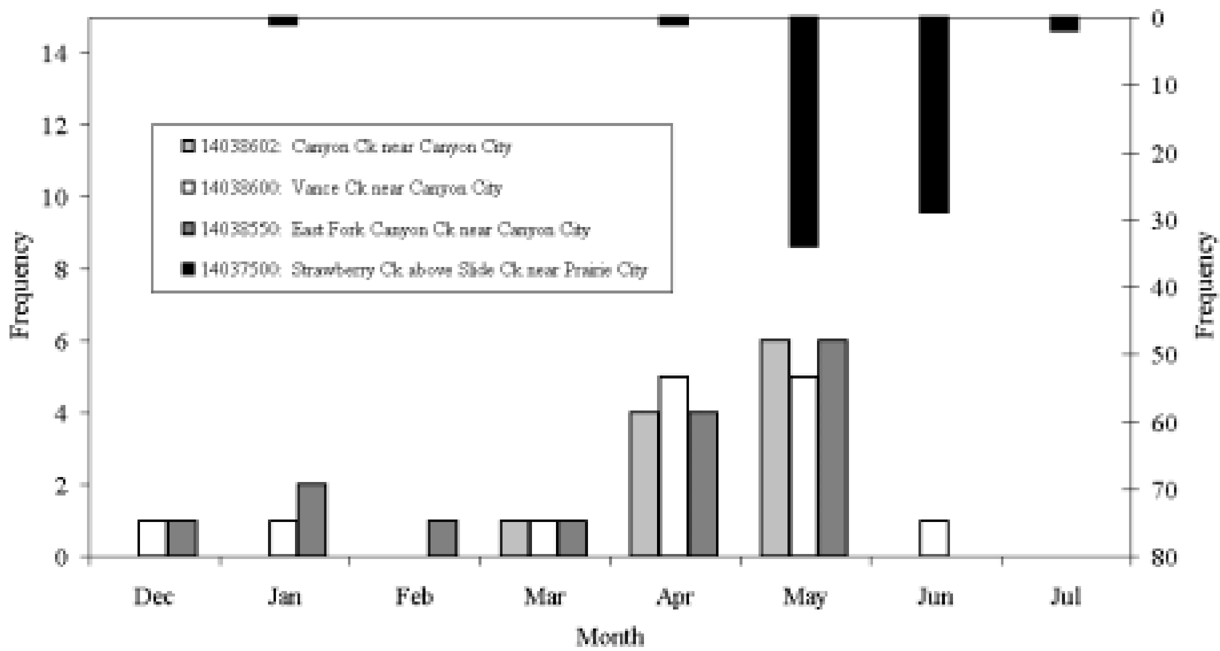
Refer to Map 1.11and Table 1.7 for gage location and characteristics.

Figure 1.8. Average, minimum and maximum mean daily discharge at gage #14038602, Canyon Creek near Canyon City.



Refer to Map 1.11 and Table 1.7 for gage location and characteristics.

Figure 1.9. Average, minimum and maximum mean daily discharge at gage 14037500, Strawberry Creek above Slide Creek near Prairie City.



Refer to Map 1.11 and Table 1.7 for gage location and characteristics. Data for gage 14037500, Strawberry Creek above Slide Creek near Prairie City, is plotted on the secondary y-axis.

Figure 1.10. Frequency distribution of peak flows by month for four gages within vicinity of Canyon Creek that have peak flow records.

1.5.5 Flood History

Data on annual peak flows, available from three gages within the Canyon Creek watershed (Vance Creek near Canyon City, #14038600; East Fork Canyon Creek near Canyon City, #14038550; and Canyon Creek near Canyon City, #14038602) plus the adjacent Strawberry Creek gage (#14037500) (Table 1.7), were used to construct a local peak flow history. For purposes of comparison, the data are presented as a time series showing the recurrence interval of the annual flow event (Figure 1.11). This approach allows for a comparison of events from watersheds of different sizes. Recurrence intervals were calculated for the period of record at gage #14037500 (Strawberry Creek above Slide Creek near Prairie City) and gage #14038602 (Canyon Creek near Canyon City) using techniques described by the Interagency Advisory Committee on Water Data (1982) and taken from Harris et al. (1979) for the remaining gages. Peak flow magnitude was next plotted against probability (i.e., 1/recurrence interval) on log-probability paper. The recurrence interval was then interpolated for each event from the plotted values.

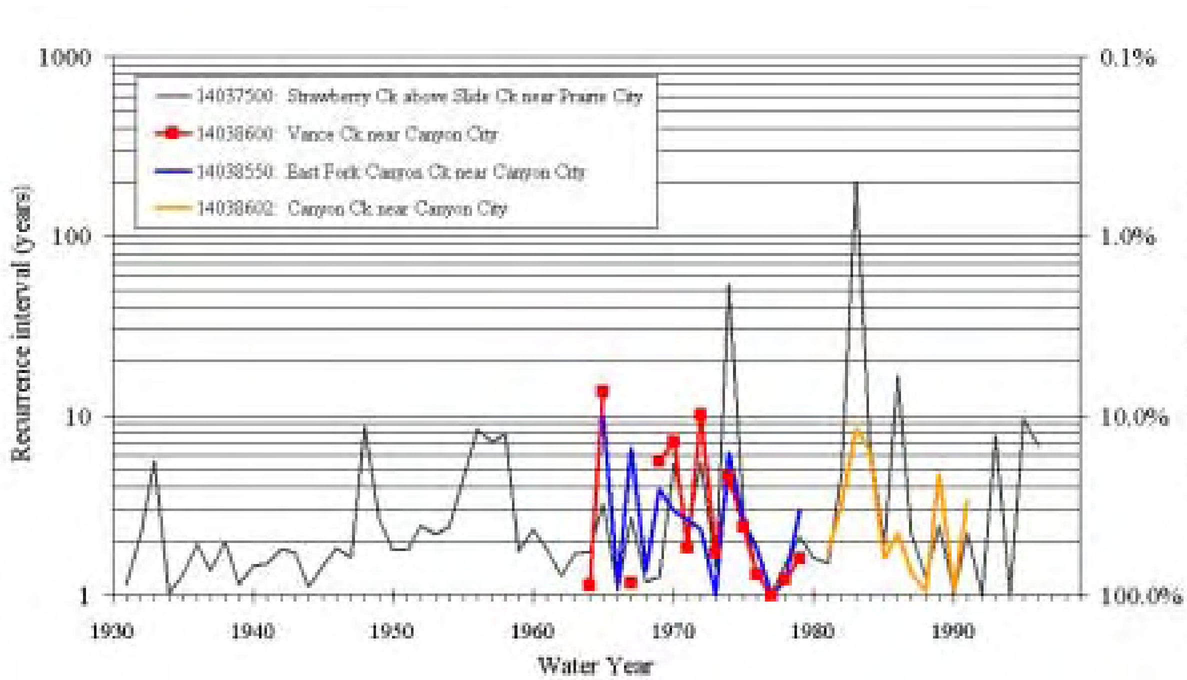


Figure 1.11. Recurrence interval and probability of occurrence associated with annual peak flow events at four stream gages in vicinity of Canyon Creek watershed.

The largest recorded peak flow event in Canyon Creek was the flood on December 21, 1964, (known as “the ’64 flood”) during water year 1965. However, at the Strawberry Creek gage, the ’64 flood was not the largest peak flow for water year 1965; the largest event was on June 5, 1965. This differential response underscores the importance of elevation on hydrologic regime; higher elevations are less susceptible to rain-on-snow storms.

Very few of the peak flows recorded at the gages within the Canyon Creek watershed occurred on or around the same date at the Strawberry Creek gage. In contrast, almost all peak flows from the two overlapping records from Canyon Creek (i.e., the Vance and East Fork gages) occurred on or around the same day, although the magnitude of the floods varied considerable in some situations (e.g., 1967, 1972; Figure 1.11).

The largest event recorded at the Canyon Creek near Canyon City gage (#14038602) occurred on May 27, 1983, and had an estimated recurrence interval of approximately 8.5 years. This event was also the largest annual event at the Strawberry Creek gage (May 31, 1983); however, at the Strawberry Creek gage the recurrence interval was estimated to be approximately 200 years (Figure 1.11). This disparity is due to the uncertainty in estimating recurrence intervals from the short data record available for the Canyon Creek gage; a longer record may have resulted in a higher calculated recurrence interval for the event.

Unfortunately, all gages within Canyon Creek were discontinued by the February 1996 storm that caused widespread flooding in much of Oregon and the northwest. The largest peak flow recorded in 1996 at the Strawberry Creek gage occurred on May 18, 1996. However, anecdotal information suggests that the February 1996 event was noteworthy for impacts to channel morphology and fisheries habitat.

1.5.6 Water Rights

In Oregon, any entity wanting to use waters of the state for a beneficial use must go through an application/permit process administered by the Oregon Water Resources Department (OWRD). Under this process, an entity applies for a permit to use a certain amount of water, and then establishes that the water is being used for a beneficial use. Once the beneficial use is established and a final proof survey is done to confirm the right, a certificate is issued. Certain water uses do not require a water right (OWRD 2001b). Exempt uses of surface water include natural springs which do not flow off the property on which they originate, stock watering, fire control, forest management, and collection of rainwater. Exempt groundwater uses include stock watering, watering of less than one-half acre of lawn and garden, and domestic water uses of no more than 15,000 gallons per day.

Water rights entitle a person or organization to use public waters of the state in a beneficial way. Oregon's water laws are based on the principle of prior appropriation (OWRD 2001b). The first entity to obtain a water right on a stream is the last to be shut off in times of low stream flows. In times when water is in short supply, the water right holder with the oldest date of priority can demand the water specified in the water right regardless of the needs of junior users. The oldest water right within the Canyon Creek watershed has a priority date of December 31, 1864, and the newest has a priority date of October 22, 2001 (OWRD 2002b).

The OWRD also approves instream water rights for protecting fish, minimizing the effects of pollution, or maintaining recreational uses (OWRD 2001b). Instream water rights set flow levels a stream reach on a monthly basis, have a priority date, and are regulated the same as other water rights. Instream water rights do not guarantee that a certain quantity of water will be present in the stream (OWRD 2001b). Also, under Oregon law, an instream water right cannot affect a use of water with a senior priority date (OWRD 2001b). Four reaches within the Canyon Creek watershed have designated instream water rights (Table 1.8).

Table 1.8. Instream Water Rights within the Canyon Creek watershed.

	Instream water right		***Instream water right***
Reach: Canyon Creek – mouth to East Fork confluence Priority: 11/3/1983 Purpose: Supporting aquatic life and minimizing pollution	1/1 - 2/1: 25 cfs 2/16 - 5/16: 34 cfs 6/1 - 6/16: 25 cfs 7/1: 15 cfs 7/16 - 10/16: 9 cfs 11/1 - 11/16: 15 cfs 12/1 - 12/16: 25 cfs	Reach: Canyon Creek – Upstream of East Fork confluence Priority: 9/11/1990 Purpose: Anadromous and resident fish rearing	1/1 - 2/16: 11 cfs 3/1 - 5/16: 17 cfs 6/1 - 6/16: 11 cfs 7/1 - 11/16: 7 cfs 12/1 - 12/16: 11 cfs
Reach: East Fork Canyon Creek Priority: 9/11/1990 Purpose: Anadromous and resident fish rearing	1/1 - 1/16: 4.8 cfs 2/1 - 2/16: 5.8 cfs 3/1 - 3/16: 11.9 cfs 4/1 - 5/16: 22 cfs 6/1 - 6/16: 15 cfs 7/1 - 7/16: 6.6 cfs 8/1 -8/16: 2.6 cfs 9/1 - 9/16: 2.1 cfs 10/1 - 10/16: 2.7 cfs 11/1 - 11/16: 4.1 cfs 12/1 - 12/16: 4.7 cfs	Reach: Middle Fork Canyon Creek Priority: 9/11/1990 Purpose: Anadromous and resident fish rearing	1/1 - 1/16: 2.5 cfs 2/1 - 2/16: 3.1 cfs 3/1 - 3/16: 6.3 cfs 4/1 - 4/16: 15.6 cfs 5/1 - 5/16: 20.4 cfs 6/1 - 6/16: 11.1 cfs 7/1 - 7/16: 2.9 cfs 8/1 -8/16: 1.3 cfs 9/1 - 9/16: 1.1 cfs 10/1 - 10/16: 1.4 cfs 11/1 - 11/16: 2.1 cfs 12/1 - 12/16: 2.4 cfs

Source: OWRD (2001a)

Data from the OWRD (OWRD 2001a, OWRD 2002b) were used to identify locations and characteristics of water use in the Canyon Creek watershed[4]. Only those water rights classified as "non-cancelled" were included in this analysis. The OWRD identifies 234 points of diversion for water rights within the Canyon Creek watershed (OWRD 2002b). The approximate locations of these points of diversion are shown in Map 1.12 (OWRD 2001a). Points of diversion for water rights are found within all subwatersheds except for the Upper East Fork and Middle Fork and are predominately from surface water sources.

Withdrawal rates associated with water rights within the Canyon Creek watershed are available through the OWRD (2002b). Rate of withdrawal in the OWRD data is

[4] *Of the two sources of data used in this portion of the assessment, the Water Rights Information System data (OWRD, 2002b) is the most accurate and up to date (K. Boles, pers. comm., 2002). The available GIS data (OWRD, 2001a) was used primarily to show locations of diversions and water use and may not accurately reflect current conditions.*

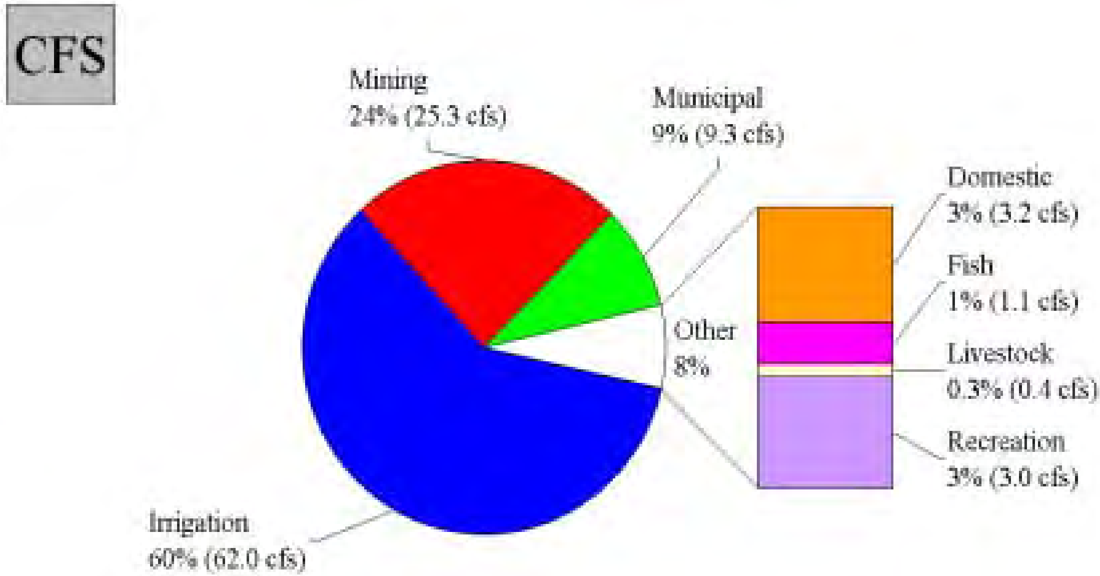
expressed either as an instantaneous rate (i.e., cubic feet per second [cfs]) or as a total yearly volume (i.e., acre-feet). Some (but not all) of the water rights in which the withdrawal rate is expressed in acre-feet have further restrictions that specify an instantaneous rate by which that water can be applied (e.g., 1/40 cfs per irrigated acre) as well as the maximum volume that can be applied in a given season or over any 30-day period. It would be most convenient when summarizing the rate of water withdrawals, to express the withdrawal rate in common units of measurement for all water uses within a sub-basin. However, use of the publicly available information from the OWRD for this type of estimate was not possible at the time of this report. Given this limitation, the withdrawal rates for the Canyon Creek watershed were estimated separately for those water rights for which rates are given as an instantaneous rate (cfs) and those for which the rate of withdrawal is given as a total yearly volume (acre-feet). Summaries for these two units of measure are given in Figure 1.12 and Figure 1.13.

Despite the difficulty in expressing all water rights in a common set of units, it is clear that irrigation is the primary use of water withdrawals in the watershed, accounting for 60% of the volume reported in units of cfs (Figure 1.12) and 5% of the volume reported in units of acre-feet (Figure 1.13). There are approximately 860 irrigated acres within the Canyon Creek watershed (Map 1.13), the majority of which is located along the mainstem of Canyon Creek (OWRD 2001a).

Two water rights for mining account for approximately one-quarter of the amount reported in units of acre-feet (Figure 1.13). These diversions are located in the Canyon City and lower Berry Creek subwatersheds. Nine municipal water rights, located within Byram Gulch and the Canyon City subwatersheds, account for an additional 9% of the amount reported in units of acre-feet (Figure 1.13).

Recreation accounts for 3% of the amount reported in units of cfs (Figure 1.12) and 16% of the amount reported in units of acre-feet (Figure 1.13). Water rights for recreation include hot springs, swimming pools, and recreational ponds along Canyon Creek near the Vance Creek confluence and Canyon Meadows Reservoir in the Canyon Meadows subwatershed.

Other water uses include livestock (69% of units of acre-feet; Figure 1.13), domestic (3% of units of cfs; Figure 1.12), and fish (not including instream rights described in *Section 1.5.6*; 1% of units of cfs; Figure 1.12). The category “miscellaneous” (10% of units of acre-feet; Figure 1.13) includes one water right for which the use is classified as “aesthetics” and two water rights for fire protection.



Data source: OWRD (2002b).

Figure 1.12. Summary of water rights within Canyon Creek watershed reported in cubic feet per second (cfs).

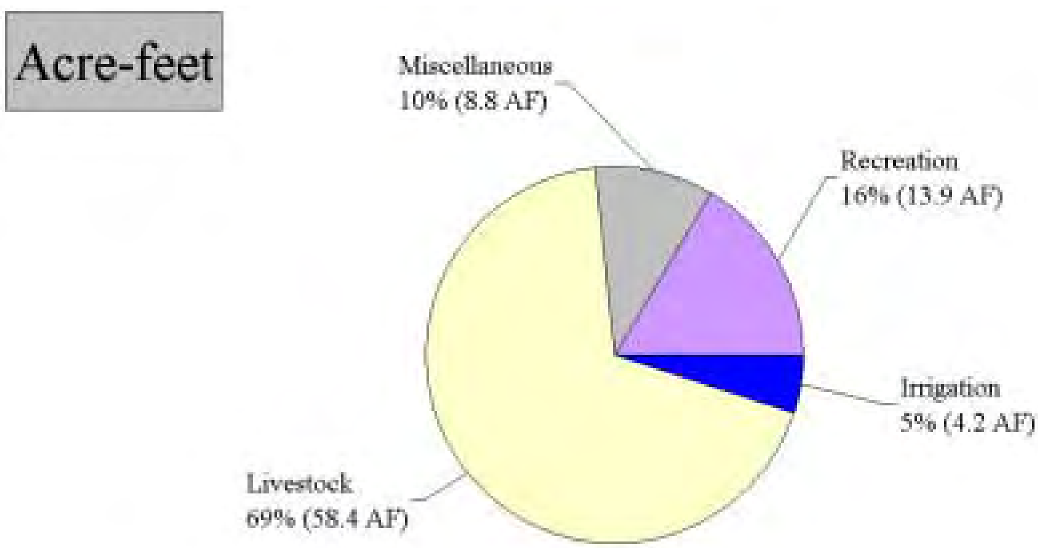


Figure 1.13. Summary of water rights within Canyon Creek watershed reported in acre-feet (AF).

1.5.7 Canyon Meadows Dam

Canyon Meadows Lake is a human-made reservoir of approximately 32 acres, located along the mainstem of Canyon Creek in the mid-portion of the Canyon Meadows subwatershed (Map 1.10). The lake is retained by a rubble dam (Figure 1.14). It was constructed to provide recreational fishing opportunities (ODFW 2001). Construction of the dam and associated campground began in 1962, and the reservoir was first filled in late spring 1964. From the beginning, it was apparent that the dam leaked and the reservoir is dry by late summer of most years. Consequently, recreational opportunities are restricted to early summer. The U.S. Army Corps of Engineers (Corps) determined that the dam does not pose a hazard due to catastrophic failure (USACE 1999); nevertheless, the control gates are left open and the reservoir is no longer filled. Given the combination of the steep channel gradient and lack of resting habitat immediately downstream of the dam, it is unlikely that steelhead accessed this area prior to dam construction; consequently, it is unlikely that the dam represents a human-made barrier steelhead access (Edwards, pers. comm. 2002).

Figure 1.14. Canyon Meadows Dam. Looking south across dam crest. Reservoir pool is located to the left. Photo taken 11/19/2002.

Several studies have concluded that leakage is occurring mainly in the talus upstream of the south abutment of the dam (Plate 5-6.6). Unsuccessful attempts were made in 1966 and 1967 to seal the leak with a grout curtain and impermeable blanket. Additional leakage was found in 1988 upstream of the dam near the north abutment. Several requests by the ODFW and U.S. Forest Service during the 1980s and 1990s to acquire funds to evaluate repair alternatives were denied. The Corps' inspection of the dam in 1999 determined that the dam was in a non-hazardous condition and several alternatives and preliminary cost estimates were developed (Table 1.9).

Table 1.9. Alternatives identified for the Canyon Meadows Dam.

Alternative	***Estimated cost (1999)***
Removal of the dam	$180,000
Alteration and abandonment	$93,000
Repair the existing design	$98,000
Use impermeable membrane	$159,000
Use a concrete facing	$305,000
Reconstruct as a concrete dam	$305,000
Reconstruct as a lined rubble dam	$555,000

From USACE (1999)

1.6 AQUATIC SPECIES AND HABITATS

1.6.1 Defining Habitat

Habitat can be defined simply as the place where a particular organism lives and the range of physical and biological conditions the organism requires to live, grow, and reproduce (Odum 1971). The abundance and distribution of fish is largely determined by the availability and distribution of resources, in both space and time (Milinski and Parker 1991). Uneven distribution in the quality and quantity of resources results in patches of better or poorer habitat available to fish. The degree by which habitat is fragmented is directly related to the success of fish populations.

Habitat can be evaluated on multiple spatial scales. As an example, a watershed is an environment composed of smaller-scale subsystems, or stream sections, which in turn are divided into stream reaches. Each stream reach is composed of many smaller habitat components, such as riffles and pools, which individual fish use for different purposes, including feeding, spawning, and finding cover from predators (Frissell et al. 1986). Because a stream is inexorably connected with its surroundings, the role of vegetation in riparian zones is important to the maintenance and survival of fish species, because vegetation offers inputs into stream channels that provide complexity and diversity to habitat components (Kauffman et al. 2002). Rivers are continuous systems. All habitat components are connected by flowing water, water that experiences the cumulative upstream effects of human management and natural processes. These cumulative effects directly influence the physical and biological conditions of the habitat, and this ultimately may reduce, fragment, or eliminate fish habitat throughout the river continuum (Turner and Meyer 1993).

The Canyon Creek Watershed Analysis is a mid-scale analysis that is limited in scope. The federal guide to Ecosystem Analysis at the Watershed Scale states that:

> "Mid-scale analyses, at the watershed scale, provide the context for management through the description and understanding of specific ecosystem conditions and capabilities. Mid-scale analysis does not work well for all ecosystem components. Some components of ecosystems are best analyzed at larger scales (e.g., wildlife or fish populations, social interactions). Broad pattern recognition, process identification, and priorities for subsequent analysis over extended periods can be effectively completed at the river basin or sub-basin scale. Characterization and analysis of any ecosystem component needs to be done at the scale appropriate for that component. The watershed becomes an identifiable analysis unit useful for reporting the results, conclusions, and recommendations in sufficient detail to provide the context for management decisions. Regardless of the physical area selected, one analysis will draw context from larger-scale analyses and provide the context for analyses at smaller scales."

This watershed analysis presents the known distribution, in both space and time, of the habitat requirements for instream organisms, particularly salmonids, including redband (and steelhead) trout, spring Chinook, westslope cutthroat trout, and brook trout.

1.6.2 Aquatic Species

1.6.2.1 Westslope Cutthroat Trout (*Oncorhynchus clarki lewisi*).

The John Day River basin has been identified as one of six major river basins in which the interior westslope cutthroat trout reside. Three life-history forms are found in this species: resident (lives in small streams), fluvial (migrates between small streams and rivers), and adfluvial (migrates between lakes and streams). The resident form of westslope cutthroat trout is found in the Canyon Creek watershed, although historically cutthroat may have been of the fluvial form in Canyon Creek and its tributaries (Shepard et al. 2002). Spawning typically occurs between April and June when water temperatures range between 43° F and 48° F (6 to 9° C), and these fish rarely live longer than four years (Behnke 2002).

The westslope cutthroat trout differ from other fish in their relatively small size and their feeding habits. These species specialize as invertebrate feeders and consequently do not compete directly with more piscivorous (fish-eating) species like bull trout (Behnke 2002). In addition to habitat degradation, hybridization with non-native redband-rainbow trout (*Oncorynchus mykiss giardneri*) and displacement by brook trout (*Salvelinus fontinalis*) in small streams represent the common biological threats to the species.

In the Canyon Creek watershed, cutthroat are considered a genetically unaltered species illustrating greater than 99% genetic purity. Consequently, they have been identified as a core conservation population (Shepard et al. 2002).

1.6.2.2 Redband/ Steelhead Trout (*Oncorynchus mykiss giardneri*)

There has been some dispute over the distinctions between the inland Columbia Basin redband trout (*O. m. giardneri*) and the Great Basin redband trout (*O. m. newberrii*); even within subspecies, there have been biochemical differences that suggest multiple subspecies (Behnke 2002). In the Canyon Creek watershed, the redband species is considered to be Columbia Basin redband trout, although similarities exist in redband found in the Silvies (Great Basin) and John Day (Columbia Basin) River systems (Bisson and Bond 1971).

Nomenclature aside, redband trout are present in two life-history forms within the Canyon Creek watershed: resident and anadromous. The resident (redband) trout typically spawn at the age of two or three years, are relatively small in size (6 to 10 inches long), and inhabit smaller streams containing clear, cool water (Behnke 2002, Edwards, pers. comm. 2002).

In contrast, the anadromous (steelhead) form spends one to three years rearing in fresh water before smolting. Adults begin to move into Canyon Creek as early as January, with the largest influx occurring April – June (Edwards, pers. comm. 2002). Unlike other salmonids, steelhead do not necessarily die after spawning. Only 1% of steelhead survive a second cycle and successfully spawn a second time (Behnke 2002). Habitat degradation is a leading bottleneck in the successes of multiple spawning by steelhead (Behnke 2002).

Redband and steelhead are found throughout the fish-bearing streams of Canyon Creek (USFS GIS Data). Steelhead are a threatened species and protected under the Endangered Species Act of 1973, as amended. Land management activities that potentially impact steelhead can occur only upon consultation with NOAA Fisheries.

1.6.2.3 Spring Chinook Salmon (*Oncorhynchus tshawytscha*)

Chinook salmon are anadromous and semelparous (i.e., dies after spawning once). Chinook display a broad variation in life history that apparently derives from the fact that the species occur in two behavioral forms, stream-type and ocean-type. Stream-type Chinook spend one or more years as fry or parr in freshwater before migrating to sea; perform extensive offshore oceanic migrations; and return to their natal river in the spring or summer, several months prior to spawning. Occasionally, males of this form mature precociously without ever going to sea. Ocean-type Chinook migrate to sea during their first year of life, normally within three months after emergence from the spawning gravel, spend most of their ocean life in coastal waters and return to their natal river in the fall a few days or weeks before spawning. Although once considered abundant in the greater John Day sub-basin, spring Chinook salmon have not been found in the Canyon Creek watershed in recent years (Edwards, pers. comm. 2002). See *Section 1.6.3.5* for more information regarding essential fish habitat (EFH) regulation for Chinook.

1.6.2.4 Brook Trout (*Salvelinus fontinalis*)

Brook trout is the most adaptive of the char species, warm-adapted (although preferring cool water) and the least specialized of the fish species in the Canyon Creek watershed. The native range of brook trout is northeastern North America, and their introduction to the intermountain west has posed serious threats to native trout, particularly bull trout (*Salvelinus confluentus*) (Behnke 2002).

Brook trout spawn in late August through October, and as a result young brook trout are able to feed and grow for several months before redband trout are hatched. Brook trout feed opportunistically on redband and other native salmonids as part of their diet (Behnke 2002, Edwards, pers. comm. 2002).

The presence of brook trout in the Canyon Creek watershed is a concern for the fecundity of other salmonids. Their distribution was limited to the reaches of Canyon Creek above Canyon Meadows Dam until the floodgates were opened in 1997. It is now expected that brook trout inhabit Canyon Creek a few miles downstream of Canyon Meadows dam as well as the reaches above the dam (Edwards, pers. comm. 2002).

1.6.2.5 Other Species

Bull trout (*Salvelinus confluentus*), now absent from Canyon Creek watershed, were historically present (ODFW 2002). See *Chapter 3* for a discussion and review of other fish species, including sculpin (*Cotus* sp.), dace, and redside shiners, in the watershed.

1.6.3 Limiting Factors Affecting Fish Populations

1.6.3.1 Stream Temperature

In general, salmonids prefer cool water (~53° – 57° F) with a high level of dissolved oxygen. When water temperatures increase, metabolic rates may increase beyond the organism's ability to consume food, at which point energy levels are not sufficient to maintain basic metabolic functions. In addition, the quantities of dissolved oxygen decline with increasing water temperatures. These compounding processes cause stress in fish and ultimately can result in death.

1.6.3.2 Livestock Grazing of Riparian Vegetation

The composition and structure of riparian vegetation is important for instream habitat. In addition to providing prey organisms and nutrient inputs, riparian cover provides complexity to the stream channel that enhances overall habitat. Low-hanging cover such as root wads, undercut banks, and shrub cover decrease the amount of light that is incident with the stream surface, which contributes to moderating water temperatures (stream shading) and provides fish visual cover from predators and visual isolation from competitors. Visual isolation from competitors can reduce aggressive competition behavior among fish and ultimately may increase the number of fish utilizing a particular area of stream (Fausch 1993, Giannico and Heider 2002).

Livestock have historically grazed and continue to graze in both upland areas and in the riparian zones of Canyon Creek watershed. Livestock directly affect stream channel parameters like width/depth ratios and bank angles. To illustrate how grazing alters fish habitat, a multidisciplinary team of leading researchers recently evaluated the effects of livestock grazing on the riparian vegetation, stream geomorphic features, and fish populations in Northeast Oregon streams (Kauffman et al. 2002). In grazing exclosures, the species composition of the riparian vegetation favored larger shrubs that were more interactive with the stream channel. Stream channels in exclosed reaches were generally narrower, deeper, and had more pool habitat than those in grazed reaches. Juvenile redband trout responses reflected these habitat improvements; densities of "young of the year" redband were significantly greater in exclosed reaches as compared with grazed reaches. As a further positive indicator of quality salmonid habitat, the presence of warm-water fishes such as redside shiners (*Richardsonius balteatus)* and speckled dace (*Rhinichthys cataractae)* was significantly lower in the exclosed reaches (Kauffman et al. 2002). The clear effects of grazing on habitat quality and fish distribution underscore the interconnectivity between riparian zones and fish habitat in the Blue Mountains.

1.6.3.3 Sedimentation and Spawning Gravels

Sediment delivered to streams provides crucial spawning habitat for salmonid species (Table 1.10). Sediment is varied in size but falls into two broad categories: coarse and fine material. The sorting and depositional patterns of these sediments determine the quality of salmonid spawning habitat. Sources of natural sediment loading include stream bank erosion, inner gorge slides, soil erosion from exposed soils, and biological activity (tree fall, burrowing, etc.).

Sediment loading increases when the quantity of soil becomes exposed to direct rainfall. Sediment sources that dramatically increase loading rates include roads, exposed cut banks, and soils exposed through vegetation removal by activities such as logging and livestock grazing. Usually, sediment derived from these land-use practices produce fine grain material. Due to its small size, fine-grain material may enter a headwater stream and travel miles in the water column before settling to the channel bottom. Stable river channels with a diversity of instream structures, such as large wood debris, and riparian vegetation distribute fine-grained sediments, and do not degrade the quality or quantity of spawning habitat. In contrast, unstable channels with degraded habitat (reduced quantities of large wood, uniform channel structure, denuded riparian vegetation) further degrade when increased fine loading occurs (Rosgen 1996).

To illustrate by example, a stream channel containing a diverse assemblage of large wood creates critical storage areas for fine grain sediment and minimizes the effects of depositional fines onto important spawning gravels (Bisson et al. 1987). If an insufficient quantity of large wood exists, there is no buffer for erratic and catastrophic deposition within the stream channel other than the stream substrate. Direct deposition of fines onto spawning gravels results in gravels becoming embedded; these cemented gravels do not function for successful spawning and invertebrate habitat because of the lack of circulating oxygen (Hunter 1991).

Furthermore, when pools, backwaters, and channel edges fill with sediment, stream aggradation results. After the pools and backwaters of a stream fill with fines, the fines move into the riffles where more gravels are replaced and can result in an overall smoothing effect of the channel and a further loss of channel diversity and quality fish habitat.

Table 1.10. Minimum area and substrate diameter range for spawning redds for salmonids found within the Canyon Creek Watershed, Oregon.

Salmonid species	***Minimum area (yd^2)***	***Substrate diameter range (in.)***
Steelhead	1.7	0.5 – 4
Redband	0.22	0.19 – 2*
Chinook	1.7	0.5 – 4
Cutthroat	0.22	0.19 – 2*
Brook	0.22	0.19 – 2*

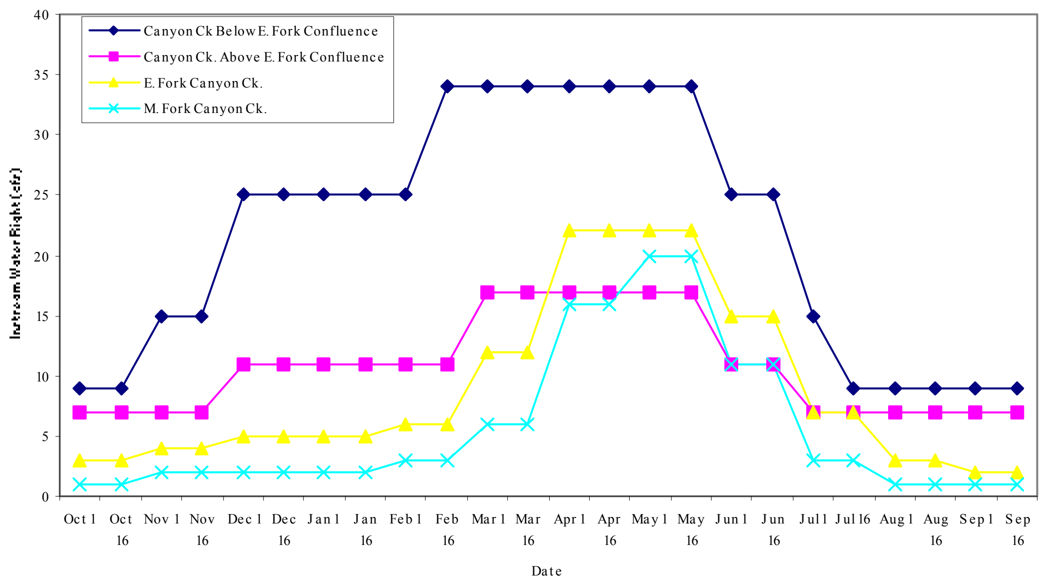
(Bjorn and Reiser 1991).

**Most individuals use the lower end of the spectrum.*

1.6.3.4 Water Rights and Instream Flow

The overwhelming majority and priority of adjudicated water rights are for the use of irrigation. (See *Water Rights* section of this chapter.) Four stream reaches in the Canyon Creek watershed have instream water rights for the purposes of supporting aquatic life and minimizing pollution and for anadromous and resident fish rearing (Figure 1.15) (OWRD 2001a). Although water rights within the Canyon Creek watershed date as early as 1864, water rights with the purpose of maintaining instream flows for aquatic habitat date to 1983; the majority of the water rights for juvenile fish rearing (nursery habitat) date as recently as 1990. Consequently, any water rights that pre-date 1990 have a priority use of water over the needs of rearing fish.

In general, the instream water rights for fish peak between March and April and drop in mid-June (Figure 1.15). Although instantaneous flows may not be available as specified by the water rights, the intent of maintaining an instream water right is to provide higher flows in summer months in order to provide several benefits to rearing fish. One such benefit is that higher flows means water takes less time to travel through a stream, which results in cooler water farther downstream. Another benefit of higher flows is that the volume of water in a stream is increased. Higher water volumes mean more of the stream channel is available as potential fish habitat. With more habitat available, "young of the year" salmonids can use more low stream-energy fringe habitat associated with the stream channel and transfer more of their metabolic energy into growth rather than maintaining position in the water column (Shirvell and Dungey 1983). Higher flows are also important for spawning in terms of increasing the connectivity of spawning habitats.



(OWRD 2001a). Water rights that pre-date the aforementioned have priority use on instream water. A more detailed description of the water rights within the Canyon Creek watershed are presented in the Hydrology section of this chapter.

Figure 1.15. The instream water rights allocated to juvenile fish rearing (priority date: 1990) and supporting aquatic life and minimizing pollution (priority date: 1983).

1.6.3.5 Managed Species

Within the Canyon Creek watershed, the Malheur National Forest Land and Resource Management Plan (LRMP) lists steelhead as "threatened" and resident redband and cutthroat trout as "sensitive" species. Juvenile spring Chinook swim up from the John Day River to rear in Canyon Creek and occasional spawning has been reported. Canyon Creek and its fish-bearing tributaries are currently managed for spring Chinook essential fish habitat (EFH) by the Oregon Department of State Lands. Although the EFH is not a State mandate, and Chinook are a sensitive species, the Pacific Fisheries Management Council designated Chinook salmon to be managed under Public Law 104-267, the Sustainable Fisheries Act of 1996. This amended the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act). Section 305(b) of the Magnuson-Stevens Act (16 U.S.C. 1855(b)) for Essential Fish Habitat (EFH) is described as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity in order to support a long-term sustainable fishery (Magnuson-Stevens Act, Section 3). This law requires Federal agencies to consult with NOAA Fisheries on management activities that may adversely affect EFH.

1.7 VEGETATION

1.7.1 Introduction

A total of 59,578 acres of National Forest System (NFS) lands was considered in the vegetation analysis of the 73,954-acre Canyon Creek watershed (henceforth known as the "analysis area"). The remaining 14,346 acres under non-federal management were not considered in the quantitative analysis because no current or complete data were available. It is recognized that this analysis has a bias toward federal land, which is a limitation in an ecosystem analysis at the watershed scale. This analysis addresses the vegetation within only ~81% of the entire watershed, most of which is located at higher elevations and is more isolated from direct, high-frequency and high-intensity human uses including urban areas, rural housing, agriculture, and livestock grazing. As a result, it is stressed that, while this analysis offers an in-depth examination of the composition, structure, and functioning of the vegetation in the Canyon Creek watershed, the vegetation outside the NFS lands and within areas that are important to aquatic, terrestrial, and cultural resources will be inadequately represented.

This watershed analysis utilized data collected from recent (2001) aerial photographs. Aerial photographs (1:12,000 scale) were interpreted using mirror stereoscopes; vegetation attributes including tree size and species, forest layers, canopy cover, and shrub species were collected according to the Blue Mountain Mapping Standards (2002) (Duck Creek Associates, Inc. *in prep.*). The vegetation analysis of current conditions presented in this section utilized the raw photo-interpreted data (PI data) to determine stand composition and structural class (Powell 2001, Uebler et al., pers. comm. 2003, Duck Creek Associates, Inc. *in prep*.).

The objectives of this watershed analysis are to describe the long-term patterns and trends of the vegetation within the watershed, with quantitative focus on the 59,578-acre analysis area.

1.7.2 Management Practices Defining the Watershed

Not unlike other watersheds in the Blue Mountains, the Canyon Creek watershed has been subject to a history of land-use practices since the 1850's. Practices including beaver trapping, mining, timber harvest, fire suppression, and fire exclusion have altered how the landscape has functioned in a variety of confounding ways. The removal of beaver and gold mining has altered the structure and complexity of stream habitat; timber harvest and the exclusion of fire have changed the way forests are structured, and how they respond to natural disturbances. The combined effects of timber harvest and fire exclusion have altered the vegetation composition and structure of the landscape the most profoundly. Removal of large-diameter overstory trees has promoted dense understory growth (overstocking) and has resulted in slow growth and poor vigor where post-harvest thinning has not occurred. Overstocking and growth stagnation render higher incidence of mortality due to bark beetles, defoliating insects, diseases such as dwarf mistletoe, and root rots (Cochran and Barrett 1998). Fire exclusion complicates this condition, especially in ponderosa pine forest types, as many ecosystem functions and attributes are changed with the removal of such a keystone disturbance process, including abundances and responses to insects and disease, landscape-level behavior of wildland fires, animal-plant interactions, nutrient cycling, productivity, and biodiversity (Keane et al. 2002). Many effects of fire exclusion are noticeable, including elevated levels of insects and disease, higher conifer densities in shrublands and grasslands, and dense understories of "shade-tolerant" species in otherwise open forests.

1.7.3 Fire as a Disturbance Process

Natural and human disturbances are important processes that shape the structure and composition of the Canyon Creek watershed. Natural disturbances include fire, insects and diseases, winds, and ice storms. In addition, floods and ice floes are important disturbances in riparian and stream ecosystems. Historic and current anthropogenic disturbances include livestock grazing, logging, mining, and roads. The exclusion of fire as a management practice is an anthropogenic disturbance that has had dramatic influences on natural disturbances that contribute to watershed structure and functioning.

Historically, fire has been the most widespread disturbance in the Canyon Creek watershed. Evidence of past fires can be found in uplands and riparian zones throughout the watershed. However, wildland fires are not a uniform influence; the nature of fire is quite variable in the Canyon Creek watershed because of the interactive effects of differences in elevation, climate, aspect, and parent materials.

1.7.4 The Fire Regime

The fire regime is defined as the regular pattern and occurrence of fire in a given ecosystem (Brown et al. 2001). Agee (1993) described fire regimes as a gradient of low, moderate and high severity fire regimes. Frequent, low intensity surface fires with a return interval of five to 25 years characterize low severity fire regimes. Fuel accumulations rates (litter, grasses and other fine fuels) are quite high in this fire regime.

Low intensity regimes are generally found at lower elevations where, for the majority of the fire season, fuel moisture contents are below the moisture of extinction (i.e., a level where moisture contents are low enough to sustain the spread of wildfire). Ponderosa pine forests typify this fire regime in the Canyon Creek watershed. Fire exclusion, logging and livestock grazing have interacted to create dramatic alterations in fuel loads and fuels structure (Arno et al. 1997). Fire exclusion has resulted in increased fuel loads in both second-growth and old growth forests. With a probable historic fire-return interval of five to 15 years, as many as 10 fire cycles have been eliminated from this ecosystem. As the biota is adapted to frequent fires, this has important influences on biodiversity as well as fuel buildups and wildland fire hazards.

Moderate severity fires are those with an intermediate return interval (35 to 75 years) and a variable fire severity. Fires in this fire regime are often characterized as low severity surface fires. Occasionally, long-return interval fire results in a complete stand replacement. Typically, wildland fires in this regime are largely understory fires except when local fire weather and fuels interact to create periods of high severity (stand-replacing fires). Douglas-fir and mixed conifer forests typify this fire regime in the Blue Mountains of Oregon.

At the higher elevations of the Strawberry Mountains, the cool/moist lodgepole pine and subalpine forests persist under a high severity fire regime. This is a fire regime typified by a long-return interval (100 to 125 years) and result in severe, stand-replacing fires. In the highest elevation forests, annual fuel accumulation rates are low and climatic conditions are such that fuel moisture contents remain above the moisture of extinction for much of the fire season. Fires may also be limiting by fuel breaks associated with ridgelines, bare rock, snow fields, and wet meadows.

1.7.5 Fire and Vegetation Structure

Forest structure and composition has a pronounced influence on wildland fire (Kauffman 1990). In low severity regimes, historic forest composition has been characterized as an uneven-aged mosaic of even-aged stands. The frequent surface fires maintained low levels of fuels and a wide separation between surface and canopy fuels (aerial fuels). Fire exclusion has resulted in an increase in surface fuels (litter, duff, downed wood). Fuel arrangement or structure has also been altered. The combined effects of timber harvest and fire exclusion have resulted in the formation of a conifer mid-story often of "shade tolerant/ fire intolerant species," such as grand fir. This mid-story functions as a source of "ladder fuels" where fire continuity is bridged between the understory and the canopy fuels. In this scenario, the fire regime has been altered from frequent low intensity surface fires to long return interval severe, stand-replacing fires. The intensity of timber harvest and degrees of overstocking as a result of timber harvest have pronounced effects on the continuity of fire in this fire regime.

Moderate severity fire regimes have a diverse composition and structure as a response to variable fire effects. Areas of recent under-burns can be typified as forests with multiple strata of trees that established following past fire events. In other sites, the structure may be even-aged where the previous fire was severe and stand replacing. Havlina (1995) described composition and structure of forests in moderate severity regimes of the Payette National Forest. In these ecosystems, the effects of fire exclusion are less pronounced. It is likely that fire exclusion has resulted in fuel accumulations as well as increases in mid-story conifer density. Yet the magnitude of alteration since Euro-American establishment is less pronounced than forests of low severity fire regimes. Forests in the mixed severity fire regimes are often the most diverse of any forest type. Douglas-fir is frequently the dominant species. Grand fir and lodgepole pine are also common. Ponderosa pine, western larch, subalpine fir and Engelmann spruce can be locally abundant.

High severity fire regimes have a forest composition of even-aged trees often in a single stratum. As the majority of the areas burned in these long-return interval fires are stand replacing, forest regeneration is often of one to three conifer species that establish in the first post-fire decade. Species most abundant in this fire regime include subalpine fir, Engelmann spruce, and lodgepole pine.

This watershed analysis describes the vegetation within the Canyon Creek watershed in the context of current and potential fire regimes, presents changes in live fuels conditions, or those conditions where forest structure and composition has diverged from their historic range, and provides conservative estimates as to the increase of uncharacteristically severe wildland fires at two spatial scales: the watershed scale, and the scale of the wildland/urban interface (WUI).

1.7.6 Wildland/Urban Interface (WUI)

The wildland/urban interface (WUI) (sometimes referred to as the "wildland intermix") is the line, area, or zone where human structures, activities and other developments meet or intermingle with forests, rangelands and other natural wildland areas. These areas are of particular management concern because human lives and economic investments in rural and urban areas are susceptible to wildland fires originating from adjacent forests and rangelands. In addition, the increased presence of human activities in the WUI is potential ignition sources that increase the probability of fire starts in this zone. In the Canyon Creek watershed, there is a sizable WUI under federal and non-federal management, primarily in lower elevations.

For the Canyon Creek watershed, the WUI has been defined to be the area extending ~1.5 miles from private property boundaries. For purposes of this watershed analysis, the WUI is defined as the area that intersects with NFS lands defined as the analysis area, or approximately 34,460 acres.

1.7.7 Summary

In this watershed analysis, the changes in the structure, composition, and functioning of forest and non-forest lands within NFS lands of the Canyon Creek watershed (the "analysis area") are quantified. The most recent data available were obtained from 2001 aerial photographs to describe the following:

- Plant species composition at the levels of potential vegetation groups (PVGs) and plant association groups (PAGs)
- Forest structure that describe the stages of stand development
- Historic fire regimes that describe the frequency and severity of fire
- Live Fuels Condition Classes that describe the degree of divergence in stand structure and composition from historic fire regimes
- Changes in expected fire severity from historic conditions resulting from live fuels conditions
- Landscape-level effects of fire exclusion and management on the composition, structure, and functioning of stands in the watershed

1.8 TERRESTRIAL SPECIES AND HABITAT

The Canyon Creek watershed contains habitat for a wide variety of terrestrial species. These habitats have been altered from historic conditions by both human and natural processes. The majority of the watershed is within upland environments. Although comprising only four percent of the watershed, riparian areas provide important habitats for many species including osprey (*Pandion haliactus*), neotropical migratory birds, beavers, and amphibians. Most of the upland forest is in warm/dry plant associations. The upland forests may provide habitat for upland game birds, such as blue and rough grouse (*Dendragapus obscurus* and *Bonasa umbellus*), along with a wide variety of raptors including red-tailed hawk (*Buteo jamaicensis*), sharp-shinned hawk (*Accipiter striatus*), Coopers hawk (*Accipiter copperii*), northern goshawk (*Accipiter gentilis*), American kestrel (*Falco sparverius*), flammulated owls (*Otus flammeolus*), and great horned owls (*Bubo virginianus*). Meadow and sagebrush habitat is limited (5%) within the watershed. The largest riparian meadow is behind Canyon Meadows Dam, which may provide habitat for amphibians and waterfowl during seasonal inundation.

More common wildlife species that may occur in the watershed include: mule deer (*Odocoileus hemionus*), Rocky Mountain elk (*Cervus elaphus*), coyote (*Canis latrans*), raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), porcupine (*Erethizon dorsatum*), snowshoe hare (*Lepus americanus*), bats, chipmunks, pocket gophers, shrews, and other rodents. These species can be found in a variety of stand structures in all the biophysical environments. While it is more likely to see the aforementioned species in a typical visit to the watershed, sightings of black bear (*Ursus americanus*) and cougar *(Felis concolor*) are not uncommon. Wolverine (*Gulo gulo luteus*) is a less common species in the watershed.

There are three federally threatened species (gray wolf *[Canis lupus]*, bald eagle *[Haliacetus leucocephalus]* and Canada lynx *[Lynx canadensis]*) and 11 sensitive species that may occur in the watershed. These species and their habitat requirements are described in Table 1.11. The gray wolf is considered extirpated from Oregon but several confirmed sightings have occurred in the Blue Mountains as relocated wolves from Idaho have dispersed into Oregon. There have been no sightings of wolves or lynx in the watershed. There are no known bald eagle nesting or winter roosting areas in the watershed. The occurrence and distribution of these species will be discussed further in *Chapter 3*.

Table 1.11. Proposed, Endangered, Threatened and Sensitive Terrestrial Wildlife Species.

Species	Status	Habitat requirements
Gray wolf *Canis lupus*	Threatened	Use a wide variety of forest, woodland, and rangeland habitats
Bald eagle *Haliacetus leucocephalus*	Threatened	Associated with lakes and rivers. Nest in coniferous, uneven-aged stands with old-growth component
Canada lynx *Lynx canadensis*	Threatened	Subalpine fir, moist grand fir, and Douglas fir forest with lodgepole pine component in a mosaic of seral stages.
California wolverine *Gulo gulo luteus*	Forest Sensitive	High elevation mixed coniferous forest with shale or rock slide areas
Pacific fisher *Martes pennanti pacifica*	Forest Sensitive	Mature multi-storied mixed conifer stands with closed canopy
Pygmy rabbit *Brachylagus idahoensis*	Forest Sensitive	Great Basin sagebrush associations with deep, friable soils.
Bufflehead *Bucephala albeola*	Forest Sensitive	Nests near mountain lakes surrounded by open woodlands containing snags. Aspen-preferred nest tree, but will nest in ponderosa pine and Douglas fir
American peregrine falcon *Falco peregrinus anatum*	Forest Sensitive	Nest on cliff ledges
Western sage grouse *Centrocercus urophasianus*	Forest Sensitive	Associated with big sagebrush
Upland sandpiper *Bartramia longicauda*	Forest Sensitive	Prefers short grass prairies with long sight distances. Prefers short grass areas for feeding and courtship and tall grasses for nesting and brood cover.
Gray flycatcher *Empidonax wrightii*	Forest Sensitive	Associated with open big sagebrush, bitterbrush or mountain mahogany, also found in open ponderosa pine, lodgepole pine or western juniper with sagebrush understory. Usually found below 6,000 feet.
Tricolored blackbird *Agelaius tricolor*	Forest Sensitive	Nests in freshwater marshes with emergent vegetation or in thickets of willows or other shrubs.
Bobolink *Dolichonyx oryzivorus*	Forest Sensitive	Nest in open prairies, grasslands, wet meadows and pastures.
Columbia spotted frog *Rana luteiventris*	Forest Sensitive	Found near cool, permanent quiet waters such as ponds, springs, marshes and slow moving streams.

The Malheur National Forest has identified two mammals and ten birds as Management Indicator Species (MIS). Forest-wide standards and guidelines developed in the LRMP to ensure that suitable habitat will be provided for these species within the Malheur National Forest as a whole. Management activities implemented through project development are designed to provide and maintain habitat for these species. While all of the MIS may not occur in the watershed, habitat requirements for all the species are discussed in Table 1.12. The occurrence and distribution of these species will be discussed in *Chapter 3*.

Table 1.12. Management Indicator Species for the Canyon Creek watershed.

Species	***Habitat requirements***
Rocky Mountain elk *Cervus elaphus*	Uses a variety of habitats. Thermal cover requires multi-strata stand structure with a canopy closure greater than 40 percent.
Pileated woodpecker *Dryocopus pileatus*	Mature or old growth forest with high canopy closure. Nest in snags >20" diameter at breast height (dbh).
Pine marten *Martes americana*	Mature or old growth mixed conifer forests with sufficient down logs.
Three-toed woodpecker *Picoides tridactylus*	Lodgepole pine forests, prefers areas with high snag densities. Nests in pole-sized snags.
Lewis' woodpecker *Melanerpes lewis*	Ponderosa pine forest with open areas for foraging. Nests in very soft snags or secondary cavity nester in snags > 15" dbh.
Red-naped sapsucker *Sphyrapicus nuchalis*	Inhabits a variety of coniferous or riparian forest with aspen.
Willamson's sapsucker *Sphyrapicus thyrodeus*	Uses open ponderosa pine to mixed conifer forest. Nests in hard snags > 20" dbh.
Downy woodpecker *Picoides pubescens*	Associated with deciduous forest but will use coniferous forest. Nest in soft snags (10 to 12" dbh).
Hairy woodpecker *Piocides villosus*	Uses a variety of habitats; prefers open forests. Nests in snags > 10" dbh.
White-headed woodpecker *Piocides albolarvatus*	Open, mature ponderosa pine or ponderosa pine mixed conifer forests. Nests in ponderosa pine snags (> 20" dbh) with moderate to extensive decay.
Black-backed woodpecker *Picoides arcticus*	Large scale disturbance areas such as fire or windthrow or mature or old growth stands. Nests in hard snags average 12" dbh.
Northern flicker *Colaptes auratus*	Uses a variety of habitats prefer open forests. Nests in soft snags > 15" dbh.

The LRMP identifies featured species in which management activities will be conducted to promote and enhance habitat. These species are discussed in Table 1.13. Of these featured species, osprey, bighorn sheep, and blue grouse are known to occur in the watershed. Due to limited habitat, upland sandpiper, sage grouse, and pronghorn are unlikely to occur in the watershed. Species habitat requirements and distribution will be discussed further in *Chapter 3*. Two "species of interest" will also be discussed in *Chapters 3 and 4*. These species of high interest to the public but are not classified as threatened, endangered or sensitive, MIS, or featured species. These species include neotropical migratory landbirds and the northern goshawk (*Accipter gentilis*).

Table 1.13. LRMP Featured Species.

Species	***Habitat requirements***
Osprey *(Pandion haliaetus)*	Nests in large snags or artificial platforms near lakes and rivers with fish populations.
Bighorn sheep *(Ovis canadensis)*	Reintroduced populations occurring in the high mountain meadows and steep canyons of eastern Oregon.
Upland sandpiper *(Bartramia longicauda)*	Nests in partly flooded meadows aand grasslands, usually with a tree fringe in the middle of higher elevation sagebrush communities.
Sage grouse *(Centrocercus urophasianus)*	Known to occur only in areas dominated by big sagebrush. Perfers big sagebrush cover at 15% to 50% of the ground. Requires open areas for courtship display.
Blue grouse *(Dendragapus obscurus)*	Year-around resident that nests in Douglas-fir or true fir dominated stands. Within these stands the grouse will seek out thickets of deciduous trees and shrubs.
Pronghorn *(Antilocapra americana)*	Occuring in grasslands, sagebrush flats, and shadscale-covered valleys. Low sagebrush is a important habitat component.

1.9 HUMAN USES

The Canyon Creek watershed has experienced human use for well over 10,000 years. At the time of historical contact, the principal occupants of the region were the Northern Paiute, who wintered near what is now Canyon City and Prairie City (Stewart 1939). The Umatilla, Tenino, Cayuse, Walla Walla, and Nez Perce also periodically used the area (Stewart 1939).

The introduction of Euro-Americans occurred in the mid 1820s as fur trappers and explorers moved through the region. The discovery of gold near Canyon City in 1862 brought a heavy influx of miners and settlers to the John Day basin during the 1860s. Subsequent historic activities in the watershed included homesteading, ranching, railroad logging, and early USFS administration.

Evidence of these activities is in the form of archaeological sites that have been documented in the watershed. These properties include sites that have been evaluated as eligible for the National Register of Historic Places (NRHP) or potentially eligible (and require further evaluation for conclusive determination).

Over one hundred years of land and resource use in the analysis area, in the form of placer mining for gold, railroad logging, grazing of large herds of sheep and cattle, and fire exclusion policy has altered the character of the analysis area. In more recent decades, timber management, camping, hiking, fishing, hunting, antler and mushroom gathering, firewood and other wood products, collecting, grazing, and permitted special uses have steadily risen as public interest in them increases.

The first Euro-American foray into the John Day region was made in 1826 by a Hudson's Bay Company fur trapper named Peter Skene Ogden (Davies 1961). Settlement did not occur until 1862, when gold was discovered, attracting many people into the region to mine the land. As placer mines production slowed in the 1870s, a transition from mining to agriculture and livestock raising began.

Cattle, horses, and sheep were the primary livestock that grazed in the watershed. As grazing increased and logging operations began in the region, the government became concerned about the nation's natural resources and proposed the development of a forest reserve. In 1906, the Blue Mountain Reserve was established to protect forests and streams from uncontrolled destruction by logging, grazing, and fire. This area was further divided on June 13, 1908, with the creation of the Malheur National Forest.

1.9.1 Current Uses

Current uses in the watershed are associated with grazing, timber management, and recreational activities. Issues related to these activities concern water rights, special uses, and treaty rights.

Currently, livestock grazing is dominated by cattle, which graze in all the lower subwatersheds. Wild horses, deer, antelope, and elk, as well as livestock, graze in the watershed. However, no specific data have been made available for this analysis.

Recreational activities in the watershed include fishing, hunting, in particular bow hunting, hiking, camping, and sightseeing. Snowmobiling and cross-country skiing are winter activities, while mushroom collecting and all terrain vehicle (ATV) use occurs from spring to fall. The heaviest visitor use in the watershed occurs along riparian corridors during the hunting months of August through November.

The United States has a treaty with the Walla Walla, Cayuse, and Umatilla Tribes, and a treaty with the Tribes of Middle Oregon, dated June 1855. These treaty rights are held by the Confederated Tribes of the Warm Springs Reservation and the Confederated Tribes of the Umatilla Reservation. Both treaties state that these tribes have the right to take fish in the streams that run through and border their reservations. They also have the right to hunt, gather roots and berries, and pasture their stock on unclaimed land. The United States Forest Service recognizes the tribal sovereignty of the Burns Paiute Tribe. The Canyon Creek watershed is within the Tribe’s area of interest. This analysis establishes a watershed context for early identification of issues covered by treaty rights, resources protected by treaty, and other tribal concerns. The results of this analysis will assist the Forest Service in complying with policies and laws relating to tribal trust resources. This analysis identifies tribal trust resources that occur in the watershed (e.g., see *Culturally Important Plants* sections throughout this document).

1.9.2 History of the Analysis Area

1.9.2.1 Logging

Past logging techniques, in addition to fire exclusion, have added to the change in vegetative composition in terms of tree species mix and stand density. These changes from past actions have changed structural stages and age classes as well. This has had an effect across the landscape of reducing fire resistant trees and allowing more fire intolerant trees to proliferate across the landscape. This changed composition, which exists across the analysis area has also created a condition where forest stands, which were once fire-adapted forests, now have become overstocked stands that are less resistant to insect infestation, disease infection, and uncharacteristically severe wildfire. Consequently, change in other vegetation components in competition for nutrients and sunlight has reduced growth of native shrubs and grasses because denser forest stands now dominate the landscape. (See *Vegetation* sections in subsequent chapters.)

1.9.2.2 Recreation Use

Recreation use in the watershed consists primarily of dispersed activities of viewing scenery, viewing wildlife, hiking, and hunting. Other year-round activities such as snowmobiling, cross-country skiing, ATV use, dispersed camping, and horn hunting are also popular pursuits. Hunting big game animals (deer and elk) and fishing are also popular activities in the watershed. Recreation places are easily accessed by combination of roads and trails to the analysis area. Dispersed camping occurs in several areas along streams within riparian areas.

Use data on the level of recreation participation and experience levels is not available for the analysis area. Information on regional trends in the Columbia River Basin indicates that hunting, day use, camping, motor viewing and fishing are primary uses of the area (Haynes and Horne 1997). Residents of Oregon, Idaho, and Washington primarily seek these recreation opportunities. The analysis area provides a supply of primarily undeveloped roaded natural and semi-primitive motorized recreation settings and experiences. Big-game hunting use will remain stable, but dependant upon Oregon Department of Fish and Wildlife controlled hunt regulations (the number of tags given out may fluctuate from year to year) and fishing use will slightly increase. Other activities such as horn hunting and mushroom collection for personal use will remain the same.

1.9.2.3 Nontimber Forest Products

Nontimber forest products include five broad categories: wild food plants such as mushrooms, fruits, nuts and berries; medicinal plants and fungi; floral greenery and horticultural stocks; plants, lichens and fungi used for fiber and dyes; and other chemical plant extracts such as oils and resins. Woody materials such as firewood, post and poles, boughs are also commonly used nontimber forest products (Weigand et al. 1999).

Commercial uses of these special forest or nontimber products is a small but growing industry in the Pacific Northwest and has been expanding from the Cascade Range to the eastside. Primary products include floral greenery, Christmas ornamentals, wild edible mushrooms, and other edibles (Schlosser and Blatner 1994). Recreational collection of wild edible mushrooms such as morels and chanterelles has developed into a major commercial industry. Collection of animal horns (shed antlers) is also a use as local people comb the landscape for shed antlers that are sold to markets for a variety of products.

Although data are limited, wild edible mushroom harvesting generates seasonal employment. Numbers and duration of employment depend on conditions that are favorable to mushroom reproduction such as fires, but the industry continues to draw pickers, wholesalers, and processors. Conflicts between causal collectors and commercial mushroom pickers have occurred in the past and are likely to continue in the future. Some environmental effects have been reported due to heavy concentrations of pickers living in dispersed campsites on the Malheur National Forest (Volk 1991).

Collection of other non-timber forest products in the analysis area includes firewood gathering by residents of Grant and Malheur counties, huckleberry picking, and post and poles harvesting. Many firewood gatherers depend on firewood to supplement or provide for subsistence needs for heating materials in the winter. Some users collect firewood either commercially or on a volunteer basis for seniors living in the area and as far away as Ontario.

1.9.2.4 Special Use Permits and Claims

Road decommissioning reduces access and may reduce these permitted uses. Special uses permitted in the analysis area besides uses associated with non-timber forest products include livestock grazing, electronic towers, power lines and other related facilities. Water rights and mining claims also occur in the analysis area. There has been interest by members of the public in obtaining outfitting and guiding permits in the general area although none are currently permitted.

1.9.2.5 Livestock Grazing

Site-specific data pertaining to the watershed was not available for this analysis that would describe the intensity and magnitude of livestock grazing. In general, livestock grazing is the most widespread land-use in the intermountain west and the presence of livestock grazing in the Canyon Creek watershed can be readily observed in both upland and riparian zones. As an anthropogenic disturbance, studies have shown livestock grazing has been attributed to significant changes in the structure, composition, and diversity of ecosystems, particularly in riparian zones. Further discussion of the effects of livestock grazing on ecosystem structure and functioning can be found throughout this document.

1.9.2.6 Mining Claims

Today, minimal activity occurs although the watershed has the highest level of activity on the Forest. Mining landscape features such as placer tailings, waste rock piles, hydraulic ditch systems, prospect holes, audits, and shafts, are common throughout most of the subwatersheds in the analysis area. Mining related properties, such as cabins, flumes, and mills or other ore processing localities are also commonplace, particularly near historic claims. There is at least one vertical mine shaft, and several mine adits that are currently open. There are some old ore processing facilities on private land within the watershed. It is unknown if there are chemicals leaching from these and other mine tailings.

2 ISSUES AND KEY QUESTIONS

2.1 ISSUE 1 - WILDLAND FIRE AND FUELS: CURRENT AND HISTORIC CONDITION AND POTENTIAL TRENDS

Past management activities, which includes timber harvest, the suppression and exclusion of fire, livestock grazing, and road construction, have altered ignition sources as well as the composition and structure of fuel loads in the watershed. Total fuel loads, as well as the horizontal and vertical continuity of fuels, have increased, which has resulted in a change in fire intensity and severity. The potential for widespread, severe, stand-replacing fires has increased in forested stands where low intensity surface fires were predominant prior to Euro-American settlement.

Key Question 1 – What are the landscape level patterns and trends of fuel loads within the watershed and how have these patterns changed through time?

Fuel Loads: Dead and downed wood, live fuels.

Fuel Continuity: Fuel vertical continuity – the presence of ladder fuels (midstory), horizontal continuity throughout the watershed, natural fuel breaks (ridgelines, rock outcrops, riparian zones).

Key question 2 – What have been the causes of landscape-level changes in fuel loads and continuity in the watershed?

Forest Dynamics and Disturbance Regimes: Changes in fire history, insect and disease outbreaks, and the resulting changes in fuel loads.

Management and Anthropogenic Disturbances: Fire exclusion/suppression; timber harvesting and livestock grazing and their effects on fuel loads and fire breaks; roads and their possible impacts as fuel breaks, points of fire suppression, and as an ignition source.

Key Question 3 – How have historic management practices altered the frequency, severity, magnitude, ignition source of wildland fires (the fire regime) within the watershed?

Historic Fire Regimes: Frequency, size, and magnitude of fires prior to Euro-American settlement within the watershed.

Fire Potential: Changes in fuel models and the potential changes in fire behavior under current scenarios.

2.2 ISSUE 2 – VEGETATION: CURRENT AND HISTORIC CONDITIONS AND POTENTIAL TRENDS

Past management activities including the suppression and exclusion of fire have altered the composition, structure, and functioning of the upland vegetation within the watershed. Activities such as timber harvesting, mining, and livestock grazing have also contributed to changes in vegetation structure and composition in both upland and riparian zones.

Key Question 1: What are the landscape-level patterns and trends for plant communities within the watershed, and how have these patterns changed through time?

Vegetation Composition and Structure: Canopy cover, forest layers (including shrubs and forbs), size classes, and species composition.

Distribution of Indicator Species: Sensitive plant species, aspen stands, non-native and noxious weeds, insects, and culturally important species.

Key Question 2: What has been the source of the landscape-scale changes in vegetation pattern throughout the watershed?

Forest Dynamics and Natural Disturbance Regimes: Fire history, disease, and the resulting changes in vegetation succession; species composition, forest structure and ecosystem health.

Management and Anthropogenic Disturbances: Fire exclusion, livestock grazing, timber harvest, mining, roads, recreation, and development.

Key Question 3: How have historic management practices altered the frequency, severity, magnitude, and distribution of landscape-scale natural disturbances within the watershed?

Fire, Insects, and Disease History: Frequency, distribution, pattern, and magnitude throughout the watershed.

Fire Potential: Expected current and future fire patterns based fuel model analysis from current vegetation data (PI data).

Grazing History: Current vegetation pattern and condition of upland and riparian zones and how pattern and condition relate to livestock grazing.

2.3 ISSUE 3 - AQUATIC SPECIES AND HABITAT

A long history of mining, agricultural practices, livestock grazing, timber harvest, road building, human uses, and fire exclusion have altered the natural disturbance regime and connectivity between upland and riparian zones; in-stream disturbance has contributed to the decay of quality in-stream habitat for threatened and endangered species. The changing landscape patterns attributed to past and current management activities affect both the physical and biological processes throughout the aquatic ecosystems within the watershed.

Key Question 1: What are the long-term patterns and trends of the riparian and aquatic ecosystems within the watershed, and what factors are limiting to the success of aquatic species?

Upland-to-Riparian Floodplain Connectivity: Juniper encroachment into upland stands limiting water quantities into stream; historic and current ecological status and trends for riparian vegetation; conifer encroachment into meadows and distribution and abundance of aspen stands; historic and current inputs from riparian vegetation affecting macroinvertebrate populations.

Climatic Conditions: Monthly and annual precipitation and temperature by sub-watershed; past and predicted snow pack dynamics; climatic conditions influence on watershed hydrology.

In-stream Habitat Requirements: Fish passage and road (culvert) conditions; sediment loading from eroding banks; stream shading; frequency of large, deep pools (greater than 3 feet deep); frequency and distribution of Coarse Wood Debris (CWD) and potential recruitment of CWD into streams; availability of suitable spawning and rearing habitat (summer and winter).

Stream Channel Characteristics: Channel morphology; bank stability; channel types; width/depth ratios; habitat connectivity (road crossing barriers, subsurface flows, etc.).

Water Quality Parameters: Temporal and spatial water temperatures, historic and current summertime water temperature patterns within the watershed, land management effect on summertime water temperatures.

Water Quantity Parameters: Mechanisms that produce peak flows; water table changes due to a loss of bank and wetland storage; frequency and magnitude of peak flows; past peak flow magnitudes affected by changes in vegetation patterns due to fuels reduction activities, past peak flow magnitudes affected by changes in vegetation patterns due to catastrophic fire in the absence of fuels reduction activities and road building; peak flow magnitude affected by changes in road drainage networks.

Aquatic Species: Historic and current distribution and abundance of important fisheries such as bull trout; Proposed, Endangered, Threatened, and Sensitive (PETS) within the watershed.

Key Question 2: What have been the causes of changes in riparian and aquatic ecosystems within the watershed?

Management activities affect the watershed. Management activities such as mining, dams, timber harvest, road building, livestock grazing, water withdrawals, fire exclusion, fishing, and recreation occur in Canyon Creek. How have the important habitat parameters listed in Key Question 1 been affected by these management activities?

2.4 ISSUE 4 - TERRESTRIAL WILDLIFE SPECIES AND HABITAT

Past management activities, such as timber harvest, livestock grazing, and fire suppression have changed natural disturbance processes, the distribution of wildlife populations, and the condition of wildlife habitat.

Key Question 1: How has the diversity and distribution of PETS and their habitat changed from historical conditions?

Habitat Conditions: PETS past and present habitat conditions, species composition, and distributions.

Key Habitats: Location of existing key habitats, areas of activities.

Key question 2: How has the diversity and distribution of non-PETS terrestrial wildlife and their habitat changed from historical conditions?

Habitat Conditions: Past and present habitat conditions, species composition, and distributions.

Key Habitats: Location of existing key habitats, areas of activities.

Key question 3: What caused the changes in diversity and distribution of PETS and other terrestrial wildlife and their habitats from historical conditions?

Management Influences: Timber harvest, livestock grazing (including wild horses), hunting and trapping, fire suppression, and roads.

2.5 ISSUE 5 - HUMAN USES

Human uses of the watershed have changed over time.

Key question 1: How have human uses, values, services, and products changed over time, and how are they expected to change in the future?

Uses and Impacts: Native American past and present uses, livestock grazing, road access, recreation uses - dispersed recreational use, hunting, horn-hunting. Special uses such as the municipal watershed and mining activities. Timber harvest opportunities and trends. Reduced wildland fire risk to local communities.

3 CURRENT CONDITIONS

3.1 AQUATIC SPECIES AND HABITAT

This section of the watershed analysis describes the distribution, presence and absence of aquatic species, and the current habitat conditions with a focus on near-term large wood debris (LWD) recruitment, vegetative stream shading, water quality and quantity, and physical habitat characteristics.

3.1.1 Fisheries

3.1.1.1 Range of Fish Occurrence

Species occurrence (i.e., presence/absence) data were obtained from stream inventories, ODFW records and from written or verbal documentation of other agencies, tribes, or archived literature (USFS GIS metadata 2000). Fish species identified as present in the watershed are listed in Table 3.1. The species listed as ONMY take into account steelhead, rainbow, and redband trout. Fish surveyors use this code when unable to differentiate among these species, a common dilemma when observing juvenile fish. Dace and red shiners are likely to be present in the watershed, but there are no survey data to determine distribution and abundance of these species (Edwards, pers. comm. 2002).

Table 3.1. Six fish species known to occur in Canyon Creek watershed.

Fish code	Scientific name	Common name
COXX	*Cottus sp.*	Sculpins
ONCL	*Oncorhynchus clarkii*	Cutthroat trout
ONMY	*Oncorhynchus mykiss*	Steelhead, rainbow, redband trout
SAFO	*Salvelinus fontinalis*	Brook trout
ONTS1	*Oncorynchus tshawytscha*	Spring Chinook salmon
ONMY1	*Oncorhynchus mykiss*	Steelhead trout
ONMY3	*Oncorhynchus mykiss*	Redband trout

Fish are present in all subwatersheds of Canyon Creek except Byram Gulch (Table 3.2, Map 3.1) (USFS Stream Coverage 2002). The distribution of certain species within the reaches of each subwatershed is described in this section.

3.1.1.1.1 Berry Creek Subwatershed

Juvenile Chinook salmon occur in the Berry Creek subwatershed of Canyon Creek. Cutthroat trout are limited to approximately three miles of Berry Creek where the upper extent of their range most likely is limited by gradient (Reach 3 exceeds 20%). Steelhead and redband trout occur in both Canyon Creek and Berry Creek.

Table 3.2. Fish species presence and linear length along streams for which particular species are known to occur.

Subwatershed name	Stream name	Species present					Miles
Berry Creek	Berry Creek	ONCL		ONMY1	ONMY3		3.611
	Canyon Creek		ONTS1	ONMY1	ONMY3		3.180
Canyon City	Canyon Creek		ONTS1	ONMY1	ONMY3		6.380
Canyon Meadows	Canyon Creek	ONCL			ONMY3	SAFO	3.639
		ONCL		ONMY1	ONMY3		4.377
	Crazy Creek	ONCL			ONMY3		2.360
Fawn	Canyon Creek		ONTS1	ONMY1	ONMY3		4.178
		ONCL		ONMY1	ONMY3		1.582
		ONCL	ONTS1	ONMY1	ONMY3		1.099
	East Fork Canyon Creek	ONCL		ONMY1	ONMY3		0.159
Lower East Fork				ONMY1	ONMY3		1.230
	East Fork Canyon Creek	ONCL		ONMY1	ONMY3		4.657
	Wall Creek			ONMY1	ONMY3		2.931
Middle Fork Canyon Creek	Middle Fork Tributary 1	ONCL					0.493
	Middle Fork Tributary 2	ONCL		ONMY1	ONMY3		0.801
	Canyon Creek	ONCL		ONMY1	ONMY3		0.267
	Middle Fork Canyon Creek	ONCL		ONMY1	ONMY3		7.963
Sugarloaf	Canyon Creek	ONCL		ONMY1	ONMY3		4.846
	Middle Fork Canyon Creek	ONCL		ONMY1	ONMY3		0.871
Upper East Fork	Brookling Creek			ONMY1	ONMY3		1.349
	E Brookling Creek			ONMY1	ONMY3		1.400
	East Fork Canyon Creek	ONCL		ONMY1	ONMY3		3.498
	Skin Shin Creek			ONMY1	ONMY3		1.041
Vance Creek					ONMY3		0.129
	Vance Creek				ONMY3		0.928
	Vance Creek			ONMY1	ONMY3		3.092

3.1.1.1.2 Canyon City Subwatershed

Steelhead and redband trout, as well as juvenile Chinook salmon, are known to occur in the Canyon City subwatershed of Canyon Creek. There is no record of these species occurring in any other watercourses within the subwatershed. Reports from ODFW suggest juvenile Chinook salmon originate in the headwaters above Prairie City and primarily use the lower reaches of Canyon Creek as summer rearing habitat. In the summer of 2000, ODFW reported that a portion of the instream flow of Canyon Creek near Canyon City traveled sub-surface, which resulted in a fish kill that included many salmonids (Edwards, pers. comm. 2002).

3.1.1.1.3 Canyon Meadows Subwatershed

Cutthroat and redband trout are known to occur in Canyon and Crazy Creek. Brook trout, spawning August through September, compete for habitat resources with cutthroat and redband trout in Canyon Creek above Canyon Meadows (Reaches 11 - 14). As a result of opening the control gates of Canyon Meadows dam, it has been suggested that brook trout likely occur below the dam in Reach 10 (Edwards, pers. comm. 2002). Steelhead trout are currently limited to Reaches 9 and 10 of Canyon Creek, although they may have access to habitat farther upstream now that the floodgates of the dam are open. Steelhead may now have to compete for habitat with brook trout above and below Canyon Meadows dam.

3.1.1.1.4 Fawn Subwatershed

USFS data suggest juvenile Chinook salmon may rear as far upstream as Canyon Creek Reach 6 above the confluence with East Gulch. This also represents the downstream extent of cutthroat trout occurrence in Canyon Creek. Steelhead and redband trout are limited in occurrence to Canyon Creek only in the Fawn subwatershed.

3.1.1.1.5 Lower East Fork Subwatershed

Cutthroat, redband, and steelhead trout have been identified in the Lower East Fork subwatershed along the entire length of the East Fork of Canyon Creek. Steelhead and redband trout occur in Wall Creek Reach 3 to the confluence with the North Fork of Wall Creek and in Wall Creek Tributary 1 Reach 1 where gradient exceeds 15% and may limit fish presence.

3.1.1.1.6 Middle Fork Canyon Creek Subwatershed

Cutthroat, redband, and steelhead trout occur along approximately eight miles of Middle Fork Canyon Creek (Reach 6) as well as a 1-mile stretch of Middle Fork Canyon Creek Tributary 2, Reach 2. Fish presence in both reaches may be limited by low summer flows and gradients exceeding 15%.

3.1.1.1.7 Sugarloaf Subwatershed

Cutthroat, steelhead, and redband trout are limited to Canyon Creek and data available at this time indicate fish do not occur in any of the tributaries in the Sugarloaf subwatershed.

3.1.1.1.8 Upper East Fork Subwatershed

Cutthroat, redband, and steelhead trout occur in the East Fork of Canyon Creek just beyond the confluence with Miners Creek (Reach 5). Steelhead and redband trout occurrence extends into Brooklings Creek (Reach 2), Skin Shin Creek (Reach 1), and East Brooklings Creek (Reach 1) where presence is probably limited to low water flows.

3.1.1.1.9 Vance Creek Subwatershed

Fish distribution in the Vance Creek subwatershed, the westernmost subwatershed in the Canyon Creek watershed, is known only for Vance Creek itself. Steelhead and redband trout are known to occur throughout Reach 1. Redband are found upstream of Reach 1 for approximately one mile into Reach 2. The abnormally cool water temperatures measured in Vance Creek make it a potential candidate for fisheries restoration (see *Stream Temperature* section later in this chapter).

3.1.1.2 Summary of USFS Stream Survey Data

A total of 22.3 miles within 17 reaches of six streams were surveyed in the Canyon Creek watershed between 1993 and 1994 (SMART database, USFS) (Map 3.2). The reaches referred to here are reaches delineated by survey crews in the 1990s. These reaches are different from the Rosgen Level I reaches discussed below in the LWD and stream shade survey conducted as part of this analysis. A complete discussion on the Rosgen Level I survey is given in the *Physical Stream Characteristics* section of this chapter.

3.1.1.3 Fish Species

Four fish species were encountered in the stream surveys: sculpins, westslope cutthroat trout, steelhead/redband trout, and brook trout (Table 3.1). The highest diversity of fish species in the Canyon Creek watershed was found in the upper reaches of Canyon Creek (within the wilderness), with three of the four species represented (sculpins, cutthroat trout and brook trout) (Table 3.3). Crazy Creek likewise supported high diversity; electrofish data indicated the presence of steelhead/redband, sculpins, and cutthroat trout during the 1994 surveys.

3.1.1.4 Population Data (Presence and Abundance)

Six reaches within five streams were electrofished in 1993 and 1994 (Table 3.4). In the Canyon Creek Wilderness reaches, cutthroat trout were the most abundant (58% of the fish counted); brook trout were also prevalent, having 33% of the fish population, primarily in the lower wilderness reach (Canyon Wilderness Reach 1). In addition, juvenile sculpins comprised approximately 15% of the population structure of the wilderness reaches of Canyon Creek. The high population densities of brook trout with cutthroat trout indicate that the wilderness reaches of Canyon Creek as well as lower reaches are areas of concern for the maintenance and survival of cutthroat populations. Westslope cutthroat trout in Canyon Creek are considered a genetically unaltered species designated as a conservation population (Shepard et al. 2002). Cutthroat may at one time have been of the fluvial form. Due to habitat loss and degradation, they are now considered resident trout.

Cutthroat trout were also abundant in the surveyed wilderness reach of Middle Fork Canyon Creek (Reach 1) and its tributaries (T4 and T7). Crazy Creek had the only electrofishing data where steelhead/redband trout were found, although visual data from snorkel counts indicate steelhead/redband were also present in Canyon Creek, Vance Creek, and Middle Fork Canyon Creek (Table 3.5). Population structure was approximately equal in electrofished sections of Crazy Creek (Reach 1), with approximately 31% cutthroat and sculpin abundance and 38% steelhead/redband abundance.

Table 3.3. SMART reaches surveyed by USFS Level II (Hankin and Reeves) steam surveys where fish were present.

Reach name	Year surveyed	Beginning river mile	Ending river mile	Miles surveyed	Species richness
Canyon Wild: Reach #1	1994	24	24.6	0.6	3
Canyon Wild: Reach #2	1994	24.6	26.3	1.7	3
Canyon: Reach #1	1993	17	17.9	0.9	1
Canyon: Reach #2	1993	17.9	19.9	2	2
Canyon: Reach #3	1993	19.9	22.2	2.3	1
Canyon: Reach #5	1993	23	24	1	1
Crazy 94: Reach #1	1994	0	2.1	2.1	3
MF Canyon T4: Reach #1	1994	0	1.7	1.7	1
MF Canyon T7: Reach #1	1994	0	0.3	0.3	1
MF Canyon Wild: Reach #1	1994	6.6	8.2	1.6	1
MF Canyon: Reach #1	1993	0	2.6	2.6	1
MF Canyon: Reach #2	1993	2.6	3.9	1.3	2
MF Canyon: Reach #3	1993	3.9	5	1.1	2
MF Canyon: Reach #4	1993	5	6.2	1.2	1
MF Canyon: Reach #5	1993	6.2	6.6	0.4	1
Vance: Reach #1	1993	0.3	1	0.7	1
Vance: Reach #3	1993	2.2	3	0.8	1

Visual counts were conducted in the same years as electrofishing data were collected (Table 3.5). Brook trout were found in the upper reaches of Canyon Creek (Reach 5), just below the wilderness boundary. Visual counts of brook trout were quite high (323 adults), although a conclusion cannot be made from snorkeling data alone that the absence of native species is a function of the high brook trout numbers.

Table 3.4. Abundance of fish species obtained from electro-fishing from stream surveys, 1993 and 1994.

Reach name	Adult brook trout	Juvenile brook trout	Adult cutthroat trout	Juvenile cutthroat trout	Adult sculpins	Juvenile sculpins	Adult steelhead /redband	Juvenile steelhead /redband
Canyon Wild: Reach #1	11	38	4	12	0	16	0	0
Canyon Wild: Reach #2	0	2	13	52	0	8	0	0
Crazy 94: Reach #1	0	0	6	11	0	17	3	18
MF Canyon T4: Reach #1	0	0	8	24	0	0	0	0
MF Canyon T7: Reach #1	0	0	1	3	0	0	0	0
MF Canyon Wild: Reach #1	0	0	16	28	0	0	0	0

Steelhead/redband were present in all eight stream reaches snorkeled. Generally, more individuals were observed in the lower reaches of Canyon Creek, Middle Fork Canyon Creek, and Vance Creek than in the upper reaches. Cutthroat trout were observed in three reaches of the Middle Fork Canyon Creek (Reaches 3, 4, and 5). Snorkel counts are indicators for fish species only and do not provide as accurate population structure information as electrofishing.

Table 3.5. Abundance of fish obtained from visual snorkeling surveys from stream surveys during 1993 and 1994.

Reach name	Adult brook trout	Juvenile brook trout	Adult cutthroat trout	Juvenile cutthroat trout	Adult sculpins	Juvenile sculpins	Adult steelhead/ redband	Juvenile steelhead/ redband
Canyon: Reach #1	0	0	0	0	0	0	2	10
Canyon: Reach #2	0	0	0	0	1	0	8	0
Canyon: Reach #3	0	0	0	0	0	0	8	0
Canyon: Reach #5	323	0	0	0	0	0	0	0
MF Canyon: Reach #1	0	0	0	0	0	0	6	27
MF Canyon: Reach #2	0	0	0	0	3	0	6	9
MF Canyon: Reach #3	0	0	0	5	0	0	9	2
MF Canyon: Reach #4	0	0	7	27	0	0	0	0
MF Canyon: Reach #5	0	0	5	7	0	0	0	0
Vance: Reach #1	0	0	0	0	0	0	1	2
Vance: Reach #3	0	0	0	0	0	0	2	0

3.1.2 Riparian Vegetation Condition and Function

Riparian zones are narrow strips of land between the aquatic interface and drier, upland habitat types. Riparian zones are important to the maintenance and diversity of ecological processes within a watershed. Riparian vegetation is critical in moderating stream energy, providing key inputs for the maintenance of food webs, aiding in stream bank stability, creating structure for retention of coarse particulate organic matter and sediment storage, provide stream shade, and acting as a source for large wood inputs into streams (Beschta 1991). Especially in the arid west, stream shading is a key process that helps to moderate stream temperatures and provide instream cover and complexity for aquatic species (through visual competition or predation). LWD inputs are essential for creating instream habitat features (i.e., pools); the potential for a particular stream to maintain a constant influx of LWD (and hence maintain quality habitat features) is an important consideration in a long-term management plan. However, little data are known for stream shading or LWD recruitment for the Canyon Creek watershed. In this section of the watershed analysis, the near-term LWD recruitment (i.e., 10 to 20 years) was quantified and all Category 1 and 2 streams rated as to their current levels of stream shading.

3.1.2.1 Large Wood Debris (LWD) Near-Term Recruitment

Riparian zones are important habitats that have many critical functions. Riparian forests produce LWD that is recruited into a stream where it creates critical habitat features for aquatic species. The Malheur National Forest recognizes the role of LWD, and the Resource Land and Management Plan Amendment #29 specifies the number of pieces of LWD to be maintained for each mile of stream in certain ecotypes. In this analysis, the current condition of the riparian zones was rated with respect to near-term (10 to 20 years) functional LWD recruitment potential.

Near-term LWD recruitment potential was evaluated for most Category 1, 2 and 3 streams within the NFS lands of Canyon Creek watershed, based upon a modified method described by the Washington Department of Natural Resources (WADNR) Forest Practices Act (WFPB 1997) and the USFS Region 6 Level 2 Stream Survey protocols (Duck Creek Associates, Inc. *in prep*.) Evaluations were made of streams that would act as sources for LWD into known fish-bearing streams during periods of high flows and flood events. The stand-level data generated from photo-interpretation (PI) of 2001, color stereo-pair (1:12,000 scale) aerial photographs were used in this analysis. Using GIS, stream coverage data were buffered to 90 feet on both stream banks. Studies have shown that as much as 95% of in-channel LWD originate within 66 feet of the stream bank (Murphy and Koski 1989). This buffer distance was chosen because LWD recruitment is a function of hillslope gradient bordering the stream and of the height of a tree. Tree heights in the analysis area seldom exceed 100 feet, and allowances were made for any large trees that potentially could enter the stream. The PI vegetation data layer (PI data) and the stream buffer polygons were intersected using GIS, creating a new polygon layer for LWD recruitment. The PI data in these new polygons was classified using a rating system for tree size classes. Multiplying the size rating by the percent canopy closure of the stand created a score for the first two tree canopy layers from PI data. The lowest canopy layer (i.e., regenerating tree layer) was not used in this analysis because it was assumed it would not be a source of near-term functional wood recruitment into the stream. The scores of canopy layers 1 and 2 were summed to create a total score. Total polygon scores were classified as having High, Moderate, or Low near-term LWD recruitment potential based on their mean diameter and canopy cover (Table 3.6) (Duck Creek Associates, Inc. *in prep*).

3.1.2.1.1 LWD at the Watershed Scale

The analysis of near-term LWD recruitment potential across the watershed is summarized in Table 3.7. Based on the parameters used in this analysis, the riparian areas of each sub-watershed are dominated by stands that have a low potential for functional LWD recruitment in the near term. The Canyon City subwatershed was not included because no eligible streams were present on NFS lands. Vance and Fawn Creek riparian zones have the lowest potential of providing instream LWD in the near term on NFS lands. There are no riparian zone stands in Vance or Fawn Creek subwatersheds that have a high recruitment potential.

Table 3.6. Range of diameters and canopy closures in each near-term large wood debris recruitment potential class used in this analysis.

Recruitment potential	Range of scores	Example ranges of values in a recruitment potential class				Total % CC	Score
		L1 DBH	L1 CC	L2 DBH	L2 CC		
High	91 -155	21 – 32	35	9 - 15	25	60	155
		15 - 21	40	5 - 9	15	55	95
Moderate	61 - 90	21 - 32	20	9 - 15	15	35	90
		15 -21	22	5 - 9	18	40	62
Low	0 - 60	21 - 32	12	5 - 9	24	36	60
		5 - 9	5	1 - 5	4	9	5

In contrast, Berry Creek subwatershed has 39% of the riparian zone classified as a high recruitment potential. Lower and Upper East Forks of Canyon Creek have similarly high recruitment potential with 33% and 32%, respectively. The majority of the Berry, Upper, and Lower East Fork subwatersheds are within the Strawberry Mountain Wilderness Area. Since these riparian zones have been protected for some time, it could explain why the LWD recruitment potential is higher there than it is along streams outside the wilderness. In the *Synthesis and Interpretation* section of this analysis (*Chapter 5-6*), LWD is evaluated and compared for fish presence/absence and potential habitat.

3.1.2.1.2 LWD at the Subwatershed Scale

Our report of the remote near-term LWD study is broken down by reach. These reaches were delineated according to Rosgen Level I methodology. The results of the Level I survey are discussed in the *Physical Stream Characteristics* section of this chapter.

3.1.2.1.2.1 Berry Creek Subwatershed

Berry Creek subwatershed (Table 3.8) has a relatively high near-term LWD recruitment potential. Berry Creek and Deer Creek have over 60% of the evaluated area in high LWD. In contrast, approximately 88% of Cougar Creek has low LWD potential. Most of the reaches with high LWD potential are higher gradient streams that may transport LWD to downstream reaches.

3.1.2.1.2.2 Canyon Meadows Subwatershed

LWD recruitment potential for Canyon Meadows subwatershed is low (Table 3.9). Seven reaches have extremely low LWD recruitment potential. Canyon Creek Reaches 13 and 14 (above the dam) have moderate LWD potential. With the absence of large-diameter trees in the riparian zone, future LWD inputs may be a limiting factor in forming quality fish habitat.

Table 3.7. LWD recruitment potential determined from 1:12,000 aerial photography by subwatershed for Canyon Creek watershed.

Subwatershed name	Near term recruitment potential	Acres	Percent of subwatershed
Berry Creek	Low	106	40
	Moderate	58	21
	High	108	38
Canyon City	Low	5	100
Canyon Meadows	Low	294	88
	Moderate	40	11
	High	2	1
Fawn	Low	133	79
	Moderate	39	21
Lower East Fork	Low	119	51
	Moderate	105	45
	High	9	4
Middle Fork Canyon Creek	Low	255	70
	Moderate	85	23
	High	27	7
Sugarloaf	Low	85	59
	Moderate	20	14
	High	39	27
Upper East Fork	Low	135	40
	Moderate	147	43
	High	57	17
Vance Creek	Low	151	90
	Moderate	17	10
Total Acres		2,036	

Acres are calculated using GIS and are approximate.

Table 3.8. Near-term LWD recruitment potential for Berry Creek subwatershed.

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod	% of low
Berry Creek	1	8.8	2.8	2.0	13.6	64.6	20.5	14.9
Berry Creek	2	26.8	2.6	9.2	38.7	69.4	6.8	23.8
Berry Creek	3	20.4	6.0	15.0	41.5	49.3	14.5	36.2
Berry Creek Tributary 1	1	15.6	10.9	12.7	39.3	39.7	27.8	32.4
Cougar Creek	1	16.2	9.2	33.8	59.3	27.4	23.9	87.5
Deer Creek	2	15.9		8.6	24.5	64.9	NA	35.1
Sheep Gulch	1	0.1	4.3	1.4	5.8	1.4	11.2	3.5
Sheep Gulch	2	4.1	15.8	4.5	24.4	16.8	64.8	18.5
Sheep Gulch unnamed tributaries	Not classified	0.2	6.5	19.3	26.0	0.7	25.2	74.2

Table 3.9. Canyon Meadows subwatershed LWD recruitment potential

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod	% of low
Big Canyon	Not Classified	0.0	0.0	41.04	41.0	0.0	0.0	100.0
Canyon Creek	9	0.0	0.0	29.61	29.6	0.0	0.0	100.0
Canyon Creek	10	0.0	2.5	51.87	54.3	0.0	4.6	95.4
Canyon Creek	11	0.0	0.0	18.08	18.1	0.0	0.0	100.0
Canyon Creek	12	0.0	0.4	24.22	24.6	0.0	1.5	98.5
Canyon Creek	13	1.605	8.6	10.02	20.2	7.9	42.6	49.5
Canyon Creek	14	0.0	12.3	46.62	58.9	0.0	20.9	79.1
Canyon Creek	Res.	0.666	16.1	20.59	37.4	1.8	43.1	55.1
Crazy Creek	1	0.0	0.0	35.07	35.1	0.0	0.0	100.0
Crazy Creek	2	0.0	0.0	17.33	17.3	0.0	0.0	100.0

3.1.2.1.2.3 Fawn Creek Subwatershed

A sufficient quantity of large diameter trees are not present in the riparian zone of Fawn Creek subwatershed to classify any reaches with a high LWD recruitment potential (Table 3.10). Only Road Gulch (Reach 1) is a moderate source of potential LWD recruitment. Based on this analysis, Fawn subwatershed is not expected to provide functional LWD to streams anytime in the next 20 years.

3.1.2.1.2.4 Lower East Fork Subwatershed

The majority of Lower East Fork subwatershed lies in the Strawberry Mountain Wilderness. Reach 2 begins immediately upstream of the wilderness boundary, yet Reach 2 is completely devoid of LWD recruitment potential (i.e., 100% of the reach was classified having a low LWD recruitment potential) (Table 3.11). Reach 3 is completely contained within the wilderness and is classified as having 76% low recruitment potential. Wall Creek and its tributaries have a moderate potential for LWD recruitment.

Table 3.10. Fawn Creek subwatershed LWD recruitment potential.

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod.	% of low
Bear Gulch	1	0.0	5.3	33.3	38.6	0.0	13.6	86.4
Bear Gulch	2	0.0	0.0	0.8	0.8	0.0	0.0	100.0
Canyon Creek	6	0.0	0.0	3.2	3.2	0.0	0.0	100.0
Canyon Creek	7	0.0	0.0	0.1	0.1	0.0	0.0	100.0
East Gulch	1	0.0	0.0	16.6	16.6	0.0	0.0	100.0
East Gulch	2	0.0	0.0	37.9	37.9	0.0	0.0	100.0
Fawn Creek	1	0.0	0.6	27.0	27.6	0.0	2.1	97.9
Road Gulch	1	0.0	30.3	1.2	31.4	0.0	96.3	3.7
Sloan Gulch	1	0.0	0.2	12.8	12.9	0.0	1.2	98.8
W F East Gulch	1	0.0	0.0	31.8	31.8	0.0	0.0	100.0

Table 3.11. Lower East Fork Creek subwatershed LWD recruitment potential

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod.	% of low
E F Canyon Creek	2	0.0	0.0	19.2	19.2	0.0	0.0	100.0
E F Canyon Creek	3	0.0	11.5	36.5	48.0	0.0	24.0	76.0
N F Wall Creek	1	3.8	3.8	16.9	24.4	15.5	15.4	69.1
N F Wall Creek	2	0.0	8.3	5.1	13.4	0.0	62.0	38.0
Wall Creek	1	0.0	48.9	3.8	52.7	0.0	92.9	7.1
Wall Creek	2	0.0	4.2	0.5	4.7	0.0	88.4	11.6
Wall Creek	3	4.8	17.9	35.6	58.3	8.2	30.8	61.0
Wall Creek T1	1	0.0	10.5	1.7	12.2	0.0	86.1	13.9

3.1.2.1.2.5 Middle Fork Canyon Creek Subwatershed

Middle Fork Canyon Creek Reaches 1, 2, and 3 are outside of the wilderness boundary (Table 3.12). Reach 1 has the lowest recruitment potential (~94% of the reach) while Reach 2 is somewhat higher (~25% of the reach classified having high potential). Reaches 5 and 6, which are both within the wilderness boundary, have a higher recruitment potential than downstream reaches. Approximately 91% of Tributary 2 (Reach 1) has low recruitment potential. Generally, the trend for recruitment potential increases as elevation increases in the Middle Fork Canyon Creek subwatershed.

Table 3.12. Middle Fork Canyon Creek subwatershed LWD recruitment potential.

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod.	% of low
M F Canyon Creek_T1	1	0.0	6.3	14.3	20.6	0.0	27.0	73.0
M F Canyon Creek_T2	1	0.0	1.1	10.1	11.2	0.0	8.8	91.2
M F Canyon Creek_T2	2	0.0	16.8	17.0	33.8	0.0	49.8	50.2
Middle Fork Canyon Creek	1	3.9	0.00	52.7	56.6	6.9		93.1
Middle Fork Canyon Creek	2	18.4	1.0	54.8	74.2	24.8	1.4	73.8
Middle Fork Canyon Creek	3	4.8	0.0	18.2	23.0	20.7	0.2	79.1
Middle Fork Canyon Creek	5	0.0	16.3	9.2	25.5	0.0	63.8	36.2
Middle Fork Canyon Creek	6	0.0	26.9	11.8	38.7	0.0	69.5	30.5
Middle Fork Canyon Creek	Not classified	0.0	17.2	66.9	84.0	0.0	20.4	79.6

3.1.2.1.2.6 Sugarloaf Subwatershed

Six streams were classified for LWD near-term recruitment potential (Table 3.13). Sugarloaf Gulch has over 70% high recruitment potential while Wickiup Creek Reach 1 has moderate potential for LWD recruitment. In contrast, four of the reaches in this subwatershed have an extremely low potential for LWD recruitment (100%) low recruitment potential. Generally, this subwatershed has a low potential to recruit LWD.

Table 3.13. Sugarloaf subwatershed LWD recruitment potential.

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod.	% of low
Big Canyon	Not rated	0.0	0.0	2.8	2.8	0.0	0.0	100.0
Canyon Creek	7	0.0	0.0	0.9	0.9	0.0	0.0	100.0
Canyon Creek	8	1.3	0.9	4.6	6.8	19.5	13.4	67.1
Canyon Creek	9	0.0	0.0	10.1	10.1	0.0	0.0	100.0
Crawford Gulch	Not rated	0.0	0.0	4.7	4.7	0.0	0.0	100.0
Sugarloaf Gulch	1	35.6	4.4	10.3	50.2	70.9	8.7	20.4
W F Wickiup Creek	1	0.0	5.9	25.7	31.6	0.0	18.7	81.3
Wickiup Creek	1	2.0	4.7	0.4	7.1	28.4	65.4	6.2
Wickiup Creek	2	0.0	3.8	25.3	29.2	0.0	13.1	86.9

3.1.2.1.2.7 Upper East Fork Subwatershed

Brooklings Creek has a moderate potential to recruit LWD (Table 3.14). East Fork Canyon Creek Reach 5 has the highest potential to recruit LWD and potential decreases downstream in Reaches 4 and 3. Skin Shin and Tamarack Creeks generally have moderate potential. The potential for near-term recruitment is varied throughout the reaches yet generally moderate within the subwatershed.

Table 3.14. Upper East Fork subwatershed LWD recruitment potential.

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod.	% of low
Brooklings Creek	1	0.0	5.4	1.0	6.4	0.0	84.2	15.8
Brooklings Creek	2	2.2	17.5	7.7	27.4	8.2	63.9	28.0
Brooklings Creek	3	3.4	8.1	17.1	28.6	12.0	28.3	59.7
E F Brooklings Creek	1	1.8	12.7	36.7	51.1	5.5	20.4	76.8
E F Canyon Creek	3	0.0	0.0	8.3	8.3	0.0	0.0	100.0
E F Canyon Creek	4	0.0	51.0	2.0	53	0.0	94	6.2
E F Canyon Creek	5	25.8	1.2	5.4	32.4	80	4	16
Skin Shin Creek	1	0.0	23.2	8.7	31.9	0.0	72.6	27.4
Skin Shin Creek	2	0.4	6.8	12.4	19.6	1.9	34.9	63.1
Tamarack Creek	1	0.0	5.0	9.6	14.6	0.0	34.1	65.9
Tamarack Creek	2	1.9	10.9	5.6	18.4	10.1	59.2	30.6
Miner's Creek	1	21.3	4.9	20.7	46.9	45.4	10.4	44.1

3.1.2.1.2.8 Vance Creek Subwatershed

This subwatershed offers little potential for near-term LWD recruitment (Table 3.15). Reach 1 has over 95% low recruitment potential classification, so this reach is expected to be limited for instream LWD in the near future. Reach 2 is divided evenly in its rating between low and moderate, while Reach 3 has over 90% classified as low potential. Both reaches of Bear Gulch have been classified as having low recruitment potential. Based on this analysis, Vance Creek subwatershed is not expected to produce or transport appreciable amounts of LWD in the near term.

Table 3.15. Vance Creek subwatershed LWD recruitment potential.

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod.	% of low
Bear Gulch	1	0.0	0.0	9.2	9.2	0.0	0.0	100.0
Bear Gulch	Not rated	0.0	0.0	2.1	2.1	0.0	0.0	100.0
Vance Creek	1	0.0	1.2	40.2	41.4	0.0	2.8	97.2
Vance Creek	2	0.0	5.8	4.9	10.7	0.0	54.2	45.8
Vance Creek	3	0.0	3.6	37.7	41.3	0.0	8.7	91.3
Vance Creek Tributary	Not rated	0.0	6.4	68.6	75.0	0.0	8.5	91.5

3.1.2.2 Shading by Tree Canopy Cover

Riparian stream shading is critical in regulating water temperature extremes, providing instream cover against predation, and acting as a source of nutrient inputs into the stream channel. Stream temperatures increase following disturbance to riparian vegetation (i.e., harvest, grazing, or fire) (Beschta and Taylor 1988). Given the high temperatures found within the Canyon Creek watershed and the importance of riparian vegetation in regulating extreme temperatures, it is important to identify stream reaches that are limited in shade and ultimately may be limited in providing quality instream habitat to fish species. In addition, it is known that shade from conifers and deciduous trees and shrubs functions differently. In winter, cold temperatures can be moderated by conifer shade acting as thermal cover.

In this study, the extent of vegetative shading on streams in the Canyon Creek watershed was determined, using protocols defined by the Oregon Watershed Enhancement Board (OWEB 1999). Stream shading was evaluated using recent color stereo-pair aerial photographs (2001, 1:12,000 scale) for most Category 1, 2, and 3 streams within the watershed. The photographs were taken in August, so it was assumed that this was the maximum shade canopy cover possible. Along the length of these streams, homogeneous polygons were delineated based upon shading and classified as having a high, moderate, or low shade potential. No distinction was made between conifers or deciduous shade in the analysis. Occasionally, comments were made on what type of vegetation created shade but was not part of the analysis. A high stream shade potential rating was assigned to polygons when the stream water surface and banks were not visible and canopy cover exceeded 70%. A moderate rating was assigned to polygons when at least one stream bank was evident and there was a 40% to 70% canopy cover. A low rating was assigned when both stream banks were visible and canopy cover < 40%. The role of topographic shading in contributing to cooler water temperature is recognized; however, the study was limited to riparian vegetation shade in this analysis. As in the LWD study, the reaches delineated by the Rosgen Level I analysis were used.

3.1.2.2.1 Stream Shading at the Watershed Scale

A total of 105 miles were evaluated for stream shading. Overall, 49 miles (47%) of streams had low potential shade, 39 miles (37%) had moderate shading, and approximatley 17 miles (16%) have a high stream shade potential. Berry Creek, Upper East Fork, and Lower East Fork subwatersheds have the highest vegetative cover, both in length and proportion of stream (Table 3.16). Approximately 12 miles of Fawn Creek have low shade potential (81%). Byram Gulch, Middle Fork Canyon Creek, and Sugarloaf are also low in shade potential (~70%, ~72%, and ~68%, respectively).

Table 3.16. Shade canopy classes given for each subwatershed in Canyon Creek.

	Stream miles in shade class				Percent of miles in a shade class		
Subwatershed	**Low**	**Mod.**	**High**	**Total miles of stream evaluated**	**Low**	**Mod.**	**High**
Berry Creek	5.06	5.79	4.58	15.43	32.79	37.54	29.67
Byram Gulch	0.74	0.32		1.07	69.79	30.21	0.00
Canyon City	1.61	3.97	0.22	5.80	27.76	68.38	3.86
Canyon Meadows	5.34	4.41	2.00	11.76	45.45	37.53	17.02
Fawn	11.80	2.37	0.40	14.57	81.00	2.92	13.78
Lower East Fork	4.48	4.63	3.95	13.05	34.31	35.45	30.24
Middle Fork Canyon Creek	8.67	2.50	0.91	12.08	71.78	20.72	7.50
Sugarloaf	6.48	3.10		9.59	67.64	32.36	0.00
Upper East Fork	1.42	9.48	4.28	15.19	9.36	62.43	28.21
Vance Creek	3.61	2.68	0.25	6.54	55.14	41.02	3.83

Shade canopy classes are shown in miles of stream per class and the percentage of stream miles each shade class represents for each subwatershed.

3.1.2.2.2 Stream Shading at the Subwatershed Scale

3.1.2.2.2.1 Berry Creek

Stream shade increases upstream in Berry Creek. Reaches 1 and 2 have low to moderate stream shade (i.e., one or both banks visible); Reach 3 has high levels of stream shade in approximately 28% of the reach (i.e., no banks are visible) (Table 3.17). A dramatic change in stream shading is present in Deer Creek between reaches. Reach 1 Deer Creek is almost entirely exposed (i.e., 98% low shade potential) and Reach 2 is heavily shaded for nearly two-thirds of the reach. Sheep Gulch is generally well shaded; >70% of both reaches of this stream have no more than one exposed bank (i.e., moderate to high shading potential). The two reaches of Canyon Creek that flow through Berry Creek subwatershed have a majority of the stream exposed to direct sunlight, especially Reach

3. Aside from Reach 3 Canyon Creek, the majority of the stream area of Berry Creek subwatershed is protected by vegetative cover.

Table 3.17. Shade classifications for Berry Creek subwatershed by number of miles and percent of total miles.

		Stream miles in shade class				Percent of stream in shade class		
Subwatershed	**Stream and reach**	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
Berry Creek	Berry Creek: Reach #1	0.00	0.95	0.74	1.68	0.00	56.29	43.71
Berry Creek	Berry Creek: Reach #2	0.01	1.60	0.12	1.73	0.81	92.47	6.71
Berry Creek	Berry Creek: Reach #3	0.50	1.17	0.18	1.85	27.03	63.04	9.93
Berry Creek	Berry Creek_T1: Reach #1	2.12	0.02	0.44	2.58	82.28	0.79	16.93
Berry Creek	Canyon Creek: Reach #3	0.00	0.00	1.05	1.05	0.00	0.00	100.00
Berry Creek	Canyon Creek: Reach #4	0.31	0.46	1.00	1.78	17.53	25.97	56.50
Berry Creek	Deer Creek: Reach #1	0.02	0.00	0.77	0.79	2.35	0.00	97.65
Berry Creek	Deer Creek: Reach #2	0.87	0.22	0.44	1.53	57.05	14.17	28.78
Berry Creek	Sheep Gulch: Reach #1	0.39	0.73	0.31	1.42	27.15	51.11	21.74
Berry Creek	Sheep Gulch: Reach #2	0.36	0.65	0.00	1.01	35.37	64.63	0.00

3.1.2.2.2.2 Canyon City Subwatershed

The confluence of the John Day River with Canyon Creek occurs in the Canyon City subwatershed, and the entirety of Canyon Creek in this subwatershed is outside the Malheur National Forest boundaries. Ranches, farms, houses, and the towns of Canyon City and John Day border Canyon Creek as it flows through this subwatershed. Deciduous trees and shrubs create almost all vegetation shade. Reaches 1 and 2 have generally moderate shading; at least one bank is exposed for the Canyon Creek within this subwatershed (Table 3.18). Although moderate levels of stream shade are found in this subwatershed, other factors (i.e., instream flows, few deep pools, etc.) contribute to high water temperatures and hence the reliance upon dense stream shade becomes more important for the maintenance of aquatic species.

Table 3.18. Shade classifications for Canyon City subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				Percent of stream in shade class		
Stream and reach	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
Canyon Creek: Reach #1	0.22	1.60	1.22	3.05	7.35	52.50	40.15
Canyon Creek: Reach #2	0.00	2.37	0.37	2.74	0.00	86.44	13.56

3.1.2.2.2.3 Canyon Meadows Subwatershed

The reaches of Canyon Creek that flow through the Canyon Meadows subwatershed generally have low to moderate stream shading, with the exception of Reach 14 (Table 3.19). Approximately two-thirds of Reaches 9 through 13 has low shade potential (4.6 miles, or 63%) and 2.7 miles (37%) have moderate shade (i.e., one stream bank exposed). Vegetative cover in Reach 14 of Canyon Creek is considerably more; approximately two-thirds (1.4 miles) of this reach has moderate to high levels of stream shade. Likewise, both reaches of Crazy Creek have moderate to high levels of shade, with the entire length of Reach 2 having both banks shaded.

Table 3.19. Shade classifications for Canyon Meadows subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				Percent of stream in shade class		
Stream and reach	**High**	**Mod.**	**Low**	**Total miles**	**High**	**Mod.**	**Low**
Canyon Creek: Reach #10	0.00	0.66	1.71	2.37	0.00	28.03	71.97
Canyon Creek: Reach #11	0.00	0.00	0.83	0.83	0.00	0.00	100.00
Canyon Creek: Reach #12	0.00	0.92	0.19	1.11	0.00	82.89	17.11
Canyon Creek: Reach #13	0.00	0.88	0.00	0.88	0.00	100.00	0.00
Canyon Creek: Reach #14	1.12	0.28	0.68	2.08	53.68	13.36	32.96
Canyon Creek: Reach #9	0.00	0.24	1.89	2.13	0.00	11.08	88.92
Crazy Creek: Reach #1	0.11	1.43	0.04	1.58	6.79	90.58	2.63
Crazy Creek: Reach #2	0.78	0.00	0.00	0.78	100.00	0.00	0.00

3.1.2.2.2.4 Fawn Subwatershed

The majority of the Fawn subwatershed has low levels of stream shade. Of the approximately 6.9 miles of Canyon Creek within this subwatershed, 6.4 miles (approximately 93%) have both banks exposed with <40% shade (i.e., low shade potential) (Table 3.20). All reaches, with the exception of Fawn (Reach 1) and Vance Creek (Reach 1), have approximately 80% of their lengths with less than 40% vegetative cover. Both Fawn and Vance Creeks had slightly higher shading, with 50% to 70% of their reach lengths having at least one stream bank shaded (40% to 70% stream shade). At the subwatershed scale, stream shade may be a limiting factor for moderating stream temperatures for the Fawn subwatershed.

Table 3.20. Shade classifications for Fawn subwatershed by number of miles and percent of total miles.

Stream and reach	Stream miles in shade class: High	Mod	Low	Total miles	Percent of stream in shade class: High	Mod	Low
Bear Gulch: Reach #1	0.00	0.30	2.08	2.37	0.00	12.58	87.42
Canyon Creek: Reach #5	0.00	0.33	1.80	2.12	0.00	15.32	84.68
Canyon Creek: Reach #6	0.00	0.12	4.05	4.17	0.00	2.95	97.05
Canyon Creek: Reach #7a	0.00	0.00	0.54	0.54	0.00	0.00	100.00
East Gulch: Reach #1	0.00	0.00	0.78	0.78	0.00	0.00	100.00
East Gulch: Reach #2	0.00	0.49	0.98	1.47	0.00	33.37	66.63
Fawn: Reach #1	0.40	0.82	0.31	1.54	26.21	53.61	20.18
Vance Creek: Reach #1	0.00	0.08	0.02	0.10	0.00	76.76	23.24
W. Fork East Gulch: Reach #1	0.00	0.23	1.23	1.46	0.00	15.69	84.31

3.1.2.2.2.5 Lower East Fork

All reaches of East Fork Canyon Creek within this subwatershed have low to moderate quantities of stream shade (Table 3.21). North Fork Wall Creek (Reach 1) has approximately 99% and Wall Creek Reach 3 has 97% moderate shade potential (i.e., one exposed bank). North Fork Wall Creek Reach 2 and Wall Creek Reach 1 each have over 70% high shade potential, and both reaches are contained within the wilderness. In general, reaches within the wilderness boundaries have higher vegetative cover of near-stream vegetation than reaches outside the wilderness.

Table 3.21. Shade classifications for Lower East Fork subwatershed by number of miles and percent of total miles.

Stream and reach	Stream miles in shade class: High	Mod	Low	Total miles	Percent of stream in shade class: High	Mod	Low
E. F. Canyon Creek: Reach #1	0.00	0.20	0.93	1.13	0.00	17.70	82.30
E. F. Canyon Creek: Reach #2	0.00	0.00	0.99	0.99	0.00	0.00	100.00
E. F. Canyon Creek: Reach #3	0.00	0.46	2.05	2.51	0.00	18.38	81.62
North Fork Wall Ck: Reach #1	0.01	1.07	0.00	1.09	1.28	98.72	0.00
North Fork Wall Ck: Reach #2	0.44	0.15	0.00	0.59	74.44	25.56	0.00
Wall Creek: Reach #1	1.92	0.38	0.41	2.70	70.98	13.97	15.05
Wall Creek: Reach #3	0.01	0.23	0.00	0.23	3.38	96.62	0.00
Wall Creek: Reach #4	1.31	1.27	0.00	2.58	50.88	49.12	0.00
Wall Creek_T1: Reach #1	0.25	0.87	0.11	1.23	20.66	70.69	8.65

3.1.2.2.2.6 Middle Fork Canyon Creek

Of the 8.6 miles of Middle Fork Canyon Creek (spanning 6 reaches), 6.6 miles (77%) have both banks exposed (i.e., low stream shade) and 1.7 miles (20%) have moderate degrees of stream shading (one bank exposed) (Table 3.22). Of these, Reach 4 has the highest shade levels (57% moderate to high stream shade), as does Reach 6 (100% moderate stream shade). Most of the lowest reaches of both tributaries to Middle Fork Canyon Creek have at least 40% vegetative cover. Reach 2 of Tributary 2 is limited in stream shade, with 1.3 miles (91%) having both banks exposed to direct sunlight.

3.1.2.2.2.7 Sugarloaf Subwatershed

Approximately 3.9 miles of the 4.0 miles (96%) of Canyon Creek that flow through this subwatershed have exposed stream banks (i.e., low stream shade) (Table 3.23). Sugarloaf Gulch is segmented with sections of moderate to low shade. The majority of Reach 1 of Wickiup Creek has moderate levels of stream shade; Reach 2 contrasts with 100% of its length having little to no stream shade. Overall, shade is a limiting factor for aquatic species in the Sugarloaf subwatershed.

Table 3.22. Shade classifications for Middle Fork subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				Percent of stream in shade class		
Stream and reach	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
MF Canyon Creek: Reach #1	0.00	0.00	2.55	2.55	0.00	0.00	100.00
MF Canyon Creek: Reach #2	0.00	0.00	1.39	1.39	0.00	0.00	100.00
MF Canyon Creek: Reach #3	0.00	0.00	1.21	1.21	0.00	0.00	100.00
MF Canyon Creek: Reach #4	0.21	0.45	0.50	1.16	17.93	39.09	42.98
MF Canyon Creek: Reach #5	0.00	0.00	0.96	0.96	0.00	0.00	100.00
MF Canyon Creek: Reach #6	0.00	1.28	0.00	1.28	0.00	100.00	0.00
MF Canyon Creek_T1: Reach #1	0.54	0.30	0.72	1.56	34.53	19.30	46.17
MF Canyon Creek_T2: Reach #1	0.16	0.32	0.01	0.49	32.55	65.71	1.75
MF Canyon Creek_T2: Reach #2	0.00	0.14	1.34	1.47	0.00	9.25	90.75

Table 3.23. Shade classifications for Sugarloaf subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				Percent of stream in shade class		
Stream and reach	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
Canyon Creek: Reach #7b	0.00	0.17	2.81	2.98	0.00	5.70	94.30
Canyon Creek: Reach #8	0.00	0.00	1.05	1.05	0.00	0.00	100.00
Sugarloaf Gulch: Reach #1	0.00	1.46	1.06	2.51	0.00	57.94	42.06
WF Wickiup Creek: Reach #1	0.00	1.16	0.29	1.45	0.00	79.68	20.32
Wickiup Creek: Reach #1	0.00	0.32	0.03	0.35	0.00	91.99	8.01
Wickiup Creek: Reach #2	0.00	0.00	1.23	1.23	0.00	0.00	100.00

3.1.2.2.2.8 Upper East Fork

The Upper East Fork subwatershed lies completely within the wilderness. Of the 4.2 miles of East Fork Canyon Creek, 4.1 miles (approximately 97%) have moderate levels of vegetative cover (Table 3.24). Brooklings Creek has approximately 63% of its length with cover exceeding 70% (i.e., high shade). East Fork Brooklings, Skin Shin and Tamarack Creeks have moderate to high stream shade; Miner's Creek has moderate shading throughout its length (i.e., one stream bank exposed to direct sunlight). Overall, reaches in this subwatershed have adequate levels of stream shading for aquatic species.

Table 3.24. Shade classifications for Upper East Fork subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				Percent of stream in shade class		
Stream and reach	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
Brooklings Creek: Reach #1	0.00	0.27	0.00	0.27	0.00	100.00	0.00
Brooklings Creek: Reach #2	1.21	0.02	0.00	1.23	98.23	1.77	0.00
Brooklings Creek: Reach #3	0.53	0.00	0.74	1.27	41.54	0.00	58.46
E. Brooklings Ck: Reach #1	1.41	0.83	0.00	2.24	63.00	37.00	0.00
E. F. Canyon Creek: Reach #4	0.00	2.31	0.14	2.45	0.00	94.24	5.76
E. F. Canyon Creek: Reach #5	0.00	1.78	0.00	1.78	0.00	100.00	0.00
Miner's Creek: Reach #1	0.00	2.12	0.00	2.12	0.00	100.00	0.00
Skin Shin Creek: Reach #1	0.23	1.16	0.00	1.38	16.51	83.49	0.00
Skin Shin Creek: Reach #2	0.19	0.31	0.32	0.82	23.25	37.74	39.01
Tamarack Creek: Reach #1	0.71	0.06	0.01	0.79	90.77	8.22	1.01
Tamarack Creek: Reach #2	0.00	0.61	0.20	0.81	0.00	75.51	24.49

3.1.2.2.2.9 Vance Creek Subwatershed

The Vance Creek subwatershed has low to moderate stream shade throughout (Table 3.25). Of the 4.4 miles of Vance Creek, 1.9 miles (43%) have at least 40% vegetative cover and 2.2 miles (51%) have less than 40% cover. In general, stream shading on Vance Creek involves a patchwork of stream cover separated by areas of exposed stream channel. Reach 1 of Vance Creek has areas of dense vegetative cover, implying this reach is an important thermal refuge in the mid-reaches of Canyon Creek. Tributary 1 has generally mixed vegetative cover (low to moderate interspersed), and Tributary 2 of Vance Creek was completely exposed to direct sunlight. Despite the low to moderate shade cover, lower water temperatures are found in Vance Creek (see *Section 3.1.14*, *Chapter 3*). The lower temperatures may be attributed to the presence of springs and/or subsurface flow.

Table 3.25. Shade classifications for Vance Creek subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				Percent of stream in shade class		
Stream and reach	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
Vance Creek: Reach #1	0.25	0.65	1.17	2.07	12.11	31.53	56.36
Vance Creek: Reach #2	0.00	0.34	0.12	0.47	0.00	73.65	26.35
Vance Creek: Reach #3	0.00	0.89	0.91	1.81	0.00	49.52	50.48
Vance Creek_T1: Reach #1	0.00	0.79	0.51	1.30	0.00	60.94	39.06
Vance Creek_T2: Reach #1	0.00	0.00	0.90	0.90	0.00	0.00	100.00

3.1.3 Water Quality

This section of the report summarizes existing water quality information for the Canyon Creek Watershed. Water quality indicators may include several biological, chemical, and/or physical parameters. Data describing current water quality conditions in Canyon Creek were available (or could be inferred) for only two parameters – water temperature and fine sediment.

3.1.3.1 Water Temperature

The federal Clean Water Act (CWA) requires that states maintain a list of water bodies that are "water quality limited," i.e., do not meet water quality standards. The listing of water quality limited streams is referred to as the "303(d) list." In Oregon, the Department of Environmental Quality (ODEQ) is responsible for maintaining the state's 303(d) list. The ODEQ periodically revises the 303(d) list. Currently, there is one stream segment within the Canyon Creek watershed that appears on the 1998 303(d) list and an additional segment proposed for inclusion on the 2002 303(d) list (Table 3.26 and Map 3.3).

Table 3.26. Water bodies within Canyon Creek watershed appearing on ODEQ 303(d) list.

List date	Water body name	Parameter/ season	Criteria	Beneficial uses	Supporting data
1998	Canyon Creek, RM 0 to 27.5	Summer water temperature	Rearing: 64 °F	Anadromous fish passage Resident fish and aquatic life Salmonid fish spawning Salmonid fish rearing	BLM Data (Site above Canyon City): 7 day average of daily maximums of 66.5/68.4 with 26 of 87 days exceeding temperature standard (64) in 1993/1994; USFS (at Hwy 65): 7 day average of daily maximums of 66/85 with 5 of 97 days exceeding standard (64) in 1993/1994.
2002	East Fork Canyon Creek, RM 0 to 9.2	Summer water temperature	Rearing: 64 °F	Salmonid fish rearing Anadromous fish passage	Laboratory Analytical Storage and Retrieval (LASAR) station #24046 at RM 2.6: In 2000, 43 days with 7 day average of daily maximums > 65 F (17.8 C).

Source: ODEQ 2002.

Additional water temperature data, available for 25 sites in the Canyon Creek watershed, were made available for this analysis by the USFS (Map 3.3 and Table 3.27). The data provided by the USFS was evaluated in the following manner: A seven-day moving average of the daily maximum temperature[5] was first calculated for each data record. The seven-day moving average of the daily maximum temperature was then compared to the ODEQ temperature criteria for salmonid rearing (64º F) and the number of days that the seven-day average exceeds the criteria was recorded. In addition, the National Marine Fisheries Service (NMFS[6] 1996) has established the following functional risk categories for summer salmonid rearing life-history stages:

- Functioning appropriately – 50 to 57 º F
- Functioning at risk – 57 to 64 º F
- Functioning at Unacceptable risk – > 64 º F

The seven-day moving average of the daily maximum temperature was also compared to the criteria identified by the NMFS, and the number of days that the seven-day average exceeds the criteria was also recorded. Time series plots of temperature data from all stations are included in Appendix 1 of this report, along with a summary of the maximum seven-day average temperature for each year and the number of days that the temperature criteria described above are exceeded.

[5] *OAR 340-04l-0006 (54) defines the numeric temperature criteria as the seven-day moving average of the daily maximum temperatures.*
[6] *Currently referred to as NOAA Fisheries.*

Table 3.27. Data availability for USFS water temperature monitoring within Canyon Creek watershed.

Map #	Site description	Sampling year								
		1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
1	E F Canyon Creek		■	■	■	■	■	■	■	
2	M F Canyon Creek @ Mouth			■	■	■		■	■	
3	M F Canyon Creek near Wilderness						■	■		
4	M F Canyon Creek, Sec. 30 (#1)						■	■	■	
5	M F Canyon Creek, Sec. 30 (#2)							■		
6	M F Canyon Creek, Sec. 36							■		
7	M F Canyon Creek above wetlands								■	
8	M F Canyon Creek below wetlands								■	
9	M F Canyon Creek blw narrow can.								■	
10	Canyon Creek above M F Canyon						■	■	■	
11	Canyon Creek above M F Canyon @ Draw									■
12	Canyon Creek 1,000' below M F Canyon									■
13	Canyon Creek above Big Canyon								■	■
14	Canyon Creek below Crazy Creek								■	
15	Canyon Creek above Crazy Creek		■	■	■	■	■	■	■	
16	Crazy Creek Sec. 4						■	■		
17	Crazy Creek @ mouth							■		
18	Canyon Creek Sec. 31							■		
19	Canyon Creek Sec. 29							■		
20	Canyon Creek above Reservoir						■	■		
21	Canyon Creek @ Boundary						■	■	■	■
22	Canyon Creek @ Wickiup Campground									■
23	Canyon Creek below Wickiup Campground (at aspen exclosure)	■	■	■	■	■				
24	Canyon Creek below Road Gulch				■	■				
25	Vance Creek @ Boundary	■	■	■	■	■	■	■		

It is important when interpreting stream temperature data to consider the climatic conditions for the year in which the data were collected. If only a single year's worth of data is collected for a given site, and the year happens to be unusually hot, then the data may not be representative of normal conditions[7]. Air temperature data from the John Day climate station (see *Chapter 1* of this report for station location) were used to evaluate how climatic conditions during the years of data collection compared to long-term conditions. A seven-day moving average maximum air temperature was calculated for the period of record (1961 to present) at the station. The maximum value for each year was recorded, and a percentile was calculated for each data point Figure 3.1). For the years having stream temperature data, three are below average (1995, 1997, 1999; Figure 3.1) and six are above average (1994, 1996, 1998, 2000, 2001, 2002; Figure 3.1). The year 2002 had the highest seven-day moving average maximum air temperature on record at the John Day station.

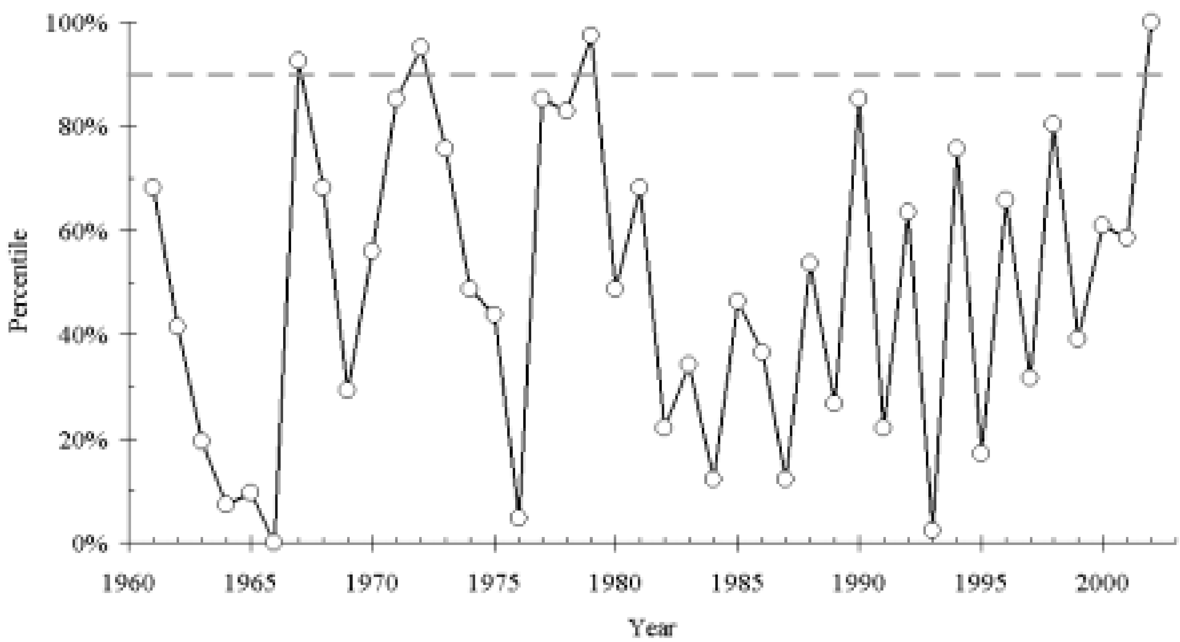


Figure 3.1. Percentiles for annual maximum seven-day average daily maximum air temperature at John Day weather station.

Twenty of the 25 streams monitored by the USFS exceed the ODEQ temperature criteria for salmonid rearing (i.e., 64º F) in most years (Figure 3.2). These streams would also be categorized as "Functioning at Unacceptable risk" using the NMFS (1996) criteria. Those stations that do not exceed the criteria are stations #16 – Crazy Creek in Section 4, #17 –

[7] *OAR 340-041-0605 recognizes these extreme conditions by stating "An exceedance of the numeric criteria… will not be deemed a temperature standard violation if it occurs when the air temperature during the warmest seven-day period of the year exceeds the 90th percentile of the seven-day average daily maximum air temperature calculated in a yearly series over the historic record."*

Crazy Creek at mouth, #19 – Canyon Creek in Section 29, #20 – Canyon Creek above Reservoir, and #25 – Vance Creek at the Forest Boundary (Figure 3.2). All five stations that do not exceed the criteria are located in headwater areas. It is interesting to note that both station #1 – East Fork Canyon Creek, and station #3 – Middle Fork Canyon Creek near wilderness, are located either within or close to the boundary of the designated wilderness area, yet both would be rated as "Functioning at Unacceptable risk" using the NMFS criteria (1996).

Three of the five streams that did not fall within the "Functioning at Unacceptable risk" criteria, do fall within the "Functioning at risk" criteria (Figure 3.2). These stations are #17 – Crazy Creek at mouth, #19 – Canyon Creek in section 29, and #20 – Canyon Creek above Reservoir. Only stations #16 – Crazy Creek in section 4, and #25 – Vance Creek at the Forest Boundary meet the "Functioning appropriately" criteria (Figure 3.2).

Regression analysis was used to determine the relationship between the annual maximum seven-day moving average of the daily maximum water temperature ($\mathbf{T_{max}}$) and the environmental variables most likely to affect water temperatures. The variables considered in the regression analysis were:

Site elevation (E). The elevation at the stream temperature monitoring site (in units of feet; determined from digital elevation model data)

Riparian shade (S). Riparian shade levels (expressed as a decimal) for the 1,000 feet of stream located immediately upstream of the temperature monitoring site. Sullivan et al. (1990) found that riparian shade levels in the 1,000-foot reach immediately upstream of a given point had the greatest influence on stream temperatures. Midpoint shade values were used for each shade category (i.e., areas classified as currently having "high" riparian shade [>70%] were assigned a value of 0.85; areas with a "moderate" shade rating [40% to 70 %] were assigned a value of 0.55; and areas with a "low" shade rating [< 40%] were assigned a value of 0.2). A length-weighted approach was used to estimate a composite shade value in situations where shade conditions change within the 1,000-foot reach.

Mean annual air temperature (T_{air}). Groundwater temperature may be approximated by the mean annual air temperature (Sullivan et al. 1990). Mean annual air temperature (in degrees F) at the Starr Ridge SNOTEL site were used to capture year-to-year variability in groundwater temperatures.

Mean annual streamflow (Q). Mean annual streamflow is another variable useful in evaluating year-to-year differences in $\mathbf{T_{max}}$. In general, maximum water temperatures will be higher in years with low streamflow and lower in wetter years. The closest active stream gage to Canyon Creek that has no data gaps between 1994 to 2002 is USGS gage # 14046000 – North Fork John Day River at Monument. Mean annual streamflow (cfs) from the North Fork gage was used in the regression model.

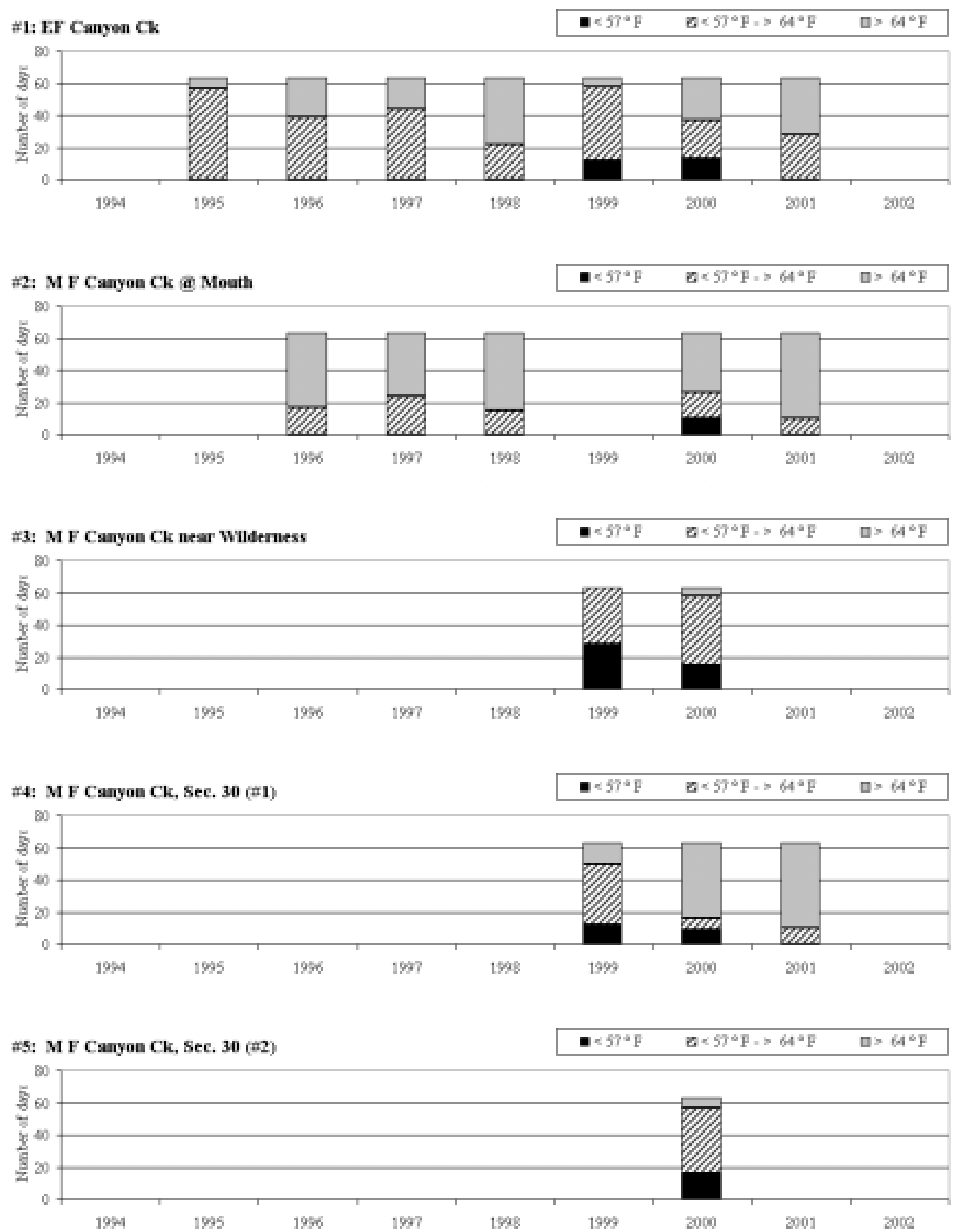


Figure 3.2. Frequency of days during the July 15th – September 15th period when the maximum seven-day moving average of daily maximum temperature is < 57 º F (i.e., functioning appropriately), 57 to 64 º F (functioning at risk), and > 64 º F (functioning at unacceptable risk).

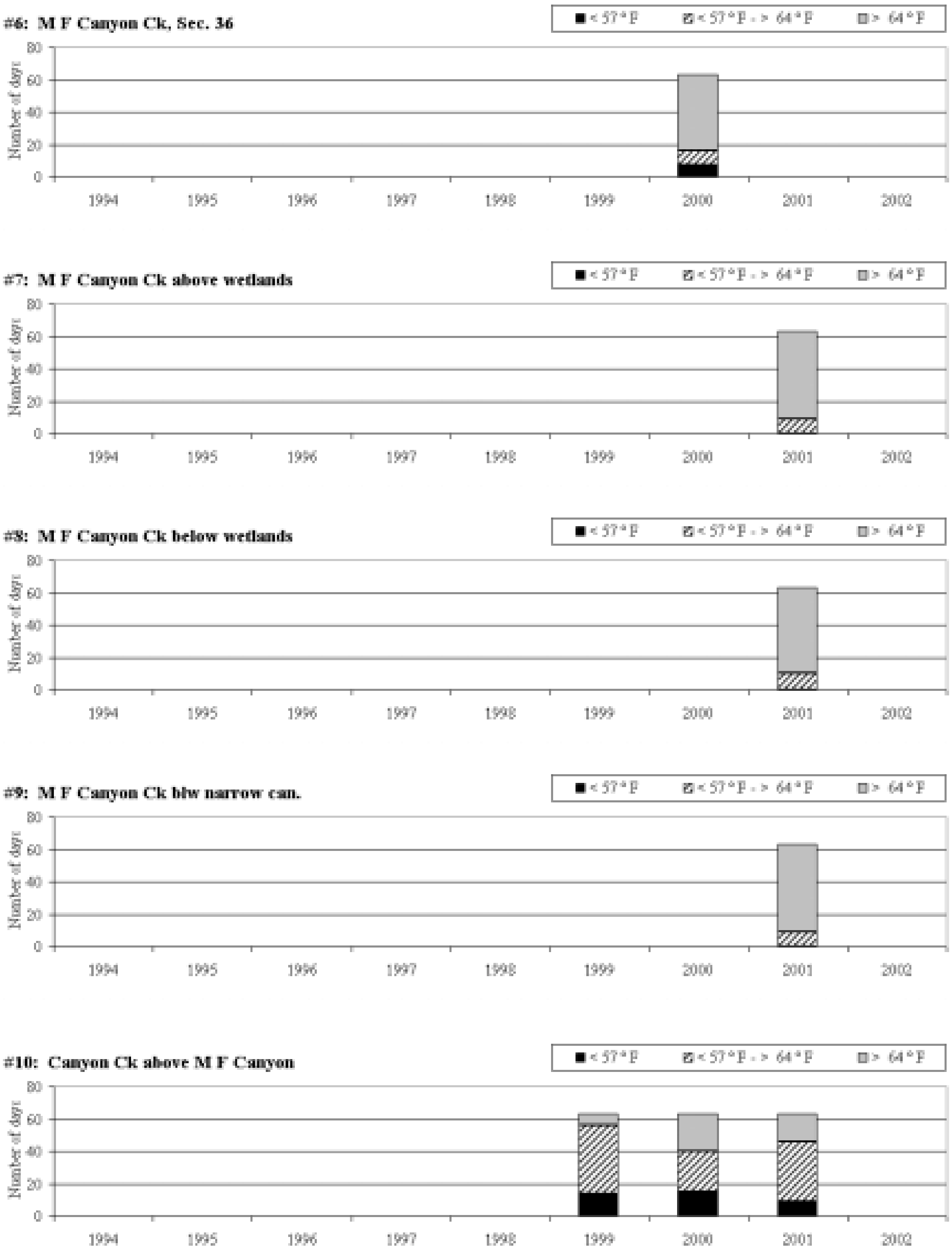


Figure 3.2 (continued). Frequency of days during the July 15th – September 15th period when the maximum seven-day moving average of daily maximum temperature is < 57 ºF (i.e., functioning appropriately), 57 to 64 º F (functioning at risk), and > 64 º F (functioning at unacceptable risk).

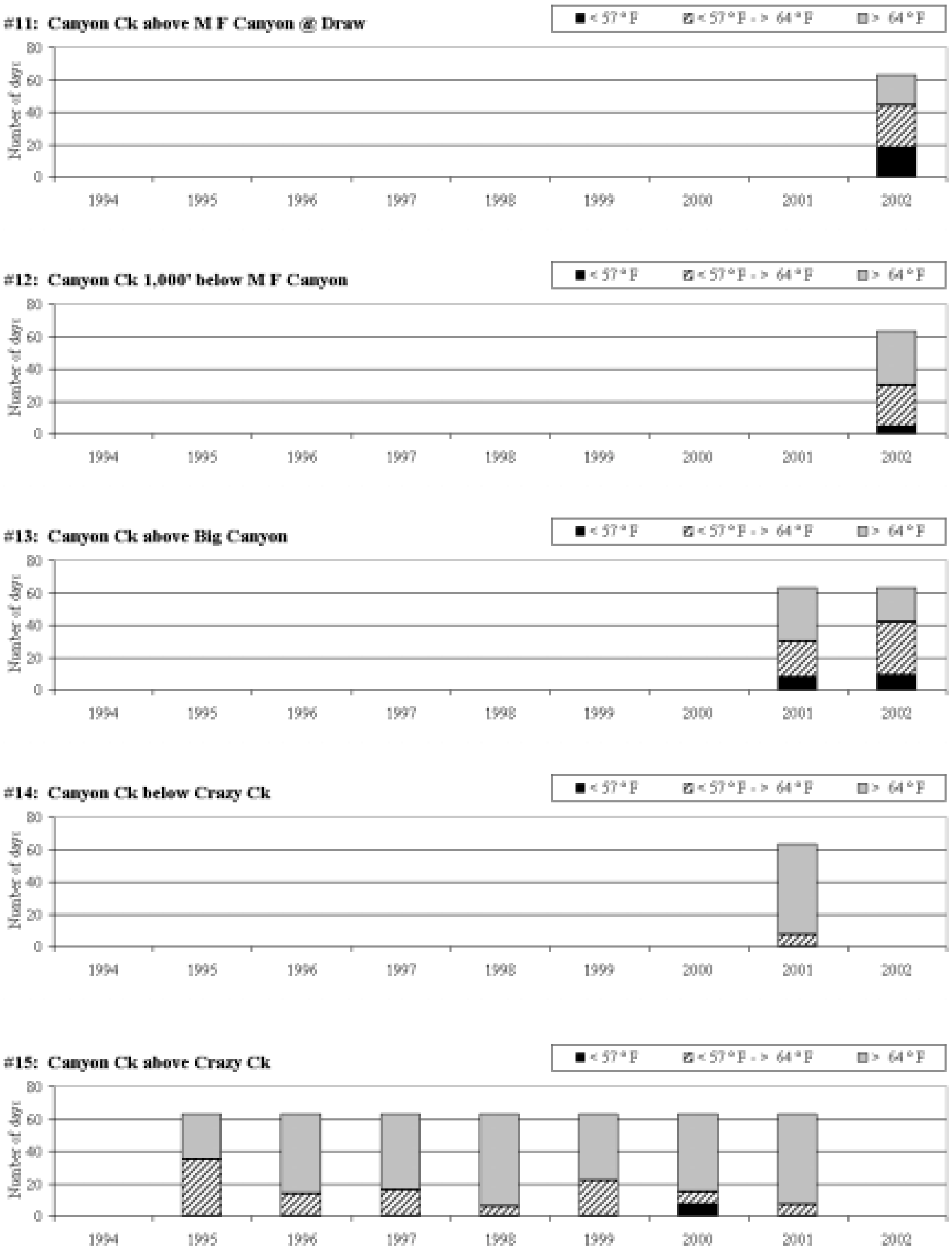


Figure 3.2 (continued). Frequency of days during the July 15th – September 15th period when the maximum seven-day moving average of daily maximum temperature is < 57 ºF (i.e., functioning appropriately), 57 to 64 º F (functioning at risk), and > 64 º F (functioning at unacceptable risk).

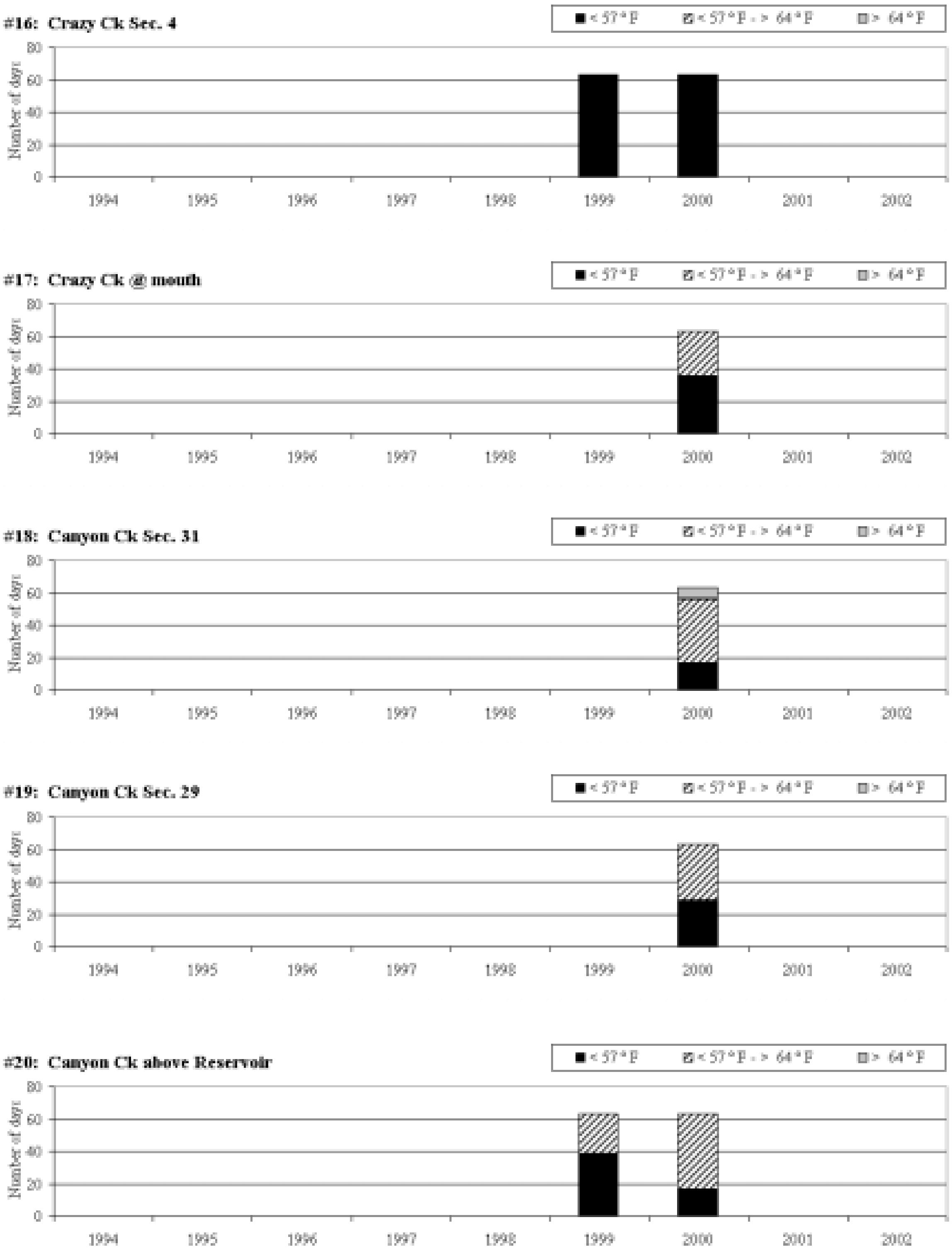


Figure 3.2 (continued). Frequency of days during the July 15th – September 15th period when the maximum seven-day moving average of daily maximum temperature is < 57 ºF (i.e., functioning appropriately), 57 to 64 º F (functioning at risk), and > 64 º F (functioning at unacceptable risk).

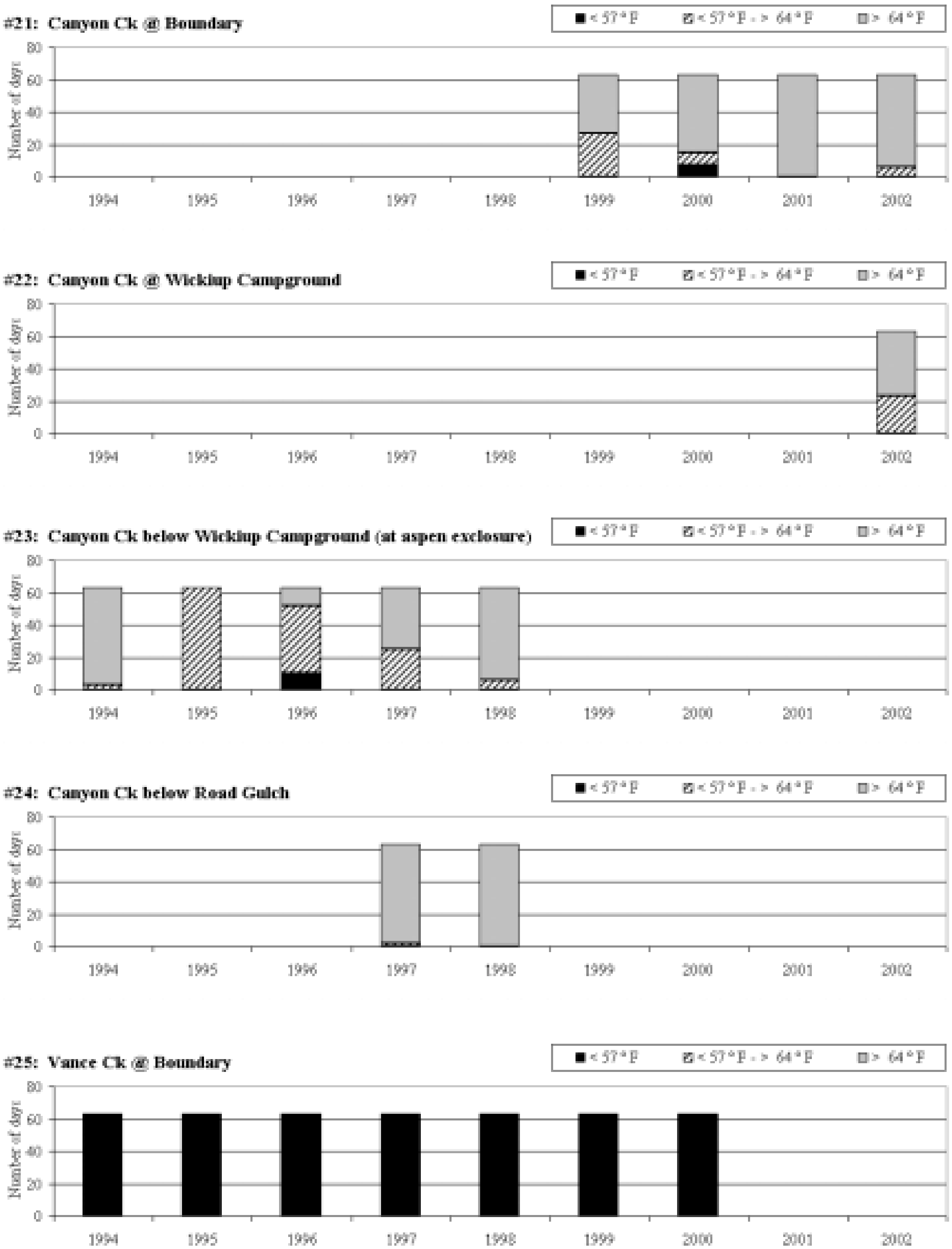


Figure 3.2 (continued). Frequency of days during the July 15th – September 15th period when the maximum seven-day moving average of daily maximum temperature is < 57 ºF (i.e., functioning appropriately), 57 to 64 º F (functioning at risk), and > 64 º F (functioning at unacceptable risk).

Distance from watershed divide (D). The final variable used in the regression analysis was distance from watershed divide (in units of miles). Distance from the watershed divide provides an index of the time that water has been exposed to ambient air temperatures. The implication is that streams that have a shorter distance to the watershed divide would be expected to have lower water temperatures

A stepwise approach was taken to eliminate those variable from the regression equation that were not statistically significant at the $p \leq 0.05$ level. The final form of the equation was:

$$T_{max} = -22.441\mathbf{S} - 0.00367\mathbf{Q} + 0.976\mathbf{D} + 70.677$$

(adjusted $R^2 = 0.811$, $n = 63$, all variables significant at $p \leq 0.00001$)

The fact that site elevation and mean annual air temperature (as a surrogate for groundwater temperature) were not statistically significant in the final equation does not necessarily mean that these are not important variables driving stream temperatures at any given site. The reason these variable were not statistically useful is probably due to the narrow range of variability in site elevations (all were between approximately 4,000 and 5,250 feet elevation) and mean annual air temperature (range from 42 to 44° F for the seven-year period).

The regression results presented above explained over 80% of the variability in T_{max} at the 25 temperature monitoring stations in the Canyon Creek watershed. The residual variability (Figure 3.3) was further examined to ascertain if there are any time-trends in the data or any additional site-specific patterns. No time trends were apparent within the residual variation. This is not surprising given the short-duration (seven years or less) of the data sets. The presence of a time-related trend in the residuals would suggest either recovery (in the case of a decreasing trend) or some disturbance that is decreasing the amount of shade or stream flow (in the case of an increasing trend).

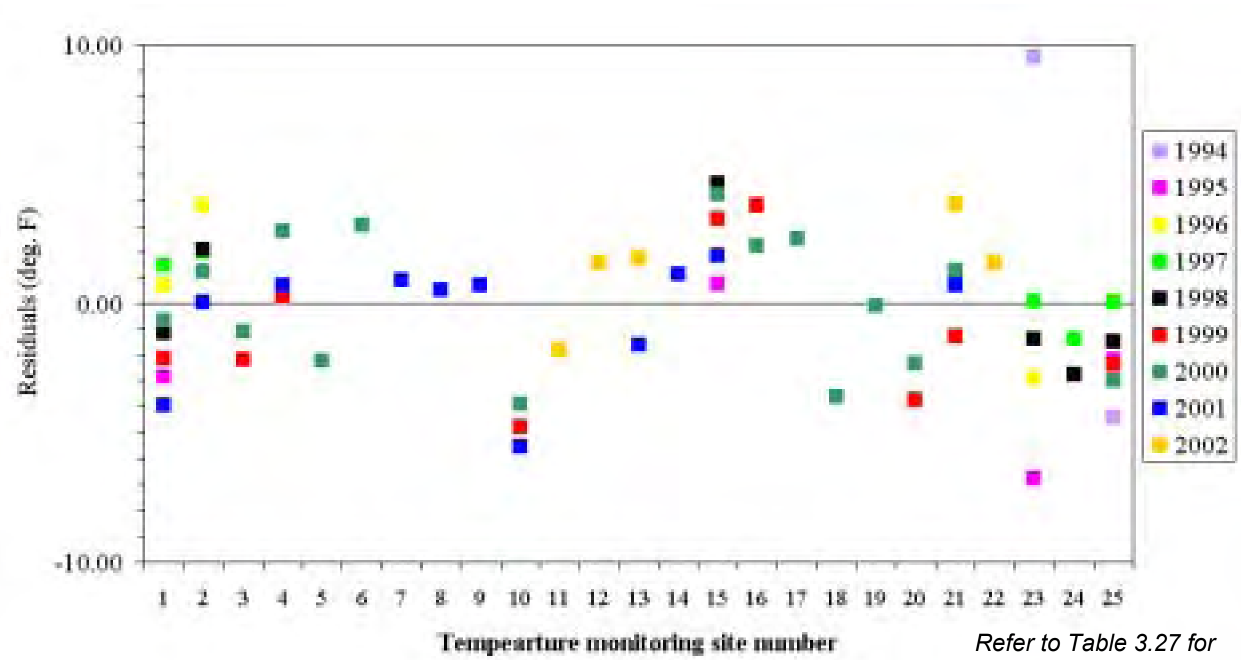
Examination of the residuals in Figure 3.3 indicate that there are several sites (e.g., 3, 10, and 25) where T_{max} is consistently cooler than expected, and other sites (e.g., 2 and 15) where T_{max} is consistently warmer than expected. These patterns suggest that there are site specific conditions that are not adequately accounted for in this regression analysis. For example, these sites may have a disproportionately large or small groundwater contribution to the total stream volume. Another item of interest in the residual variation is the how tight the residuals are clustered. The large year-to-year variation in the residuals at site #23 may be indicative of a large site-specific disturbance (e.g., removal of a beaver dam upstream). Despite the limitations, several points can be drawn from the analysis discussed above:

1. Stream temperatures are highly responsive to differences in riparian shade levels. Reductions in stream shade levels, through some type of riparian disturbance, will be

expected to increase stream temperatures. Conversely, actions that lead to an increase in riparian shading are expected to result in decreased stream temperatures.

2. Stream temperatures are sensitive to both natural and human-caused variations in summertime stream flow. Low base flow conditions, brought about by climatic conditions or human-related activities, will likely result in increased stream temperatures

3. Inherent differences in site conditions (e.g., elevation, distance from watershed divide, etc.) must also be considered when evaluating T_{max}.



Refer to Table 3.27 for description of site locations.

Figure 3.3. Residual variability from stream temperature regression model.

3.1.3.2 Sedimentation

3.1.3.2.1 Road-generated

Road-generated sediment can be a large source of sedimentation in some watersheds, particularly when the overall density of roads is high, the roads see frequent use, or the roads are located in steep terrain. The USFS has recently completed a road inventory within the Canyon Creek watershed (USFS 2002a) (Map 3.4). Results from this survey were used to qualitatively assess current road-related sedimentation concerns.

Overall road length and road density are summarized in Table 3.28. There are approximately 315 miles of roads within the Canyon Creek watershed, 204 miles of which are administered by the USFS. Road density for the entire road system ranges from 0.0 miles/mi^2 (i.e., no roads) in the Upper East Fork subwatershed to 5.2 miles/mi^2 in the Vance Creek subwatershed and density is 2.7 miles/mi^2 for the watershed overall. Road density for roads administered by the USFS ranges from 0.0 miles/mi^2 in the Upper East Fork and Berry Creek subwatersheds to 4.2 miles/mi^2 in the Vance Creek subwatershed and is 1.8 miles/mi^2 for the watershed overall.

Table 3.28. Road length and density by subwatershed within Canyon Creek watershed.

Subwatershed	***Total miles road***	***Subwatershed area (mi^2)***	***Road density: all roads (mi/mi^2)***	***Total miles USFS road***	***Road density: USFS roads (mi/mi^2)***
Berry Creek	22.1	15.1	1.5	0.0	0.0
Byram Gulch	1.5	1.4	1.1	0.7	0.5
Canyon City	38.4	8.8	4.4	0.1	0.0
Canyon Meadows	53.3	13.5	3.9	50.7	3.7
Fawn	81.9	21.9	3.7	54.2	2.5
Lower East Fork	2.0	12.1	0.2	1.2	0.1
Middle Fork Canyon Creek	21.9	11.1	2.0	21.9	2.0
Sugarloaf	55.1	11.6	4.8	44.4	3.8
Upper East Fork	0.0	12.6	0.0	0.0	0.0
Vance Creek	38.5	7.4	5.2	31.0	4.2
Entire Watershed	314.7	115.6	2.7	204.2	1.8

USFS roads within the Canyon Creek watershed having identified erosion concerns that are within 60 meters (~200 feet) of fish-bearing streams are summarized in Figure 3.4 (Map 3.5). Approximately half the USFS road system is open in the Fawn Creek subwatershed; two-thirds of the road system is open in the Sugarloaf, Vance Creek, and Middle Fork Canyon subwatersheds; 80% of the roads are open in the Canyon Meadows subwatershed; and 100% of the roads are currently open in the Lower East Fork subwatershed.

The recently completed USFS road inventory for the Canyon Creek watershed (USFS 2002a) identified road segments that have problems with respect to surface erosion. Twenty-seven miles of USFS roads were identified as currently having an erosion concern (Table 3.29). The majority of these roads are located within the Canyon Meadows, Sugarloaf, and Vance Creek subwatersheds.

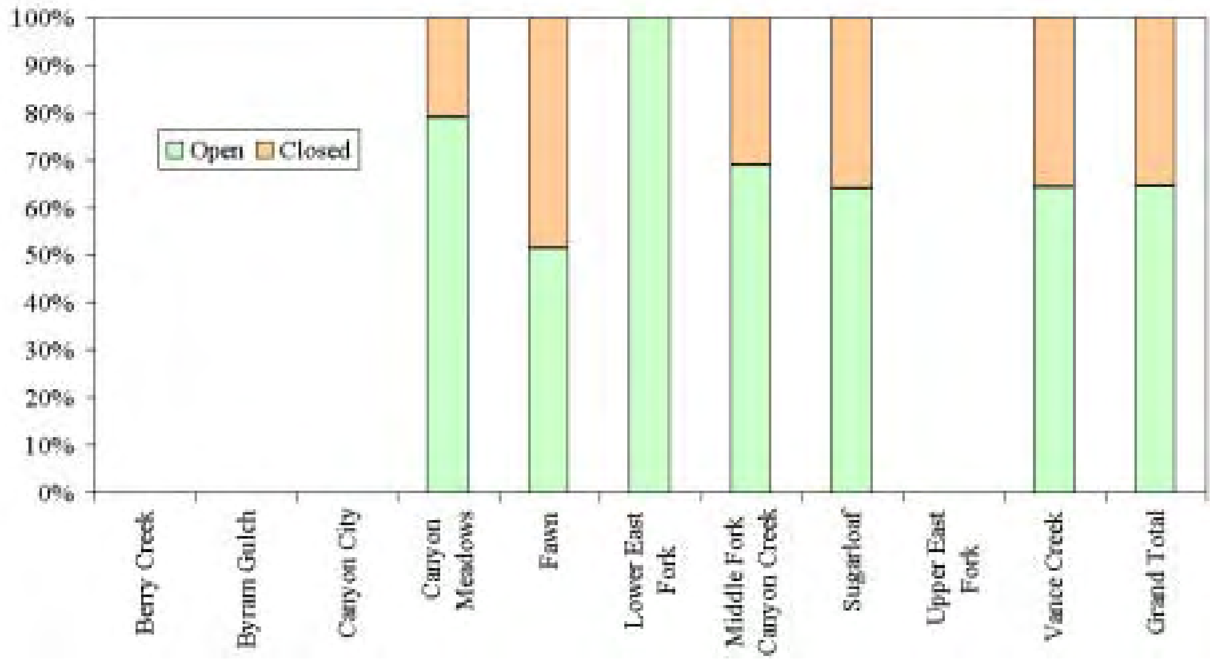


Figure 3.4. Summary of current USFS road closure status by subwatershed within Canyon Creek watershed.

Table 3.29. Summary of road length with identified erosion concerns, and road length identified for possible decommissioning.

Subwatershed	***Miles of USFS road with identified erosion concern***	***Miles of USFS road with identified erosion concern within 60 meters of fish-bearing stream***	***Miles of USFS road identified for possible decommissioning***
Berry Creek			
Byram Gulch			
Canyon City			
Canyon Meadows	8.3	1.1	8.9
Fawn	2.2	0.1	11.1
Lower East Fork			
Middle Fork Canyon Creek	2.1	0.3	2.8
Sugarloaf	7.9	2.0	4.8
Upper East Fork			
Vance Creek	6.7	0.3	5.5
Entire watershed	27.2	3.8	33.1

Further analysis of this data set was performed to pinpoint roads that may contribute considerable amounts of sediment to streams. It is generally accepted that the greatest amount of sediment will be delivered from road segments that are within 60 meters (~200 feet) of a stream (OWEB 1999, WFPB 1997). This 60-meter distance was used as an approximate break point to identify the majority of the road segments likely to contribute considerable amounts of sediments to the stream system. A total of 3.8 miles of USFS roads were identified as currently having erosion concern and are located within 60 meters of fish-bearing streams. The majority (2.0 miles) of these roads are within the Sugarloaf subwatershed.

An alternative approach was also used to identify road segments that may be delivering large amounts of sediment to the stream system. Information on road surfacing types is available as an attribute in the USFS GIS data coverage for the watershed. Also available are the erodibility ratings for the underlying soil polygons. For the purposes of this analysis, it was assumed that the erosion potential for native surfaced roads is represented by the erodibility rating of the underlying soil. Native-surfaced USFS roads are shown in Map 3.6. The distribution of native-surfaced roads by underlying soil erodibility class is summarized in Table 3.30

Table 3.30. Miles of native-surfaced road by underlying soil erosion class within Canyon Creek watershed.

	Soil erosion class					
Subwatershed	**Low**	**Low-Mod**	**Moderate**	**Mod-High**	**High**	**Very High**
Berry Creek	-	-	-	-	-	-
Byram Gulch	-	-	-	-	-	0.7
Canyon City	-	-	-	-	-	-
Canyon Meadows	-	2.0	21.0	12.7	-	3.1
Fawn	-	1.4	14.8	9.5	1.5	15.8
Lower East Fork	-	-	-	-	0.3	-
Middle Fork Canyon Creek	0.5	5.6	0.5	7.2	1.6	1.4
Sugarloaf	-	0.5	16.9	5.5	-	12.5
Upper East Fork	-	-	-	-	-	-
Vance Creek	-	0.4	3.2	8.0	-	10.5
Entire watershed	**0.5**	**9.8**	**56.4**	**42.9**	**3.4**	**44.1**

Only a very small proportion of the native-surfaced USFS roads within the watershed occur on areas where the soil erodibility class is rated as either Low (0.5 miles of road, or 0.3% of the total road length; Table 3.30) or Low-Moderate (6% of the total road length). The majority of the road length falls within the Moderate (36% of the total road length) and Moderate-High (27% of the total road length) classes. Only a small proportion of the native-surfaced USFS roads occur on areas of High soil erosion potential (2% of the total road length); however, 28% of the total road length occurs on soils classified as having Very High erosion potential.

As in the preceding section, a second analysis was performed for those road segments that are located within 60 meters of fish-bearing streams (Table 3.31). A total of 3.6 miles of USFS roads were identified as being located within 60 meters of fish-bearing streams. Approximately one mile of these road segments are located on soils classed as having Very High erosion potential, and these are located within the Middle Fork Canyon Creek and Sugarloaf subwatersheds.

Table 3.31. Miles of native-surfaced road within 60 meters of fish-bearing streams by underlying soil erosion class within Canyon Creek watershed.

	Soil erosion class					
Subwatershed	***Low***	***Low-Mod***	***Moderate***	***Mod-High***	***High***	***Very High***
Berry Creek	-	-	-	-	-	-
Byram Gulch	-	-	-	-	-	-
Canyon City	-	-	-	-	-	-
Canyon Meadows	-	0.3	0.1	0.1	0.1	-
Fawn	0.0	-	-	-	0.2	-
Lower East Fork	-	-	-	0.1	-	-
Middle Fork Canyon Creek	-	0.9	0.4	-	-	0.2
Sugarloaf	-	-	0.3	-	-	0.8
Upper East Fork	-	-	-	-	-	-
Vance Creek	-	-	-	-	-	-
Entire watershed	0.0	1.2	0.8	0.1	0.3	1.0

The USFS road inventory for the Canyon Creek watershed (USFS, 2002) identified road segments that may be candidates for decommissioning[8]. Roads identified for possible decommissioning are shown in Map 3.7 and summarized in Table 3.29. Approximately 33 miles are identified for possible decommissioning within the watershed; located within the Fawn, Canyon Meadows, Vance Creek, Sugarloaf, and Middle Fork Canyon Creek subwatersheds.

One final item from the USFS road inventory for the Canyon Creek watershed (USFS 2002a) is the maintenance concerns identified by road segment. Maintenance concerns

[8] *The road segments identified for possible decommissioning discussed here are based solely on field-review by District personnel. A road analysis must be completed before any decision is made as to which road segments (if any) are recommended for decommissioning*

are summarized for the entire watershed in Figure 3.5. The five primary maintenance concerns include blading, brushing, culvert installation/maintenance, ditch installation/ maintenance, and waterbar installation/ maintenance. With the exception of brush removal, all these maintenance concerns, if implemented, will tend to reduce road-related sediment generation.

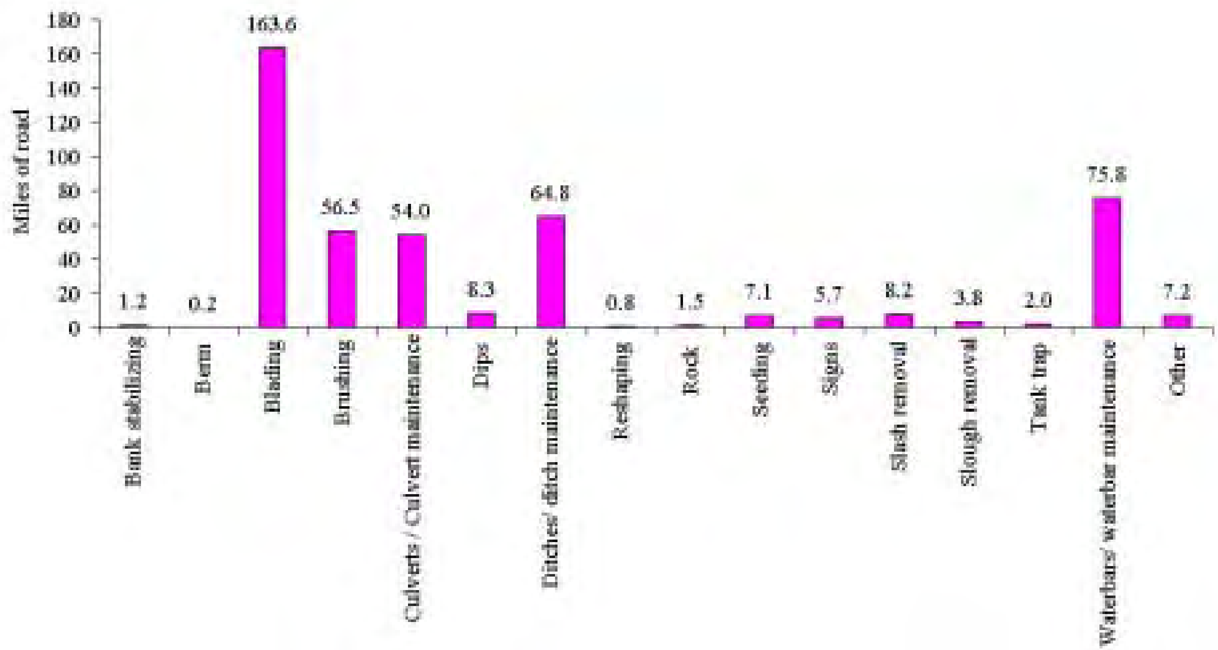


Figure 3.5. Miles of road within Canyon Creek watershed identified by maintenance concern. Source: USFS (2002).

In summary, although no quantitative evaluation of sediment-generation from roads is available for the Canyon Creek watershed, the following points can be made based on the qualitative metrics used in this evaluation:

Road density. Road density is generally accepted as being positively correlated with sedimentation (USFS 1996). However, recent studies from eastern Washington (Schiess and Krogstad 2000) indicate that road density alone is a poor indicator of sediment delivery to streams and that other factors (e.g., road surfacing and use) may be far more important. In a relative sense, road density in the Canyon Creek watershed can be used to identify those subbasins where road-related sediment may be of the most concern; Vance Creek, Sugarloaf, Canyon City, Canyon Meadows, and the Fawn subwatersheds all have road densities of from 3.7 to 5.2 miles/mile^2 (Table 3.28).

Road use. Sediment production and delivery is positively correlated with road use, particularly during wet weather (WFPB 1997). While no data exists on current use levels for roads in the watershed, information on closure status (Figure 3.4) indicates that most roads are open for use.

Identified erosion concerns. Recent road inventories conducted by the USFS indicate that a very small proportion of the roads within the watershed (27 miles of the approximately 200 miles of USFS roads; Table 3.29) currently have any erosion concern; and of the roads in close proximity to streams only four miles of road currently have an identified erosion concern (Table 3.29). Problem roads are located primarily in the Sugarloaf and Canyon Meadows subwatersheds.

Erosion concerns based on native surfaced roads. Additional analysis was performed to evaluate the distribution of native-surfaced roads within areas of high soil erodibility. Native-surfaced roads located on soils with a Very High erodibility classification are found primarily in the Fawn, Sugarloaf, and Vance Creek subwatersheds (Table 3.30). Native-surfaced roads located within 60 meters of fish-bearing streams, and on soils with a Very High erodibility classification, are found only in the Middle Fork Canyon Creek and Sugarloaf subwatersheds (Table 3.31).

Road decommissioning. Approximately 33 miles of USFS roads are identified for possible decommissioning within the Canyon Creek watershed (Table 3.29). The majority of the roads identified for possible decommissioning (Map 3.7) are the roads identified as having erosion concerns (Map 3.8).

Identified maintenance concerns. Implementation of the primary maintenance concerns identified in the recent road inventory will tend to reduce road-related sediment generation

The results presented here reflect the professional judgment of district personnel who feel that roads are not having a big effect on stream sedimentation and that most sediment is the result of stream bank erosion (McNeil, pers. comm. 2002). Soils within the forested portions of the watershed are generally permeable and overland flow is rare.

3.1.3.2.2 Mass Wasting

Mass wasting events can contribute large volumes of sediment to stream channels. No systematic assessment of mass wasting failures is available for the Canyon Creek watershed; however, based on available anecdotal information summarized below, it does not appear that mass wasting is a large source of sedimentation.

Grant County was included in a statewide inventory of mass failures associated with four large storms that occurred in 1996 and 1997 (Hofmeister 2000). Although these storm events were large (i.e., recurrence intervals up to or exceeding 25 years) in western Oregon, they do not appear to have been noteworthy in the area of the Canyon Creek watershed. Only one event in Grant County is identified in this inventory and it is located west of the Canyon Creek watershed along the South Fork of the John Day River.

Vegetation typing has recently been conducted in the watershed (see the *Current Vegetation* section for more details) using the Malheur, Umatilla, and Wallowa-Whitman National Forests Vegetation Polygon Mapping and Classification Standards. One of the "Existing Life Form" codes used in this typing is the "NL - Landform failure" code used to denote areas of natural slumps and other existing mass wasting features. Only one mass wasting feature was identified during this inventory; it is an area of approximately 11 acres that delivers to the fish-bearing tributary 4 of the Middle Fork Canyon Creek (Figure 3.6). This landslide has apparently existed since at least the fall of 1986, when it was first noted by a hunter in the area (Brown, pers. comm. 2002). The slide exists in an area that is primarily composed of volcanic ash type soils. This slide was not noted during a stream survey in the area conducted in 1994; however, an additional slide was noted along the Middle Fork Canyon Creek downstream of tributary 6 (Figure 3.6). This second slide was reported to have been approximately 160 feet long and approximately 20 to 30 feet high and was thought to have occurred in 1985/1986. The stream survey also reported an additional slide approximately 50 feet in length located immediately upstream of tributary 6. All three slides presumably occurred around the same time and all are located within the Strawberry Mountain Wilderness area.

3.1.4 Water Quantity

3.1.4.1 Effects of water withdrawals

The Oregon Water Resources Department (OWRD) Water Availability Report System (WARS) provides estimates of the net effects of water withdrawals on monthly stream flows at four locations within the Canyon Creek watershed (OWRD 2002c). The four locations are 1) the mouth of Canyon Creek, 2) East Fork Canyon Creek at the mouth, 3) Canyon Creek above East Fork Canyon Creek, and 4) Middle Fork Canyon Creek at the mouth.

In estimating the net effects of water withdrawals on monthly stream flows, the OWRD has taken into account the fact that a portion of the water withdrawn from the water source returns to the stream. Only the portion of each withdrawal that is actually consumed (i.e., the consumptive use) is included in the net estimate. A consumptive use is defined by the OWRD as any water use that causes a net reduction in stream flow (OWRD 2002c). These uses are usually associated with an evaporative or transpirative loss. The OWRD recognizes four major categories of consumptive use: irrigation, municipal, storage, and all others (e.g., domestic, livestock).

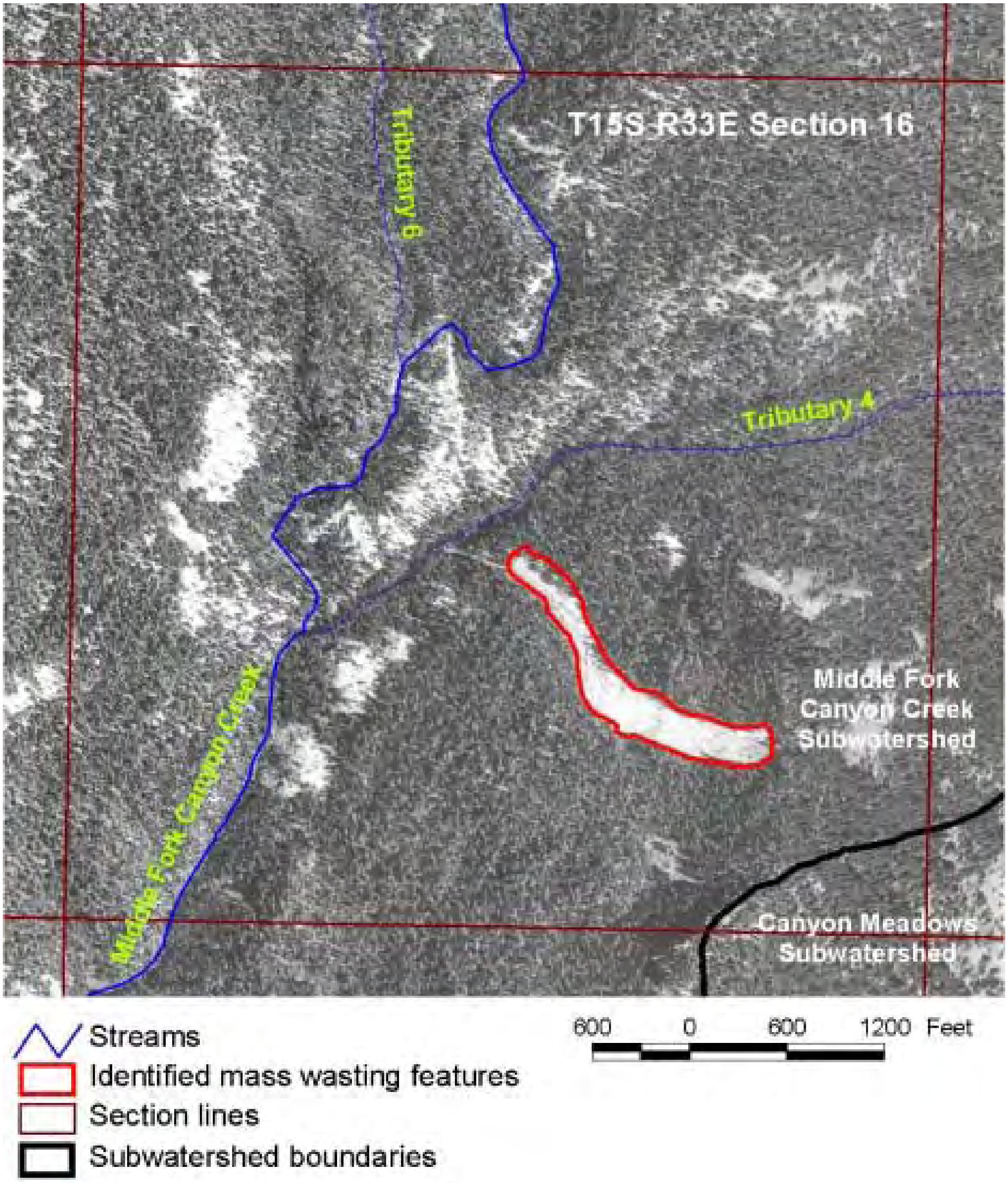


Figure 3.6. Location of mass wasting feature identified in the Middle Fork Canyon Creek subwatershed.

The OWRD estimates the consumptive use for irrigation using estimates made by the USGS, including estimates from the 1987 Census of Agriculture, estimates from the OSU Cooperative Extension Office, 1989-90 Oregon Agriculture and Fisheries Statistics, and an OSU Study of Crop Water Requirements (OWRD 2001b). Irrigation uses are not estimated to be 100% consumptive. Consumptive use from other categories of use is obtained by multiplying a consumptive use coefficient (e.g., for domestic use, the coefficient is 0.20) by the maximum diversion rate allowed for the water right. The OWRD assumes that all of the non-consumed part of a diversion is returned to the stream from which it was diverted. The exception is when diversions are from one watershed to another, in which case the use is considered to be 100% (i.e., the consumptive use equals the diversion rate).

The net effect of water withdrawals on monthly stream flows was estimated at each of the four locations (i.e., the mouths of Canyon, East Fork Canyon, and Middle Fork Canyon; and Canyon Creek above East Fork Canyon) in the following manner:

1. The estimated monthly natural stream flows[9] for average and dry years (represented by the 50% and 80% exceedance flow[10] respectively) were first plotted for each location.
2. The portion of all water withdrawals that does not return to the stream (i.e., the consumptive uses) was added to water diverted for storage for each month and plotted on the same graph.
3. If an instream water right exists for the subwatershed, this was also shown on the graph
4. Finally, the sum of instream water rights, consumptive uses, and storage was plotted on the graph.

Figure 3.7 (top graph) shows the estimated net effect of water withdrawals on monthly stream flows at the mouth of Canyon Creek. These estimates indicate that consumptive water use plus storage does not exceed the estimated volume of natural stream flow in any month in average years (50% exceedance flows); however, in dry years (80% exceedance flows) consumptive water use plus storage does exceed the estimated volume of natural stream flow in the months of August and September. In other words, if all the water that is allowed under existing water rights (exclusive of instream rights) is withdrawn, there would be stream flow in all months during “normal” years, but there would be no stream flow in the months of August and September in “dry” years. Instream

[9] *As calculated by the OWRD.*

[10] *The 50% exceedance stream flow is the stream flow that occurs at least 50% of the time in a given month. Conversely, the stream flow is also less than the 50% exceedance flow half the time. The 50% exceedance flow can be thought of as the average stream flow for that month. The 80% exceedance stream flow is exceeded 80% of the time. The 80% flow is smaller than the 50% flow and can be thought of as the stream flow that occurs in a dry month. These exceedance stream flow statistics are used by the OWRD to set the standard for over-appropriation: the 50% exceedance flow for storage and the 80% exceedance flow for other appropriations (OWRD, 2002c).*

water rights are limited to no more than the natural 50% exceedance stream flow (OWRD 2002a). It appears, based on the data shown in Figure 3.7 (top graph), that the instream water rights for Canyon Creek at the mouth were set at or near the natural 50% exceedance stream flow for the summer and fall months. Consequently, the sum of instream water rights, consumptive uses, and storage exceeds the estimated volume of natural stream flow in both average (50% exceedance flows) and dry (80% exceedance flows) years in the months of October to February and July to September. In other words, there is no way, given these estimated volumes of natural flow and the water withdrawals allowed, for the instream water rights to be fulfilled in these months.

Figure 3.7 (bottom graph) shows the estimated net effect of water withdrawals on monthly stream flows at the mouth of East Fork Canyon Creek. These estimates indicate that consumptive water use plus storage does not exceed the estimated volume of natural stream flow in any month in either average (50% exceedance flows) and dry (80% exceedance flows) years. In other words, if all of the water is withdrawn that is allowed under existing water rights (exclusive of instream rights), there would still be some stream flow in all months during both “normal” and “dry” years. The sum of instream water rights, consumptive uses, and storage exceeds the estimated volume of natural stream flow during average years (50% exceedance flows) in the months of July, August, September, and October. In dry years (80% exceedance flows), the sum of instream water rights, consumptive uses, and storage exceeds the estimated volume of natural stream flow during all months except April and May. In other words, instream water rights will not be fulfilled in these months if all other water rights are fully used.

The estimated net effect of water withdrawals on monthly stream flows for Canyon Creek above the mouth of East Fork Canyon Creek is show in Figure 3.8 (top graph). These estimates indicate that consumptive water use plus storage does not exceed the estimated volume of natural stream flow in any month in either average (50% exceedance flows) or dry (80% exceedance flows) years. In other words, if all the water is withdrawn that is allowed under existing water rights (exclusive of instream rights), there would still be some stream flow in all months during both “normal” and “dry” years. The sum of instream water rights, consumptive uses, and storage does not exceed the estimated volume of natural stream flow during average years (50% exceedance flows) in any month. In dry years (80% exceedance flows), the sum of instream water rights, consumptive uses, and storage exceeds the estimated volume of natural stream flow during all months except April, May, and June. In other words, instream water rights will not be fulfilled in these months if all other water rights are fully used.

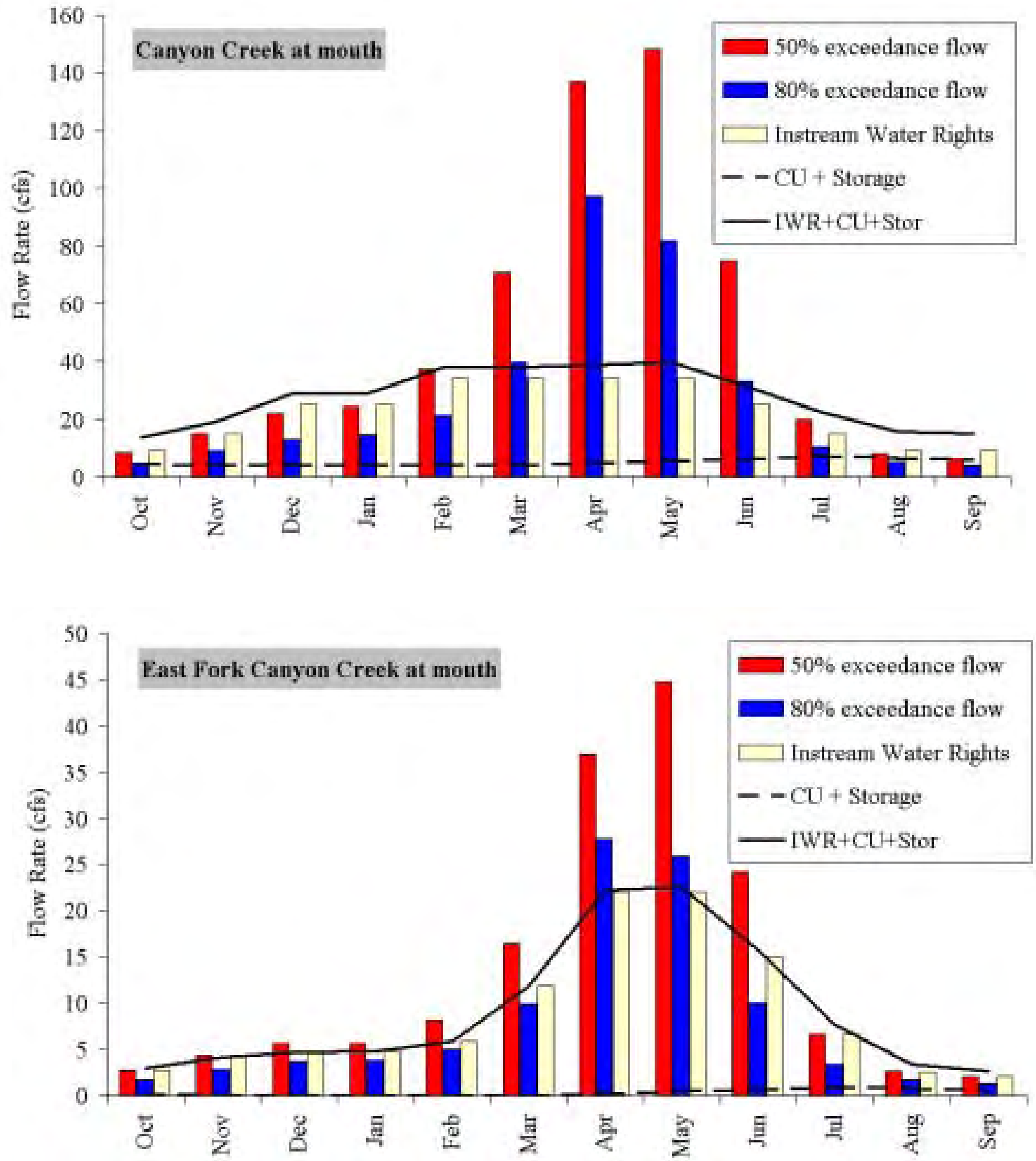


Figure 3.7. Estimated net effect of water withdrawals on monthly stream flows at the mouth of Canyon Creek (top graph) and at the mouth of the East Fork Canyon Creek (bottom graph).

Shown in Figure 3.7 are estimated natural stream flows for average and dry years (50% and 80% exceedance flows); instream water rights; the sum of consumptive uses (CU) and water storage; and the sum of instream water rights (IWR), consumptive uses (CU) and storage (STOR) (data source: OWRD [2002a]).

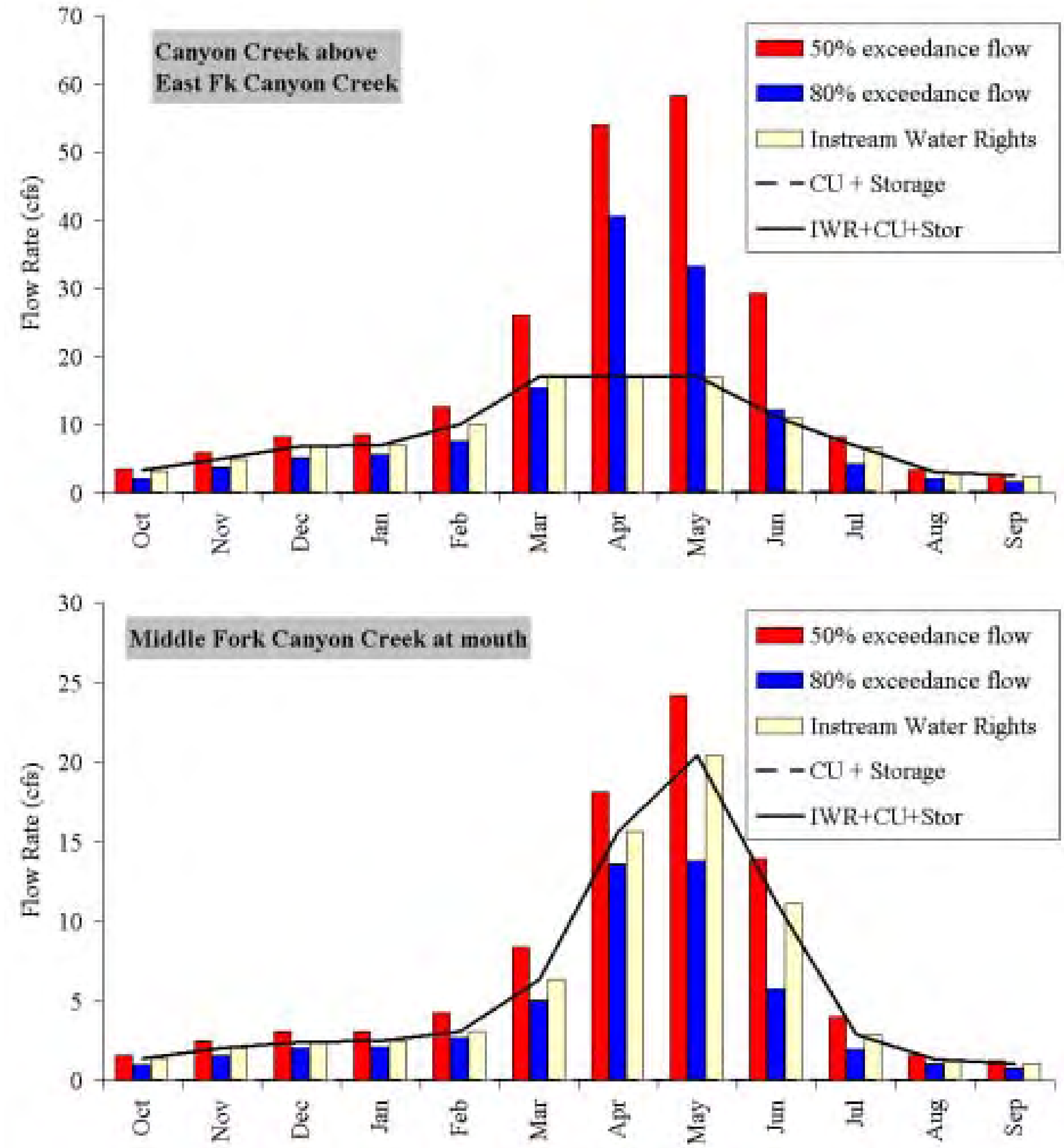


Figure 3.8. Estimated net effect of water withdrawals on monthly stream flows at Canyon Creek above East Fork Canyon (top graph), and at the mouth of the Middle Fork Canyon Creek (bottom graph).

Shown in Figure 3.8 are estimated natural stream flows for average and dry years (50% and 80% exceedance flows); instream water rights; the sum of consumptive uses (CU) and water storage; and the sum of instream water rights (IWR), consumptive uses (CU) and storage (STOR) (data source: OWRD [2002a]).

Figure 3.8 (bottom graph) shows the estimated net effect of water withdrawals on monthly stream flows for the Middle Fork of Canyon Creek at the mouth. These estimates indicate that consumptive water use plus storage does not exceed the estimated volume of natural stream flow in any month in either average (50% exceedance flows) or dry (80% exceedance flows) years. In other words, if all of the water is withdrawn that is allowed under existing water rights (exclusive of instream rights), there would still be some stream flow in all months during both "normal" and "dry" years. When instream rights are added, the sum of instream water rights, consumptive uses, and storage does not exceed the estimated volume of natural stream flow during average years (50% exceedance flows) in any month. In dry years (80% exceedance flows), the sum of instream water rights, consumptive uses, and storage exceeds the estimated volume of natural stream flow during all months. In other words, instream water rights will not be fulfilled in these months if all other water rights are fully utilized.

3.1.4.2 Effects of Other Land Uses

Figure 3.9 is a generalized diagram showing the primary interactions between land use impacts that may be found in the Canyon Creek watershed and changes in peak, annual, and low stream flows. Note that Figure 3.9 does not include "top-level" land uses (e.g., Urbanization, Agriculture, Forest Management, etc.). The reason for this is that there often is considerable overlap between top-level land uses and the underlying hydrologic processes that they affect. For example, both forest management and agricultural practices have the ability to affect vegetation removal, soil erosion/mass wasting, wetland degradation, channel down-cutting, dike/levee construction, soil compaction, and road development. This analyst believes that, rather than discussing impacts by top-level land uses, it is more appropriate to discuss land use impacts in terms of the underlying processes.

Vegetation Removal. Rain-on-snow (ROS) is the common term used to describe wintertime conditions when relatively warm wind and rain combine to produce rapid snowmelt (Coffin and Harr 1992). ROS flood events may occur in areas having appreciable wintertime snow packs and are independent of land use. Removal of the forest canopy can augment ROS peak flows by increasing snow accumulation in openings (Troendle 1983, Bosch and Hewlett 1982) and increasing the rate of snowmelt by increasing the effective wind speeds at the snowpack surface (Harr 1981, Harr 1986, Coffin and Harr 1992). The extent to which forest removal may augment ROS peak flows is a function of the amount of harvesting within the elevation range that defines the ROS zone. At low elevations (below the ROS zone), winter temperatures are generally too warm to allow for much snow accumulation, and at higher elevations wintertime precipitation generally falls as snow. As discussed in *Chapter 1* of this report, ROS appears to be an important process in peak flow generation within the Canyon Creek watershed. Consequently, the potential exists for peak flows to be augmented by forest harvesting.

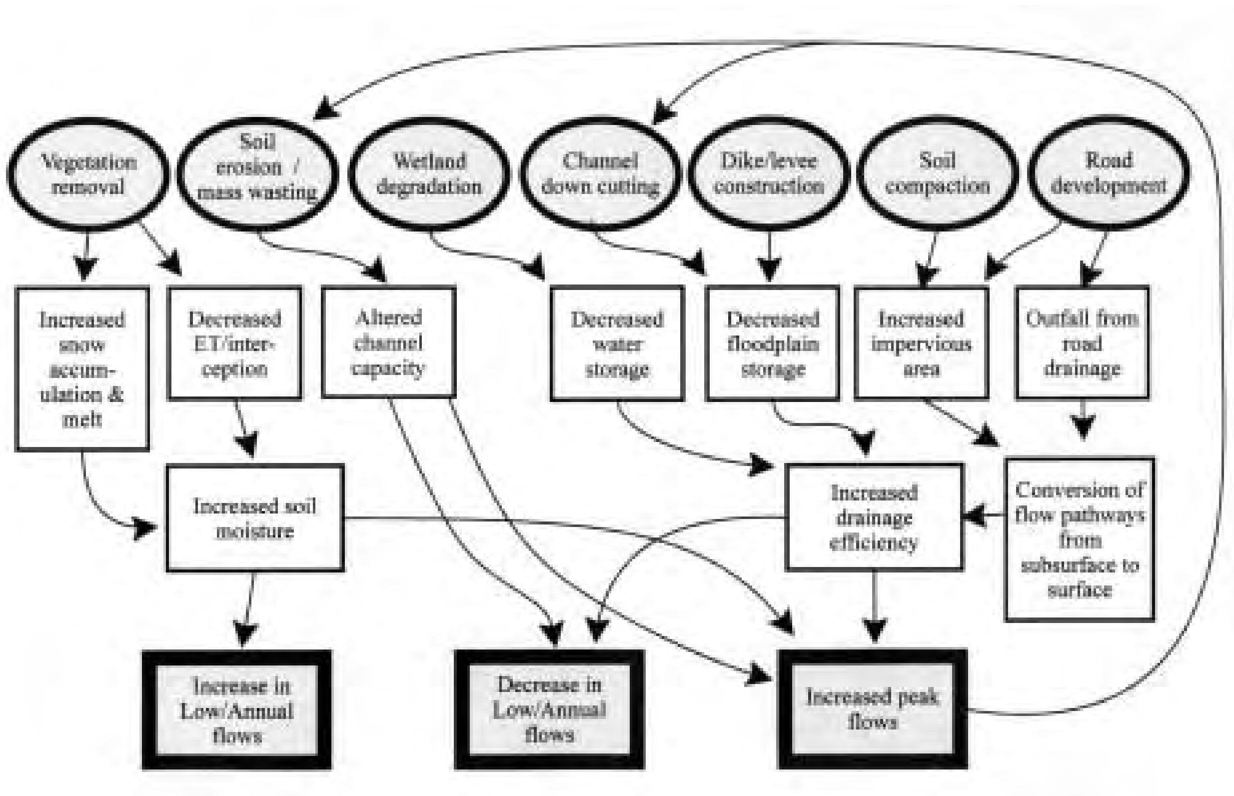


Figure 3.9. Generalized diagram of the primary interactions between land uses and changes in peak, annual, and low stream flows (adapted from Ziemer, 1998).

Similarly, in a model simulation of a snowmelt-dominated watershed in interior British Columbia, Whitaker et al. (2002) found that greater snow accumulation and melt in clear-cut areas also result in peak flow increases. The authors found that vegetation removal in the bottom 20% of a drainage results in little or no change in peak flow due to the thin low-elevation snowpack and the timing of snowmelt, while clear-cut area correlates well with peak flow increases at higher elevations.

Vegetation can intercept a portion of the precipitation falling on a watershed, a further portion of which is evaporated back to the atmosphere during or after a storm event, thereby reducing the net precipitation reaching the soil (Dunne and Leopold 1978). Evapotranspiration by vegetation removes moisture from the soil profile and returns it to the atmosphere (Dunne and Leopold, 1978). Increases in peak flows have been observed in some situations following harvest of trees, which are presumed to be the result of loss of canopy interception and evapotranspiration (Ziemer 1998). Several studies (Harr et al. 1979, Helvey 1980, Harr and Krygier 1972, Bosch and Hewlett 1982, Harr 1983, Hetherington 1987, Kattelmann et al. 1983, Troendle 1983, and Keppeler 1998) have shown that water yield increases throughout the year, with the largest relative increases occurring during the summer and early fall months following logging. These studies have reported increases in summer flows ranging from 15% to 148%.

Both increased snow accumulation and melt and decreased evapotranspiration and canopy interception can increase levels of soil moisture, resulting in increased peak flows, low flows, and annual stream flow volumes. Conversely, the expansion of western juniper communities may have the effect of reducing water yields and lowering base flows.

Western juniper is a native species to eastern Oregon. Juniper forests, defined as areas having at least 10% juniper crown cover, occur on more than 2.2 million acres in eastern Oregon today (Gedney et al. 1999). This is a five-fold increase from an earlier inventory conducted in 1936 that estimated the area of juniper forest to be 420,000 acres (Cowlin et al. 1942). The majority of the present juniper forests was established between 1850 and 1900 during a period of reduced fire frequency and intensity and drought-free climatic conditions (Gedney et al. 1999). Juniper expansion during this period may also be linked to the introduction of large numbers of livestock which led to a loss of fine fuels from grazing, further reducing the frequency of fire (Belsky 1996). Future expansion of juniper forests is predicted to occur in areas now classified as juniper savanna, as crown cover of juniper trees increases from less than to more than 10%, potentially increasing the area of juniper forest in the state to as much as five million acres (Gedney et al. 1999) (see *Juniper Encroachment s*ection of this chapter for further discussion of western juniper).

Juniper can have an effect on the amount of precipitation reaching the soil. Gedney et al. (1999) report that the crown of juniper trees intercept more than half the annual precipitation, which is returned to the atmosphere through evaporation or sublimation (the process whereby snow passes directly to water vapor without melting). Juniper can out-compete other vegetation for available soil moisture by transpiring year-round and through its extensive root networks that can occupy an area several times larger than the tree's crown diameter (Gedney et al. 1999).

Although the potential exists for juniper to reduce stream flows through canopy interception and removal of soil moisture, little quantitative research is available that proves this to be the case.

The majority of applicable water yield studies has been conducted in the southwestern United States on watersheds dominated by pinyon-juniper woodlands. Most of these studies found no increase in water yield following pinyon-juniper removal (Belsky 1996). A study conducted by Clary et al. (1974) found no change in water yield when trees were removed by cabling and then burned or were felled by hand and left in place, but did find increases in streamflow when trees were killed by herbicide and left standing. The increases in water yield found by Clary et al. (1974) may have been due to the absence of soil disturbance and continued shade from the standing dead trees in the herbicide-treated watershed. Several reasons explain why increases in water yield following removal of juniper may not be realized (the following is taken from Belsky 1996):

- In arid and semi-arid climates, most snow- and rain-water simply recharge the soil column; little excess is available to move downslope to streams.
- Herbaceous plants and shrubs that replace trees also intercept rain and snow, reducing the amount of water reaching the ground.
- Replacement plants also transpire and deplete soil water.
- Tree removal exposes the soil and understory plants to direct sunlight, causing elevated temperatures and increased evapotranspiration.
- Tree removal exposes soils and understory plants to more wind, which increases evapotranspiration.
- In areas where water is in excess of that needed to recharge the soil, this water may go to shallow aquifers rather than to streams.

No quantitative information is available for the Canyon Creek watershed on possible impacts to streamflow due to changes in vegetation composition.

Soil erosion and mass wasting. Soil erosion and mass wasting can increase quantities of sediments transported in stream systems. Deposition of both coarse and fine sediments in stream channels can result in a decrease in channel conveyance capacity, leading to an effective increase in frequency of flooding (Dunne and Leopold 1978). In addition to the effects on peak flows, increases in aggradation of coarse sediments can increase the proportion of streamflow that travels subsurface, resulting in a reduction of effective summer low flows. Furthermore, increased peak flows can further exacerbate sedimentation problems through increased bank erosion and mass wasting. No quantitative information on channel aggradation or sedimentation is available for the Canyon Creek watershed.

Wetland degradation. Wetlands have the ability to intercept and store storm runoff, thereby reducing peak flows (Mitsch and Gosselink 1986). This water is released over time and may be important to augment summertime low flows. No quantitative information on wetland loss is available for the Canyon Creek watershed. However, it is likely that most streams in the watershed have experienced some level of stream incision and down-cutting, which is likely to have resulted in wetland loss (McNeil, pers. comm. 2002).

Channel down-cutting and channelization. Channel down-cutting and channelization have the same effect on the stream system: decreasing the amount of water that can be stored in channel banks and the floodplain. The difference between the two processes are that channel down-cutting occurs without direct human assistance in response to changes in water volume and sediment loads, whereas channelization occurs through conscious human design through the construction of dikes and levees. Potential disadvantages to dikes and levees include loss of floodwater storage within the floodplain, which can result in higher downstream peak flows, reduced groundwater recharge, and subsequently lower summertime base flows.

No quantitative information on channel down-cutting is available for the Canyon Creek watershed. However, as stated above, it is likely that most streams in the watershed have experienced some level of stream incision and down-cutting (McNeil, pers. comm. 2002), which is likely to have resulted in loss of bank storage. In addition, a decrease in the beaver population, and the subsequent loss of beaver dams within the watershed, may be a contributing factor to loss of water storage and channel down cutting.

Soil compaction. Soil compaction can increase the amount of impervious area occurring in a watershed. Increases in the amount of impervious area result in increased peak flow magnitudes. By eliminating or reducing infiltration of precipitation, the travel time to stream channels is shortened (Dunne and Leopold 1978). In addition to the effects on peak flows, increases in impervious area also reduce summer low flows by reduction of groundwater recharge (Dunne and Leopold 1978). May et al. (1997) suggest that impairment begins when percent total impervious area in a watershed reaches 10%.

One approach to assessing the potential impacts of compaction at the subwatershed scale is through use of the equivalent roaded area (ERA) analysis (McGurk and Fong 1995). The ERA methodology is a cumulative effects assessment tool that converts timber harvest, fires, and grazing effects into the equivalent area of roads that these activities would represent. This is done through the use of coefficients that are applied to the area occupied by each activity. The result from the ERA analysis is the proportion of the analysis area (expressed as a percentage) that is "equivalent" to a similar area occupied by roads. The results of the analysis are compared with a threshold of concern (TOC) that is specific to each area. An ERA analysis has been completed for the Middle Fork Canyon Creek, Canyon Meadows, and Vance Creek subwatersheds (McNeil, pers. comm. 2002), the results are given in Table 3.32.

Table 3.32. Equivalent roaded area (ERA) calculations for three subwatersheds withinthe Canyon Creek watershed.

			Equivalent roaded area (acres)						
Subwatershed	**Area (acres)**	**Year**	**Roads**	**Timber harvest**	**Fire**	**Grazing**	**Total**	**ERA (%)**	**TOC (%)**
Middle Fork Canyon Creek	7,079	1,998	66	331	97	27	521	**7.4%**	**12%**
		2,003	66	257	82	27	432	**6.1%**	
Canyon Meadows	8,662	1,998	167	279	8	45	499	**5.8%**	**14%**
		2,003	167	215	7	45	434	**5.0%**	
Vance Creek	4,758	1,994	101	526	8	53	688	**14.5%**	**12%**
		2,003	101	341	5	53	500	**10.5%**	

Also shown are threshold of concern (TOC) values for each subwatershed (Source: R. McNeil, pers. comm. 2002).

The results for the ERA model runs suggest that compaction is currently below the threshold of concern for all three of the subwatersheds that were analyzed, although current conditions are close to the threshold within the Vance Creek subwatershed.

No additional quantitative information is available on soil compaction for the remainder of the Canyon Creek watershed. However, analyses associated with timber sale preparation suggests that only a very small portion (<5%) of most forested area are detrimentally impacted (McNeil, pers. comm. 2002). Most compaction in forested areas is most likely legacy conditions from past ground-based logging activities in the 1950s.

Outfall from road drainage. Road networks have the potential to affect watershed hydrology by changing the pathways by which water moves through the watershed. Road networks affect flow routing by interception of subsurface flow at the road cutslope (Megahan 1972, Burroughs et al. 1972, King and Tennyson 1984, Best et al. 1995) and through a reduction in road-surface infiltration rates resulting in overland flow (Ziemer 1998). The net result may be that surface runoff is routed more quickly to the stream system if the road drainage network is well-connected with the stream channel network.

No information is available for the Canyon Creek watershed on the level of connectivity between the road drainage and stream channel networks. Further study of this possible impact should be focused on those subwatersheds that have the highest road densities (see Table 3.28).

3.1.5 Physical Stream Channel Characteristics

3.1.5.1 Channel Types

Classification of stream channels within a watershed is an important part of understanding the inherent spatial variation in aquatic habitat conditions and is important in prioritizing and understanding the limitations to possible restoration activities. The underlying assumption in any channel typing scheme is that the morphological channel characteristics are the result of geologic, climatic, and vegetative interactions. Furthermore, similar channel types can be expected to respond in a similar manner to natural or human-caused changes within a watershed in the supply of water, sediment, or wood inputs.

The classification scheme used in this analysis is commonly referred to as the Rosgen methodology (Rosgen 1994). The Rosgen methodology utilizes a hierarchical approach to channel classification. The most extensive classification within the methodology, the Level I classification, is based on broad-scale features that can be remotely derived.

A description of the Rosgen level I classification is provided in Table 3.33.

Table 3.33. Characteristics of Rosgen stream type classifications.

Stream type	General description	Entrench-ment ratio	W/D ratio	Sinuosity	Slope	Landform/soils/features
Aa +	Very steep, deeply entrenched, debris transport streams.	< 1.4	< 12	1.0 to 1.1	>0.10	Very high relief. Erosional, bedrock or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with/deep scour pools; waterfalls.
A	Steep, entrenched, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.	< 1.4	< 12	1.0 to 1.2	0.04 to 0.10	High relief. Erosional or depositional and bedrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step-pool bed morphology.
B	Moderately entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools. Very stable plan and profile. Stable banks.	1.4 to 2.2	> 12	> 1.2	0.02 to 0.039	Moderate relief, colluvial deposition and/or residual soils. Moderate entrenchment and W/D ratio. Narrow, gently sloping valleys. Rapids predominate with occasional pools.
C	Low gradient, meandering, point-bar, riffle/pool, alluvial channels with broad, well defined floodplains	> 2.2	> 12	> 1.4	< 0.02	Broad valleys with terraces, in association with floodplains, alluvial soils. Slightly entrenched with well-defined meandering channel. Riffle-pool bed morphology.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks.	n/a	> 40	n/a	< 0.04	Broad valleys with alluvial and colluvial fans. Glacial debris and depositional features. Active lateral adjustment, with abundance of sediment supply.
DA	Anastomosing (multiple channels) narrow and deep with expansive well vegetated floodplain and associated wetlands. Very gentle relief with highly variable sinuosities. Stable streambanks.	> 4.0	< 40	Variable	< 0.005	Broad, low-gradient valleys with fine alluvium and/ or lacustrine soils. Anastomosed (multiple channel) geologic control creating fine deposition with well-vegetated bars that are laterally stable with broad wetland floodplains.
E	Low gradient, meandering riffle/pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander width ratio.	> 2.2	< 12	> 1.5	< 0.02	Broad valley/meadows. Alluvial materials with floodplain. Highly sinuous with stable, well vegetated banks. Riffle-pool morphology with very low width/depth ratio.
F	Entrenched meandering rime/pool channel on low gradients with high width/depth ratio.	< 1.4	> 12	> 1.4	< 0.02	Entrenched in highly weathered material. Gentle gradients, with a high W/D ratio. Meandering, laterally unstable with high bank-erosion rates. Riffle-pool morphology.
G	Entrenched "gulley" step/pool and low Width/depth ratio on moderate Gradients.	< 1.4	< 12	> 1.2	0.02 to 0.039	Gulley, step-pool morphology with moderate slopes and low W/D ratio. Narrow valleys, or deeply incised in alluvial or colluvial materials; i.e., fans or deltas. Unstable, with grade control problems and high bank erosion rates.

From Rosgen (1994).

The Rosgen level I approach is based primarily on four factors: the stream entrenchment ratio, which is the ratio of the flood prone area to the bankfull channel width; the bankfull channel width to bankfull depth ratio; channel sinuosity; and channel gradient or slope. All these parameter, with the exception of the width-depth (w-d) ratio, can be remotely derived.

The Rosgen level I classification methodology was applied to Class 1-3 streams within the Canyon Creek watershed. The spatial distribution of Rosgen channel types are shown in Map 3.9 and summarized in Figure 3.10.

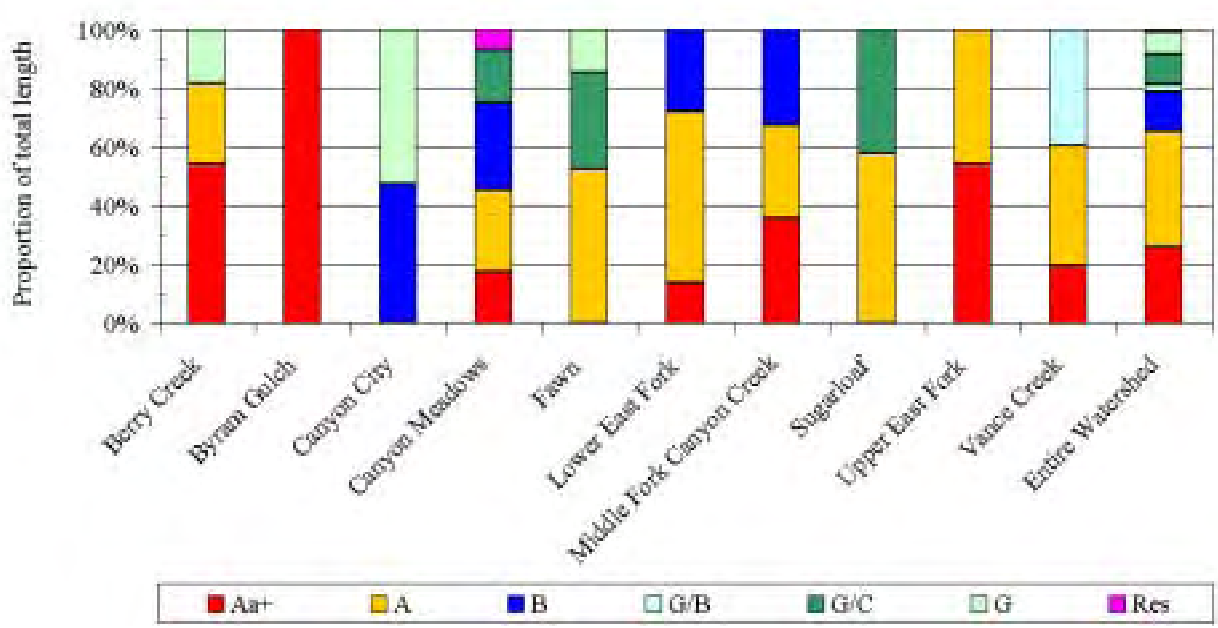


Figure 3.10. Distribution of Rosgen level I channel types by subwatershed, and for the entire Canyon Creek watershed.

The “Aa+” stream types are very steep (>10% channel gradient) streams located exclusively in headwater areas in the Canyon Creek watershed (Map 3.9). Transport processes dominate in these reaches, as they are often source areas for downstream deposition. Type Aa+ channels make up approximately one-quarter of the stream length within the entire Canyon Creek watershed and range from 100% of the total channel length in the Byram Gulch subwatershed to 14% in the Lower East fork subwatershed (Figure 3.10). Type Aa+ channels are not found at all in the Canyon City, Fawn, or Sugarloaf subwatersheds.

Channel type “A” are similar to the “Aa+” classification, the primary difference being that these channel types are lower gradient (4-10%). Consequently, these channel types tend to be located immediately downstream of the type “Aa+” channels (Map 3.9). Type A channels make up the largest proportion (40%) of the stream length within the entire

Canyon Creek watershed, and are found in all subwatersheds with the exception of Byram Gulch and Canyon City, ranging from 58% of the total channel length in the Lower East Fork and Sugarloaf subwatersheds to 27% in the Berry Creek subwatershed (Figure 3.10).

Rosgen channel type “B” streams typically are positioned downstream of type “A” channels (Map 3.9) because they are more moderate in gradient. Although these streams are morphologically dominated by hillslope (as opposed to floodplain) processes, they often contain some areas of floodplain development and may be both transport and depositional reaches. Within the Canyon Creek watershed, type “B” channels are typically found at the lower end of the larger tributaries (Map 3.9); one exception is the section of type “B” channel located along the mainstem of Canyon Creek downstream of Byram Gulch. Type “B” channels make up 13% of the stream length in the entire Canyon Creek watershed and are found within five of the nine subwatersheds where they comprise from 28% to 47% of the total channel length (Figure 3.10).

Rosgen type “G” or “gullied” channels are narrow, entrenched, non-meandering channels that are often downcut within alluvial deposits. The majority of the mainstem of Canyon Creek downstream of Vance Creek has been classified as a “G” type channel (Map 3.9). In addition, several streams within the watershed exhibit some “G” channel type characteristics, although it was not clear (based on available information) if these channels are truly “G” types. The downstream portion of Vance Creek (Map 3.9) exhibits characteristics of both “B” and “G” channel types: consequently, this area was classified as a “G/B” type. Similarly, the mainstem of Canyon Creek upstream of Vance Creek exhibits characteristics of both the “G” and “C” channel types and was classified as a “G/C” channel type. Rosgen type “C” channels consist of relatively low-gradient streams with well-developed floodplains and are typically highly responsive to sediment and wood inputs.

The final channel type shown in Map 3.9 is the “RES” channel type. This is not a Rosgen type, but rather refers to the portion of Canyon Creek that flows through the site of the Canyon Meadows reservoir.

3.1.5.2 Stream Channel Characteristics

Very few data are readily-available to characterize current stream channel conditions within the Canyon Creek watershed. The primary source of data, and the only source used in the analysis presented here, is the Stream Management, Analysis, Reporting, and Tracking (SMART) database, that consists of several stream surveys conducted within the watershed during summer 1993 and 1994. Additional fishery habitat surveys conducted during 1982 to 1986 contain general information on riparian plant communities, pool/riffle counts, stream stability, etc.; however, these data exist only on field forms that have not been summarized. Consequently, these data were not included in this analysis.

The SMART data were useful in evaluating fish habitat at the reach and subwatershed scales. Characteristics such as pieces of LWD and number of pools per mile of stream are useful in evaluating the longitudinal connectivity of instream habitats available for fish. These data, in combination with streambed substrate, stream gradient, stream temperature, shade, and LWD potential are useful indicators in evaluating how habitat is functioning for salmonids (NOAA Fisheries 1996, USFWS 1996). A synthesis of the physical habitat characteristics information presented in this chapter will be presented in the S*ynthesis and Interpretation* section in *Chapter 5-6*.

The SMART reaches are located primarily within the Middle Fork Canyon Creek, Canyon Meadows, and Vance Creek subwatersheds (Table 3.34, Map 3.2). All reaches included in the SMART surveys are located on National Forest lands. data is summarized for the 23 individual reaches in Table 3.34, Table 3.35, and Table 3.36. A total of 30 miles of stream was included in the SMART database (Table 3.35). The majority of the stream reaches were classified as having either narrow or moderate V-shaped valleys shape, with valley floor widths less than 100 feet and steep valley side slopes. Only the lower portions of the Middle Fork Canyon Creek and Canyon Creek proper reaches were classified as having flat valley floors. Only the Middle Fork Canyon Creek tributaries T4, T6, and T7 were rated as “deeply” incised; the remaining reaches being evenly split between “moderate” and “shallow” entrenchment.

Average wetted and bankfull widths and average residual pool depths are given in Table 3.35. Residual pool depth is defined as the depth below the lowest point of the pool tailout. Bankfull w-d ratios range from 5.8 in Vance Creek Reach #3, to 17.6 in Middle Fork Canyon Creek Reach #2. Wetted w-d ratios range from 5.5 in Middle Fork Canyon Creek T6 to 15.1 in Canyon Creek Reach #2. The Northwest Forest Plan defines streams as “Functioning appropriately” when the wetted w-d ratio is <10; “Functioning at risk” when the w-d ratio is 11 to 20, and “Functioning at Unacceptable risk” when the w-d ratio is >20. Based on this criteria, thirteen of the 23 reaches would be classified as “Functioning appropriately,” and the remaining streams would be “Functioning at risk.”

Stream channel bed and bank conditions are summarized for the SMART reaches in Table 3.36. The dominant streambed substrate among the reaches is cobble-sized material in ten of the reaches, gravel in eight reaches, sand in four reaches, and small boulders in one reach. Coarseness of streambed material generally increases with increasing channel gradient. Sub-dominant streambed material is primarily gravel in the cobble-dominated reaches and sand in the gravel-dominated reaches. The majority of stream banks are reported as being 76-100% armored, with the remainder being 51-75% armored. The dominant bank substrate is primarily gravel and sand, with some areas of cobble and one reach being bedrock-dominated. Sub-dominant bank substrate is also primarily gravel and sand. The majority (12) of the reaches are identified as not being embedded (i.e., the estimated cobble embeddedness is <35%).

Table 3.34. SMART database – general reach characteristics.

Reach	Nominal river mile: From	Nominal river mile: To	Surveyed length (miles)	(1) Valley form	Sinuosity	(2) Channel entrenchment	(3) Width Class	Gradient (%)
Vance: Reach #1	0.3	1.0	0.9	2	1.06	M	1	3
Vance: Reach #2	1.0	2.2	1.2	2	1.04	S	1	4
Vance: Reach #3	2.2	3.0	0.9	2	1.16	S	1	8
MF Canyon: Reach #1	0.0	2.6	2.8	8	1.06	M	2	2
MF Canyon: Reach #2	2.6	3.9	1.5	8	1.02	S	2	4
MF Canyon: Reach #3	3.9	5.0	1.2	3	1.1	S	1	5
MF Canyon: Reach #4	5.0	6.2	1.0	3	1.07	M	1	4
MF Canyon: Reach #5	6.2	6.6	0.4	3	1.12	M	1	7
SF Vance: Reach #1	0.0	1.2	1.4	2	1.03	S	1	11
Fawn: Reach #1	0.3	1.2	0.9	3	1.12	M	1	8
Canyon: Reach #1	17.0	17.9	1.1	8	1.02	S	2	2
Canyon: Reach #2	17.9	19.9	2.5	8	1.04	S	2	2
Canyon: Reach #3	19.9	22.2	2.5	8	1.07	M	2	4
Canyon: Reach #4	22.2	23.0		8	1	S	2	0
Canyon: Reach #5	23.0	24.0	1.1	3	1.04	S	1	3
Crazy 94: Reach #1	0.0	2.1	2.6	3	1.05	S	1	6
MF Canyon T1: Reach #1	0.0	0.5	0.5	3	1	M	1	25
Canyon Wild: Reach #1	24.0	24.6	0.8	3	1	M	1	5
Canyon Wild: Reach #2	24.6	26.3	1.9	3	1.13	M	1	9
MF Canyon T6: Reach #1	0.0	0.7	0.8	3	1.17	D	1	15
MF Canyon Wild: Reach #1	6.6	8.2	1.8	3	1.19	M	1	9
MF Canyon T4: Reach #1	0.0	1.7	1.9	2	1.13	D	1	16
MF Canyon T7: Reach #1	0.0	0.3	0.3	3	1.2	D	1	13

Note: (1) Valley form classes: 2: Narrow V-shaped, floor width <100ft with >60% side slope
3: Moderate V-shaped, floor width <100ft with 30-60% side slope
8: Narrow flat-floored, floor width 100-300ft with >30% sideslope
(2) Channel entrenchment: D= deep; M=moderate; S=shallow
(3) Width classes: 1=valley width <100ft; 2=valley width 100-300ft

Table 3.35. SMART database – Channel widths and depths.

Reach	Average wetted width (ft)	Average bankfull width (ft)	Average residual depth (ft)	Bankfull width-depth ratio	Wetted width-depth ratio
Vance: Reach #1	6.5	10.3	1.1	8.14	7.76
Vance: Reach #2	5.2	11.1	1.1	10.08	8.42
Vance: Reach #3	5.4	10.5	1.1	5.81	5.82
MF Canyon: Reach #1	12.4	26.6	1.6	15.26	9.60
MF Canyon: Reach #2	12.2	25.0	1.4	17.58	12.65
MF Canyon: Reach #3	11.3	19.3	1.5	12.18	10.60
MF Canyon: Reach #4	9.5	11.5	1.3	7.48	11.27
MF Canyon: Reach #5	7.7	10.0	1.5	8.33	7.68
SF Vance: Reach #1	3.5	15.0	0.7	16.33	7.19
Fawn: Reach #1	3.1	5.7	0.6	6.87	11.02
Canyon: Reach #1	12.8	16.6	1.6	11.19	12.51
Canyon: Reach #2	9.2	17.9	1.2	14.96	15.13
Canyon: Reach #3	7.8	13.3	1.1	10.99	10.89
Canyon: Reach #4					
Canyon: Reach #5	6.5	12.5	1.0	11.26	11.56
Crazy 94: Reach #1	3.3	4.0	0.6	8.76	8.43
MF Canyon T1: Reach #1	3.3	5.0	0.6	6.73	5.80
Canyon Wild: Reach #1	6.2	10.3	0.8	17.00	10.42
Canyon Wild: Reach #2	5.2	8.7	0.7	14.21	9.81
MF Canyon T6: Reach #1	3.2	4.2	0.7	7.36	5.54
MF Canyon Wild: Reach #1	5.3	8.9	0.9	12.42	7.28
MF Canyon T4: Reach #1	4.8	7.8	0.8	10.76	7.52
MF Canyon T7: Reach #1	3.8	5.5	0.6	10.55	6.59

Table 3.36. SMART database – channel bed and bank condition.

Reach	(1) Dominant channel bed substrate	Sub-dominant channel bed substrate	(2) Embedded-ness	(3) Bank ground cover	Dominant bank substrate	Sub-dominant bank substrate
Vance: Reach #1	GR	SA	Y	4	SA	GR
Vance: Reach #2	GR	SA	N	4	SA	GR
Vance: Reach #3	SA	GR	Y	4	SA	GR
MF Canyon: Reach #1	GR	CO	N	4	GR	SA
MF Canyon: Reach #2	CO	GR	N	4	GR	SA
MF Canyon: Reach #3	CO	SB	N	4	GR	SA
MF Canyon: Reach #4	CO	GR	N	4	GR	CO
MF Canyon: Reach #5	SB	CO	Y	4	BR	GR
SF Vance: Reach #1	SA	GR	Y	3	SA	SA
Fawn: Reach #1	SA	GR	Y	3	SA	GR
Canyon: Reach #1	GR	SA	N	3	GR	SA
Canyon: Reach #2	GR	CO	N	4	GR	SA
Canyon: Reach #3	CO	GR	Y	4	GR	SA
Canyon: Reach #4	SA	SA				
Canyon: Reach #5	GR	SA	Y	4	GR	SA
Crazy 94: Reach #1	GR	SA	Y	4	GR	CO
MF Canyon T1: Reach #1	CO	GR	N	4	SA	GR
Canyon Wild: Reach #1	CO	GR	Y	3	GR	GR
Canyon Wild: Reach #2	CO	GR	Y	4	CO	GR
MF Canyon T6: Reach #1	GR	SA	N	3	SA	GR
MF Canyon Wild: Reach #1	CO	GR	N	4	CO	GR
MF Canyon T4: Reach #1	CO	GR	N	4	CO	GR
MF Canyon T7: Reach #1	CO	GR	N	3	CO	GR

Notes: (1): Substrate codes: BR= Bedrock, CO= Cobble, GR= Gravel, SA= Sand, SB= Small Boulder
(2): Embeddedness.: Estimated cobble embeddedness in the unit is >35% = Y (yes).
(3): Bank ground cover: 3= 51-75% armored, 4= 76-100% armored

3.2 VEGETATION

3.2.1 Introduction

In this chapter, the current conditions of vegetation within Canyon Creek watershed were evaluated. The focus is on the analysis area, or the 59,578 acres under NFS administration. Quantitative analysis was designed to address the following vegetation attributes.

- Plant species composition at the levels of potential vegetation groups (PVGs) and plant association groups (PAGs)
- Forest structures that describe the stages of stand development
- Historic fire regimes that describe the frequency and severity of fire
- Live fuels condition classes that describe the degree of divergence in stand structure and composition from historic fire regimes

In addition to the effects of fire exclusion, this section presents a qualitative analysis of other important factors that have had an effect on the vegetation within the watershed, including timber harvest and insects and disease.

3.2.2 Species Composition

3.2.2.1 Watershed Scale

The topographically diverse watershed supports a high diversity of tree species; within the 59,578-acre analysis area, eleven tree species were encountered in the canopy layers (Table 3.37). Ponderosa pine and Douglas-fir were the most dominant. Ecologically responsive species, or those sensitive to disturbance, including quaking aspen, black cottonwood, and whitebark pine, were also present within the watershed.

Vegetation types of the Canyon Creek watershed are summarized into five broad categories: forested uplands, non-forested uplands, forested riparian zones, non-forested riparian zones, and non-vegetated lands. For a particular stand to be considered “forest,” it must contain a minimum of 10% tree canopy closure, as evaluated from aerial photography (Blue Mountain Mapping Standards 2002).

Table 3.37. Eleven tree species encountered within canopy layers and acreage they dominate within 59,578-acre analysis area.

Species	Scientific name	Elevational range (ft)	Acres in dominance	% of analysis area
Ponderosa pine	*Pinus ponderosa*	3,903 – 7,061	21,289	36%
Douglas-fir	*Pseudotsuga menziesii*	3,960 – 7,772	18,095	30%
Grand fir	*Abies grandis*	4,034 – 7,772	11,537	19%
Western juniper	*Juniperus occidentalis*	4,009 – 6,664	1,450	2%
Lodgepole pine	*Pinus contorta*	4,329 – 7,656	771	1%
Subalpine fir	*Abies lasiocarpa*	5,625 – 7,772	663	1%
Western larch	*Larix occidentalis*	4,041 – 6,970	335	1%
Quaking aspen	*Populus tremuloides*	3,903 – 5,960	1	<1%
Whitebark pine	*Pinus albicaulis*	7,093 – 7,550	0	0%
Englemann spruce	*Picea englemannii*	4,595 – 7,122	0	0%
Black cottonwood	*Populus balsamifera*	3,903 – 4,206	0	0%

Data collected from 1:12,000 color aerial photographs, Duck Creek Associates, Inc. in prep.

Canyon Creek watershed contains 73,954 acres, of which 59,578 (~81%) are within the analysis area (Table 3.38). Overall, 56,880 acres (95%) are within upland environments, 2,227 acres (4%) are within riparian zones and 470 acres (1%) are non-vegetated, including gravel mines, rock outcrops, or administrative lands.

Table 3.38. Five broad catergories of stands within the analysis area.

Vegetation category	Total acres within the analysis area	Percentage of analysis area	Percentage of entire watershed
Forested Uplands	52,176	88%	71%
Non-Forested Uplands	4,705	8%	6%
Forested Riparian Zones	2,028	3%	3%
Non-Forested Riparian Zones	199	<1%	<1%
Non-Vegetated/ Administrative Lands	470	1%	1%
Total Acres	59,578		81%

The analysis area represents 59,578-acre Malheur National Forest System lands, or 81% of the Canyon Creek watershed.

At the watershed scale, 21 potential vegetation groups (PVGs) were identified in the analysis area. Forested stands were assigned a plant association group (PAG) (USFS 2002b) (Map 3.10, Map 3.11), (Table 3.39).

Overall, Dry Upland Forest having the warm-dry plant association groups was the most common vegetation type in the watershed (Table 3.39). These forests were generally found in lower elevations, and were typified by a combination of ponderosa pine, Douglas-fir, and warm grand fir plant associations. Shrubland and Herbland (upland grasslands and meadows) communities were also prevalent within the watershed. A total of 3,220 acres were Upland Shrublands and 140 acres were Riparian Shrublands (6% and <1% of the analysis area, respectively). Upland Herblands composed approximately 2% of the analysis area (1,155 acres); approximately 60 acres of Riparian Herblands (i.e., meadows) were also encountered.

Table 3.39. Watershed-scale summary of 21 Potential Vegetation Groups (PVGs) and Plant Association Groups (PAGs) determined from PI data for 59,578-acre analysis area within Canyon Creek watershed.

Potential Vegetation Group (PVG)	Plant Association Group (PAG)	Acres	Percent of analysis area
Cold Upland Forest	Cold Dry	1,760	3.0%
Cold Upland Forest	Cool Dry	44	0.1%
Moist Upland Forest	Cool Moist	10,270	17.2%
Dry Upland Forest	Hot Dry	6,461	10.8%
Dry Upland Forest	Warm Dry	33,344	56.0%
Moist Woodland	Hot Moist	130	0.2%
Dry Woodland	Hot Dry	168	0.3%
Cold Upland Shrubland		439	0.7%
Moist Upland Shrubland		2,562	4.3%
Dry Upland Shrubland		549	0.9%
Cold Upland Herbland		168	0.3%
Moist Upland Herbland		919	1.5%
Dry Upland Herbland		68	0.1%
High SM* Riparian Forest	Cold High SM*	12	0.0%
High SM* Riparian Forest	Warm High SM*	256	0.4%
Moderate SM* Riparian Forest	Cold Moderate SM*	2	0.0%
Moderate SM* Riparian Forest	Warm Moderate SM*	26	0.0%
Low SM* Riparian Forest	Cold Low SM*	325	0.5%
Low SM* Riparian Forest	Warm Low SM*	1,407	2.4%
High SM* Riparian Shrubland		22	0.0%
Moderate SM* Riparian Herbland		41	0.1%
Low SM* Riparian Shrubland		47	0.1%
Moderate SM* Riparian Shrubland		71	0.1%
Low SM* Riparian Herbland		19	0.0%
Non Vegetated Land		430	0.7%
Administrative Land		40	0.1%
Total Acres		**59,578**	

**Soil Moisture.*

3.2.2.2 Forested Uplands

A total of 51,878 acres (87% of the analysis area) have upland forest vegetation potential and 298 acres (<1%) have potential for upland woodlands (Table 3.40). These upland forest-types make a transition across a wide elevational range and contain stands that are dominated by one of seven main species: ponderosa pine, Douglas-fir, grand fir, lodgepole pine, subalpine fir, western larch, and western juniper.

Overall, dry upland forest-types with warm-dry plant associations dominate approximately half the analysis area (Table 3.40); these stands are characterized by a transition from ponderosa pine and Douglas-fir co-dominated stands to a grand fir/Douglas-fir co-dominance.

Table 3.40. Potential vegetation groups (PVGs) and plant association groupings (PAGs) for forested upland types within the 59,580-acre analysis area.

Potential Vegetation Group (PVG)	Plant Association Group (PAG)	Total acres	Percent of forested upland vegetation	Elevational range (ft)		Dominant species*
Cold Upland Forest	Cold / Dry	1,760	3%	6,238	7,772	SA, DF, GF,LP, WL,
	Cool / Dry	44	<1%	5,881	6,935	LP
Moist Upland Forest	Cool / Moist	10,270	20%	4,595	7,752	GF, DF, LP, WL
Dry Upland Forest	Warm / Dry	33,344	64%	4,010	6,881	PP, DF, GF, WL
	Hot / Dry	6,461	12%	4,009	6,883	PP, DF
Moist Woodland	Hot / Moist	130	<1%	4,442	5,894	WJ
Dry Woodland	Hot / Dry	168	<1%	4,355	5,200	WJ
Total Forested Upland Types		**52,176**	**100%**	**4,009**	**7,772**	

**SA = Subalpine Fir; DF = Douglas-Fir; GF = Grand Fir; LP = Lodgepole Pine; WL = Western Larch; PP = Ponderosa Pine, WJ = Western Juniper*

Insects and disease are a visible disturbance factor within the forested uplands of the Canyon Creek watershed; severe infestations and damage have been recently documented within the watershed (Spiegel and Schmitt 2002). Mortality and decay to disease, particularly dwarf mistletoe, has led to increased fuel loading in many different forest types. Fuel loads from fallen- and standing-dead trees accompany living trees in decayed condition and a generally overstocked understory. This combination has led to an increase in vertical continuity of fuels and the increased likelihood of crown fires. See the *Insects and Disease* section of this chapter for further discussion on the conditions within the watershed.

3.2.2.3 Non-Forested Uplands

Approximately 8% of the analysis area is non-forested uplands (Table 3.41). Moist Upland Shrublands dominated by big mountain sagebrush (*Artemesia tridentata*) and curltail mountain mahogany (*Cercocarpus ledifolius*) typify the common shrubland plant communities. These communities are highly susceptible to encroachment by western juniper in fire-excluded areas (Paysen et al. 2000). Dry Upland Shrublands in hot-dry plant associations are present; these communities are dominated by stiff sagebrush (*Artemesia rigida*) and Sandberg's bluegrass (*Poa sandbergii).* Cold Upland Shrublands are also present, and are found in predominantly subalpine zones (ca. 6,500 feet).

Herblands are less common within the Canyon Creek watershed (Table 1.14). Moist Upland Herblands dominated by Idaho fescue (*Festuca idahoensis*) and bluebunch wheatgrass (*Agropyron spicatum*) are the most common grasslands. In upper elevations (ca. 6,500 feet), species including alpine elk sedge (*Carex geyeri*) and green fescue (*Festuca viridula*) typify these subalpine meadows and grasslands.

Table 3.41. Potential vegetation groups (PVGs) for 3,973 acres of non-forested upland vegetation within 59,578-acre analysis area.

Potential Vegetation Group (PVG)	Total acres	Percent of non-forested upland vegetation	Elevational range (ft)	
			Min.	Max.
Cold Upland Herblands	168	4%	6,227	7,457
Moist Upland Herblands	919	20%	3,990	6,444
Dry Upland Herblands	68	1%	4,364	4,846
Cold Upland Shrubland	439	9%	5,846	7,697
Moist Upland Shrubland	2,562	54%	4,203	6,450
Dry Upland Shrubland	549	12%	4,245	5,194
Total Non-Forest Upland Types	4,705	100%	3,990	7,697

3.2.2.4 Riparian Zones

Although riparian zones are a relatively minor contingent in land area within a watershed, they are essential components to properly functioning ecosystems, particularly in the arid and semi-arid environments of eastern Oregon. Linkages among plant species composition, stream channel structure and stability, groundwater hydrology, and nutrient cycling have been well documented (Dwire 2001, Otting 1998, Kauffman et al. 2002, and others). The proximity of water in riparian zones lends to a shift in species composition between xeric and mesic plant associations; soil moisture and groundwater table elevations are a key indicator of plant species composition (Dwire 2001, Elmore and Beschta 1987, Kauffman et al. 2002).

Plant species provide different functions for stream channels and instream habitat depending on a variety of factors, including stream gradient, floodplain width, channel type, etc. In the higher-gradient streams typically found in upper elevations, conifers provide essential inputs of large wood debris into streams, which in turn create instream structures that function in the development of deep pools and instream habitat.

In contrast, meandering streams in floodplain environments are dependent upon deep-rooted plant species such as sedges (*Carex* spp.) and rushes (i.e., *Juncus* spp.). These plants provide bank stability, catch fine sediments during flood events, increase groundwater infiltration rates, and retain coarse organic particulate matter critical in the maintenance of instream food webs (Brookshire 2001, Dwire 2001, Kauffman et al. *submitted*). Hardwood abundance provides essential shade to properly moderate extremes and fluctuations in water temperatures as well as provide key nutrient inputs from litterfall.

In the Canyon Creek watershed, the riparian vegetation is divided into two coarsely defined categories: Forested Riparian and Non-Forested Riparian Zones (Table 3.38).

3.2.2.5 Forested Riparian Zones

In addition to potential vegetation groups, broad plant association groupings have been defined for forested riparian zones (USFS 2002e). Soil moisture (SM) and temperature are the key indicators to describe the vegetation potential for riparian stands (USFS 2002e). Forested riparian stands within the analysis area are dominated by grand fir, Douglas-fir, ponderosa pine, western larch, or quaking aspen (*Populus tremuloides*).

Warm, low SM Forested Riparian stands are the most common plant association group (Table 3.42); these stands are associated with floodplain environments and low stream gradients. The tree species are typically a grand fir/Douglas-fir community type with a minor component of ponderosa pine. Common snowberry is prevalent in the understory along with hardwood species near the stream channel, predominantly willows (*Salix* spp.), red osier dogwood (*Cornus stolonifera*), and alders (*Alnus* spp.).

Other forested riparian plant association groups include cold, low-soil moisture-stands dominated by grand fir, lodgepole pine, and Englemann spruce with a minor component of Douglas-fir. These stands are typically found in narrow stream channel environments, cold air drainages and mid-elevation sites (ca. 5,500 feet); understory components include alder, currants (*Ribes* spp.), and Kentucky bluegrass (*Poa pratensis*).

Table 3.42. Potential vegetation groups (PVGs) and plant association groupings (PAGs) for forested riparian zones within 59,578-acres analysis area.

Potential Vegetation Group (PVG)	Plant Association Group (PAG)	Total acres	Percent of forested riparian zones	Elevational range (ft) Min.	Max.
High SM* Riparian Forest	Cold, High SM	12	1%	6,253	6,253
	Warm, High SM	256	13%	5,694	6,453
Moderate SM Riparian Forest	Cold, Moderate SM	2	<1%	4,731	4,731
	Warm, Moderate SM	26	1%	5,346	6,259
Low SM Riparian Forest	Cold, Low SM	325	16%	4,952	5,730
	Warm, Low SM	1,407	69%	4,041	5,902
Total Forested Riparian Zones		**2,028**	**100%**		

**SM = Soil Moisture*

3.2.2.6 Non-Forested Riparian Zones

Shrublands comprised approximately two-thirds of the Non-Forested Riparian zones (Table 3.43). Of these riparian shrublands, half are classified as having moderate soil moisture vegetation types. Willows, alders, and red osier dogwood dominate these shrubland communities. Sedges, grasses (*Poa* spp.), and mesic forbs are common along the stream banks.

Among riparian herblands, sedge meadows are the most common vegetation group (Moderate SM Riparian Herbland, Table 3.43). These floodplain meadows are characterized by a sparse presence of ponderosa pine, Douglas-fir, grand fir, and lodgepole pine, with myriad of sedge and rush species that correspond with water table elevation.

The single largest meadow in the Canyon Creek watershed is found behind Canyon Meadows Dam. Spike rushes (*Eleocharis* spp.) dominate this 27.8-acre artificial meadow along with a minor component of currants (*Ribes* spp.). Although the dam is inactive and the floodgates have been permanently opened, complete inundations from rainfall and snowmelt are common because the dam structure remains in place.

Table 3.43. Potential vegetation groups (PVGs) for non-forested riparian zones within the 59,578-acre analysis area.

Potential Vegetation Group (PVG)	Total acres	Percent of forested riparian zones	Elevational range (ft) Min.	Max.
Moderate SM* Riparian Herbland	41	21%	4,281	6,632
Low SM Riparian Herbland	19	9%	4,290	5,041
High SM Riparian Shrubland	22	11%	5,583	6,864
Low SM Riparian Shrubland	47	24%	3,903	4,992
Moderate SM Riparian Shrubland	71	35%	4,241	4,610
Total Non-Forested Riparian Zones	199	100%		

SM = Soil Moisture

3.2.2.7 Non-Vegetated Lands

A total of 450 acres, or 1% of the analysis area, are classified as non-vegetative lands because the vegetation potential was determined to be marginal (i.e., less than 20% vegetated) or land dedicated to administrative uses (i.e., buildings or roads) (Table 3.44). Stands that were temporarily non-forested due to recent disturbance events, such as timber harvest, fire, or disease, were classified according to their potential vegetation (PVG) and not considered "non-vegetated lands" (USFS 2002e).

Table 3.44. Non-vegetated land within 59,578-acre analysis area.

Land type	Description	Total acres	% of non-vegetative land
Administrative Land	Buildings, Structures, Roads	38	8%
	Cultivated Land	3	1%
Non-Vegetated Land	Landform failure	11	2%
	Anthropogenically disturbed	6	<1%
	Rocky Land	391	87%
	Sand, shoreline, or interior	1	<1%
	Talus Land	20	4%
	Other Non-Vegetated	1	<1%
Total Non-Vegetated Land		450	100%

3.2.2.8 Quaking Aspen

Quaking aspen was encountered in 12 stands within the analysis area, two of which were dominated by aspen (Map 3.12). Although site-specific evaluations of aspen has not been conducted for this watershed analysis, the general trends of aspen within the Malheur National Forest involve a highly decadent overstory with very low levels of aspen regeneration. Two factors greatly influence this condition of aspen groves: 1) dense shading from an established conifer overstory (usually ponderosa pine), and/or 2) grazing by ungulates, particularly livestock. Properly constructed exclosures to prevent grazing pressures in other areas of the Malheur National Forest have been successful for aspen restoration as have removal of coniferous shade.

3.2.2.9 Cottonwoods

Three stands were identified from aerial photographs where cottonwoods were present (Map 3.12). Because cottonwoods are dependent on flood scouring for their success, their range is typically restricted to floodplain environments. Floodplain environments are less common in the analysis area on NFS lands than in the non-federal management areas. Thus much of the discussion and analysis of cottonwoods abundance was outside the scope of this watershed analysis.

3.2.2.10 Federally Listed Plant Species

The documented extent of federally listed plant species within the Canyon Creek watershed is limited. One stand containing the species *Thelypodium eucosmum* was found in the Byram Gulch area of the Canyon City subwatershed (Map 3.12). This species is listed as a Species of Concern under the Endangered Species Act (ESA) and Listed Threatened under Oregon ESA, and ranked second in rarity under the National and State Heritage Programs. The extent of distribution of other listed species within the watershed is not known. Increased biodiversity is one beneficial effect of restoring fire as a disturbance process.

3.2.2.11 Culturally Important Plants

While the Canyon Creek watershed may not be an area of concentrated plant use by nearby tribes, several culturally important plant species occur in small populations. Big huckleberry *(Vaccinium membranaceum*) is probably the most common plant species. Fire suppression, dense canopy cover in overstocked conifer stands, and intensive browse levels are all factors that limit the distribution of productive huckleberry patches, although the extent of the limitation has not been quantified.

Populations of chokecherry *(Prunus virginiana*) typically occur along smaller streams and primarily where rock outcrops or steep terrain limit browsing access by deer, elk and cattle. Because of the harsh environments, many of these plants may be too small to produce fruit (USFS 2002d).

Plants such as onions *(Allium spp*), biscuitroot *(Lomatium spp*), yampah *(Perideridia spp*), and bitterroot *(Lewisia redeviv*a), are found on open scab flats. Bitterroot tends to prefer dry, rocky sites with shallow soils and is the least common culturally important plant species, probably because its preferred habitat is uncommon. While most are not highly palatable to deer, elk and cattle, these root crops can suffer from overuse of scablands when large numbers of animals trample saturated soils and displace the roots. This effect tends to occur early in the growing season when vernal moisture is still present on many scabs (USFS 2002d).

3.2.2.12 Juniper Encroachment

Classifying potential vegetation types is problematic due to changes in vegetation composition and structure after decades of fire exclusion. Encroachment by western juniper is one example. PI data identified 87 stands representing ~1,450 acres containing ≥10% canopy cover dominated by western juniper (life form class "CJ," Blue Mountain Mapping Standards 2002). Further analysis from mirror stereoscopes indicated only about 300 acres were potentially true juniper woodland communities; the remaining approximately 1,150 acres were shrubland, grasslands, or hot-dry upland forest that had been severely encroached upon by western juniper (Table 3.45).

Table 3.45. 1,450 acres within analysis area dominated by ≥10% canopy cover of western juniper.

Potential Vegetation Group	Plant Association Group	Acres	Percent of total
Dry Upland Forest	Hot Dry	421	29%
Moist Upland Shrubland		455	31%
Moist Upland Herbland		240	17%
Dry Upland Herbland		37	3%
Moist Woodland	Hot Moist	130	9%
Dry Woodland	Hot Dry	168	12%
Total acres dominated by western juniper		1,450	

Prior to fire exclusion, the majority of the juniper-dominated forests were likely dominated by shrubs (31%) and dry upland forest (29%) (Table 3.45). In general, the juniper-invaded shrubland communities were those dominated by mountain big sagebrush and curl-leaf mountain mahogany. The dry upland forest types dominated by juniper had similar shrub compositions, with ponderosa pine in the overstory. This analysis is only a cursory examination of the degree of juniper encroachment upon non-woodland vegetation groups. With a long history of fire exclusion in the watershed, it is expected encroachment of other conifers (ponderosa pine and Douglas-fir) is likely in grasslands and shrublands. Ground-truth and landscape-level analyses on grazing intensities are recommended to ascertain the effects of conifer encroachment on traditionally non-forested ecosystems.

3.2.2.13 Subwatershed Scale

At the subwatershed scale, the majority (>50%) of the vegetation in the analysis area was within the Dry Upland Forest type within the warm-dry plant association groups (Table 3.46) excepting only Canyon City, Lower East Fork, and Upper East Fork subwatersheds.

Diversity of vegetation types (PVGs) was lowest in Vance Creek, with approximately 86% of the 4,169 acres in Dry Upland Forest (Table 3.46). Of these forest stands, 2,056 acres (~49% of the Vance Creek subwatershed) were warm-dry ponderosa pine plant associations; 605 acres (~15%) were Douglas-fir plant associations; and 430 acres (~10%) were hot-dry ponderosa pine plant associations (i.e., with mountain mahogany or mountain big sagebrush). A total of 326 acres, or about 8% of Vance Creek subwatershed, was temporarily non-forested due to timber harvest and was considered to have the potential for Dry Upland Forest, warm-dry plant associations.

In contrast, Canyon Meadows, Middle Fork, and Lower East Fork Canyon Creek had the highest diversity in vegetation types (15, 16, and 16, respectively, Table 3.46). In these subwatersheds, vegetation was largely composed of Moist Upland Forest vegetation groups, especially moist grand fir-dominated communities containing components of lodgepole pine. The diversity in riparian vegetation was also more pronounced in these subwatersheds. Riparian areas contained several soil moisture associations and vegetation types. In the upper elevations of these subwatersheds, riparian forest types ranged from high soil moisture to low soil moisture in lower elevations, and vegetation types transitioned from forest to meadows and moist shrub communities (i.e., *Alnus* spp., *Cornus* spp., *Salix* spp., etc.) along the elevational gradient. Finer resolution of riparian areas was not possible using PI data alone, and sufficient data as to plant association, seral stage, and overall riparian condition were not available.

Table 3.46. Distribution of 21 Potential Vegetation Groups (PVGs) and plant association groups (PAGs) within nine subwatersheds of 59,578-acre analysis area.

Potential Vegetation Group	***PAG***	***Berry Creek***		***Canyon City***		***Canyon Meadows***		***Fawn***		***Lower East Fork***		***Middle Fork Canyon Creek***		***Sugarloaf***		***Upper East Fork***		***Vance Creek***	
		Acres	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**
Cold Upland Forest	Cold Dry	339	5.9%	45	7.4%	88	1.0%					532	7.5%			756	9.4%		
Cold Upland Forest	Cool Dry	6	0.1%			38	0.4%												
Moist Upland Forest	Cool Moist	1,382	23.9%	41	6.8%	1,087	12.6%	79	0.7%	2,609	35.5%	1,459	20.6%	49	0.7%	3,563	44.2%		
Dry Upland Forest	Hot Dry	463	8.0%	236	38.9%	1,119	12.9%	1,679	15.3%	609	8.3%	506	7.1%	1,142	16.5%	246	3.1%	462	11.1%
Dry Upland Forest	Warm Dry	2,891	50.1%	240	39.6%	5,825	67.3%	7,022	64.1%	2,861	38.9%	3,910	55.2%	4,657	67.4%	2,804	34.8%	3,134	75.2%
Moist Woodland	Hot Moist							12	0.1%					91	1.3%	26	0.3%		
Dry Woodland	Hot Dry									71	1.0%	5	0.1%	91	1.3%				
Cold Upland Shrubland		130	2.2%	3	0.5%	60	0.7%			1	0.0%	170	2.4%	7	0.1%	68	0.9%		
Moist Upland Shrubland		56	1.0%	29	4.7%	50	0.6%	1,683	15.4%	149	2.0%	81	1.1%	264	3.8%			250	6.0%
Dry Upland Shrubland										465	6.3%	6	0.1%	77	1.1%				
Cold Upland Herbland		6	0.1%			12	0.1%			26	0.4%	36	0.5%			88	1.1%		
Moist Upland Herbland		156	2.7%	12	1.9%	51	0.6%	70	0.6%	244	3.3%	77	1.1%	211	3.1%	1	0.0%	98	2.4%
Dry Upland Herbland										31	0.4%			37	0.5%				
High SM Riparian Forest	Cold High SM															12	0.2%		
High SM Riparian Forest	Warm High SM	12	0.2%			24	0.3%			23	0.3%	62	0.9%			135	1.7%		
Moderate SM Riparian Forest	Cold Moderate SM									2	0.0%								
Moderate SM Riparian Forest	Warm Moderate SM					1	0.0%			24	0.3%	2	0.0%						
Low SM Riparian Forest	Cold Low SM					61	0.7%			36	0.5%	72	1.0%			156	1.9%		
Low SM Riparian Forest	Warm Low SM	182	3.2%			147	1.7%	348	3.2%	53	0.7%	106	1.5%	270	3.9%	97	1.2%	202	4.9%
High SM Riparian Shrubland						2	0.0%					6	0.1%			14	0.2%		
Moderate SM Riparian Herbland						32	0.4%			3	0.0%	5	0.1%			1	0.0%		
Low SM Riparian Shrubland								20	0.2%			4	0.1%					23	0.6%
Moderate SM Riparian Shrubland								36	0.3%	35	0.5%								
Low SM Riparian Herbland						9	0.1%	4	0.0%	6	0.1%								
Non Vegetated Land		155	2.7%	2	0.3%	14	0.2%	6	0.1%	108	1.5%	40	0.6%	9	0.1%	96	1.2%		
Administrative Land						37	0.4%	3	0.0%					0	0.0%				
Total Acres		5,777		607		8,657		10,962		7,358		7,078		6,907		8,062		4,169	

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3.2.2.14 Wildland/Urban Interface (WUI)

Due to its position in the lower elevations, the vegetation types within the wildland/urban interface (WUI) under NFS management (34,460 acres) had higher concentrations of the Dry Upland Forest types than did the area outside the WUI (Map 3.10, Table 3.47). Dry Upland Forest in the warm-dry plant associations (i.e., ponderosa pine, Douglas-fir, and warm grand fir types) comprised approximately two-thirds of the land area within the WUI (22,308 acres), and the WUI contained two-thirds of all of the land area of Dry Upland Forest within the Canyon Creek watershed. Of these warm-dry plant associations, ponderosa pine-dominated stands encompassed 11,874 acres (34%), Douglas-fir dominated stands occupied 7,738 acres (~23% of the WUI), grand fir was dominant in 2,040 acres (~6%), and 49 acres (1%) was dominated by western larch for a total of 22,308 forested acres within the WUI analysis area. The remaining 607 acres (~2%) were temporarily non-forested lands from recent harvest or fire.

A total of 12,152 acres were classified as non-forest within the WUI, the majority of which were upland shrublands. Approximately 86% of the shrublands found in the entire analysis area were located within the WUI. The majority of these shrublands (1,010 acres) were dominated by mountain big sagebrush with an average canopy cover of approximately 18%; mountain mahogany-dominated shrublands averaged approximately 29% cover and comprised 450 acres of the WUI. Shrublands with mixed compositions (e.g., sagebrush, bitterbrush, and mountain mahogany) comprised 893 acres of the WUI. A total of 540 acres were identified as hot-dry Upland Shrubland vegetation groups; these shrublands are typified by their presence of low sagebrush (*Artemesia arbuscula*) and stiff sagebrush (*Artemesia rigida*) intermixed with bare rock and shallow soils. Approximately 455 acres determined to have Upland Shrubland potential also contained at least a 10% co-dominance of western juniper (see the *Juniper Encroachment* section of this chapter).

Table 3.47. Potential Vegetation Groups (PVGs) and plant association groups (PAGs)within 59,578-acre analysis area.

Potential Vegetation Group	PAG	NFS lands within Wildland/ Urban Interface (WUI)		NFS lands outside WUI		Entire analysis area	
		Acres	%	Acres	%	Acres	%
Cold Upland Forest	Cold Dry	137	0.4%	1,623	6.5%	1,760	3.0%
Cold Upland Forest	Cool Dry	6	0.0%	38	0.2%	44	0.1%
Moist Upland Forest	Cool Moist	1,412	4.1%	8,858	35.3%	10,270	17.2%
Dry Upland Forest	Hot Dry	5,206	15.1%	1,255	5.0%	6,461	10.8%
Dry Upland Forest	Warm Dry	22,309	64.7%	11,035	43.9%	33,344	56.0%
Moist Woodland	Hot Moist	103	0.3%	26	0.1%	130	0.2%
Dry Woodland	Hot Dry	162	0.5%	5	0.0%	168	0.3%
Cold Upland Shrubland		127	0.4%	312	1.2%	439	0.7%
Moist Upland Shrubland		2,383	6.9%	179	0.7%	2,562	4.3%
Dry Upland Shrubland		533	1.6%	16	0.1%	549	0.9%
Cold Upland Herbland		6	0.0%	162	0.6%	168	0.3%
Moist Upland Herbland		520	1.5%	399	1.6%	919	1.5%
Dry Upland Herbland		68	0.2%	0	0.0%	68	0.1%
High SM Riparian Forest	Cold High SM*	0	0.0%	12	0.0%	12	0.0%
High SM Riparian Forest	Warm High SM	0	0.0%	256	1.0%	256	0.4%
Moderate SM Riparian Forest	Cold Moderate SM	0	0.0%	2	0.0%	2	0.0%
Moderate SM Riparian Forest	Warm Moderate SM	1	0.0%	26	0.1%	26	0.0%
Low SM Riparian Forest	Cold Low SM	58	0.2%	267	1.1%	325	0.5%
Low SM Riparian Forest	Warm Low SM	1,069	3.1%	338	1.3%	1,407	2.4%
High SM Riparian Shrubland		0	0.0%	22	0.1%	22	0.0%
Moderate SM Riparian Herbland		39	0.1%	2	0.0%	41	0.1%
Low SM Riparian Shrubland		43	0.1%	4	0.0%	47	0.1%
Moderate SM Riparian Shrubland		54	0.2%	17	0.1%	71	0.1%
Low SM Riparian Herbland		19	0.1%	0	0.0%	19	0.0%
Non Vegetated Land		166	0.5%	264	1.1%	430	0.7%
Administrative Land		40	0.1%	0	0.0%	40	0.1%
Total Acres		34,460		25,118		59,578	

*Soil Moisture

3.2.3 Structure: Stages of Stand Development

3.2.3.1 Watershed and Subwatershed Scale

A total of 12 structural classes were identified in the 59,578-acre analysis area. (Map 3.13, Table 3.48). Structural classifications for upland and riparian forest types were based upon PI data using methodology presented by Powell (2001); woodland structural classifications were made using methodology following ICBEMP (2000) and Duck Creek Associates (*in preparation*). Structural determinations follow PVG classifications defined in the *Species Composition* section of this chapter (Powell 2001).

Table 3.48. Distribution of 12 structural classes found within 59,578-acre analysis area.

Structural class	Description	Acres	Percent of analysis area
OFMS	Old Forest Multi Strata	10,085	16.9%
OFSS	Old Forest Single Stratum	201	0.3%
SECC	Stem Exclusion Closed Canopy	3,871	6.5%
SEOC	Stem Exclusion Open Canopy	21,529	36.1%
SI	Stand Initiation	332	0.6%
UR	Understory Regeneration	28	0.0%
YFMS	Young Forest Multi Strata	17,064	28.6%
WOMS	Woodland Old Multi Strata	152	0.3%
WSE	Woodland Stem Exclusion	145	0.2%
BG	Bare Ground	796	1.3%
NF	Non-Forested Land	5,334	9.0%
ADM	Administrative Land	40	0.1%
Total Acres		59,578	

At the watershed scale, the majority of the vegetation was in stem exclusion, open canopy (SEOC) or young forest, multi-strata (YFMS) structural stages. A total of 21,529 acres (36% of the analysis area) were SEOC and 17,064 (~29%) were YFMS. Approximately 17% of the analysis area was considered old forest, with 10,085 acres having old forest, multi-strata (OFMS) and 201 acres within the old forest single stratum stage (OFSS).

At the subwatershed scale, the majority of the old growth forest (OFSS and OFMS) was found in the Sugarloaf subwatershed (2,652 acres, or ~38% of the Sugarloaf subwatershed) (Table 3.49). These old forest stands were predominantly composed of Dry Upland Forest with warm-dry plant associations, including ponderosa pine (1,263 acres), Douglas-fir (739 acres), and warm, grand fir types (117 acres). Old-growth Dry Upland Forest within the hot-dry plant associations was also found within Sugarloaf subwatershed. Approximately 297 acres of old-growth ponderosa pine were found (240 acres within OFMS and 57 within OFSS), primarily within the ponderosa pine/ mountain big sagebrush and mountain mahogany plant associations. An additional ~35 acres dominated by hot/dry ponderosa pine plant associations were determined to be old-growth structure. These sites have been altered through encroachment by western juniper. Within riparian zones, Sugarloaf contained 178 acres of old-structured grand fir and 23 acres dominated by Douglas-fir within the Low Soil Moisture Riparian Forest Potential Vegetation Group (Table 3.49).

Lower East Fork subwatershed also contained a large area of old growth forest. A total of 1,718 acres (~23% of the Lower East Fork subwatershed) composed primarily of old forest, multi-strata, Dry Upland Forest within the warm-dry plant associations were encountered in Lower East Fork. These forests were dominated by Douglas-fir (893 acres, or 12% of Lower East Fork subwatershed), ponderosa pine (439 acres, or ~6%), and grand fir (361 acres, or ~5%).

In contrast, the Canyon Meadows subwatershed contained the highest proportion and most land area within the stem exclusion phase[11]. A total of 5,409 acres (63% of Canyon Meadows land area) were considered stem exclusion open canopy (SEOC) and 1,339 acres (15% of Canyon Meadows) were within the stem exclusion closed canopy (SECC) structural stage. The majority of these stands were contiguous across the subwatershed, with patchy areas containing either younger forest (YFMS) or old forest structure (OFMS or OFSS). The vegetation types were predominantly Dry Upland Douglas-fir plant communities (2,305 acres, or 26.5% of the Canyon Meadows subwatershed). Warm grand fir types were also prevalent, comprising 1,441 acres (~16% of Canyon Meadows), as were warm-dry ponderosa pine plant associations (1,065 acres or ~12% of Canyon Meadows).

11 Recent comments generated during peer-review with Forest Service silviculturists suggest classifications within the Stem Exclusion Open Canopy phase of Canyon Meadows may also include a fair component of Young Forest Multi-Strata structure. PI data indicated canopy closure in the overstory was below 10%, suggesting a non-viable overstory. Upon further review, it is likely more than 3 tree layers were present: Overstory canopy, a medium-tall canopy, a pole-sized regeneration layer, and a seedling layer. Due to the constraints applied by the mapping standards, photo interpretation has likely consolidated the two mid-story layers into one, resulting in the classification of a non-viable overstory combined with a very dense mid-story (of a single, averaged size class). Hence, Stem Exclusion Open Canopy stands in Canyon Meadows could also be considered Young Forest Multi –Strata. Further remote-sensing and ground truth analysis is recommended to elucidate the stand-specific structure in this area (Uebler et al. pers. comm.*).*

Table 3.49. The distribution of the 12 structural classes for each of nine subwatersheds within analysis area.

Structural Class and Description		**Berry Creek**		**Canyon City**		**Canyon Meadows**		**Fawn**		**Lower East Fork**		**Middle Fork Canyon Creek**		**Sugarloaf**		**Upper East Fork**		**Vance Creek**	
		Acres	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**
OFMS	Old Forest Multi Strata	883	15%	86	14%	572	7%	1,862	17%	1,718	23%	847	12%	2,582	37%	1,012	13%	523	13%
OFSS	Old Forest Single Stratum					7	0%					3	0%	70	1%	121	2%		
SECC	Stem Exclusion Closed Canopy	264	5%	45	7%	1,339	15%	902	8%	227	3%	571	8%	250	4%	159	2%	114	3%
SEOC	Stem Exclusion Open Canopy	2,403	42%	208	34%	5,459	63%	2,233	20%	1,858	25%	3,890	55%	1,121	16%	3,248	40%	1,110	27%
SI	Stand Initiation	185	3%			2	0%	39	0%	3	0%	3	0%	87	1%			13	0%
UR	Understory Regeneration	12	0%					2	0%			3	0%	6	0%			4	0%
YFMS	Young Forest Multi Strata	1,528	26%	224	37%	967	11%	3,859	35%	2,412	33%	1,220	17%	1,965	28%	3,181	39%	1,708	41%
WOMS	Woodland Old Multi Strata													152	2%				
WSE	Woodland Stem Exclusion							12	0%	71	1%	5	0%	30	0%	26	0%		
BG	Bare Ground					44	1%	231	2%			109	2%	37	1%	48	1%	326	8%
NF	Non-Forested Land	502	9%	45	7%	230	3%	1,819	17%	1,068	15%	425	6%	606	9%	268	3%	371	9%
ADM	Administrative Land					37	0%	3	0%					0	0%				
	Total Acres	5,777		607		8,657		10,962		7,358		7,078		6,907		8,062		4,169	

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3.2.3.2 Wildland/Urban Interface (WUI)

The WUI contains a generally higher proportion of old growth forest structure (OFMS and OFSS) than the Canyon Creek watershed as a whole) (Map 3.13, Table 3.50). Excluding the 1,108 acres of old growth structure within the wilderness designation, the WUI contains 5,182 acres (~15% of the WUI) of old growth, or approximately equal in proportion to the rest of the watershed. As is the case in the entire watershed, the majority of the stand structure within the WUI was within the stem exclusion phase (SEOC and SECC) or young forest (YFMS). Considering PVGs within the WUI were biased toward warmer, drier upland forests (i.e., ponderosa pine plant associations) (Table 3.50), the prevalence of stem exclusion and young forest structural classes suggest the WUI contains a higher proportion of overstocked stands than the watershed as a whole. Further discussion on the consequences of this overstocking is discussed in later sections and chapters.

Table 3.50. Twelve structural classes defined for vegetation contained within boundaries of 59,578-acre analysis area.

		NFS lands within Wildland/Urban Interface (WUI)		NFS lands outside WUI		Entire analysis area	
Structural class	**Description**	**Acres**	**% area**	**Acres**	**% area**	**Acres**	**% area**
OFMS	Old Forest Multi Strata	6,291	18.3%	3,794	15.1%	10,085	16.9%
OFSS	Old Forest Single Stratum	77	0.2%	124	0.5%	201	0.3%
SECC	Stem Exclusion Closed Canopy	2,352	6.8%	1,519	6.0%	3,871	6.5%
SEOC	Stem Exclusion Open Canopy	11,720	34.0%	9,809	39.1%	21,529	36.1%
SI	Stand Initiation	246	0.7%	86	0.3%	332	0.6%
UR	Understory Regeneration	25	0.1%	3	0.0%	28	0.0%
YFMS	Young Forest Multi Strata	8,878	25.8%	8,185	32.6%	17,064	28.6%
WOMS	Woodland Old Multi Strata	152	0.4%	0	0.0%	152	0.3%
WSE	Woodland Stem Exclusion	113	0.3%	32	0.1%	145	0.2%
BG	Bare Ground	607	1.8%	188	0.7%	796	1.3%
NF	Non-Forested Land	3,957	11.5%	1,377	5.5%	5,334	9.0%
ADM	Administrative Land	40	0.1%	0	0.0%	40	0.1%
	Total acres	34,460		25,118		59,578	

3.2.4 Fire Regimes: Frequency and Severity of Historic Fire

Fire regimes were assigned for each stand within the analysis area (Duck Creek Associates, *in prep.*) (Map 3.15, Table 3.51). One of five general fire regimes was assigned to each polygon, based upon the PVGs and PAGs of each stand (USFS Malheur National Forest Fire Management Plan).

Table 3.51. Five broadly-based fire regimes for describing frequency and severity of fire under natural, non-excluded conditions (i.e., historical fire regimes).

Fire regime	Description	Mean Fire Return Interval (MFRI) (years)	Number of acres	% of analysis area
I	Frequent fires of low severity (not stand replacing fires)	<35	15,637	26.2%
II	Frequent fires of high severity (stand replacing fire)	<35	2,907	4.9%
III	Mixed return intervals of mixed severity.	35-100	27,604	46.3%
IV	Long return interval of high severity (stand replacing fires).	100-200	11,758	19.7%
V	Very long return interval of high severity (stand replacing fires)	>200	1,671	2.8%
	Total Acres		59,578	

Source: Adapted from the Malheur National Forest Fire Management Plan and PI data.

3.2.4.1 Watershed and Subwatershed Scale

Fire regimes were assigned on the basis of potential vegetation (i.e., PVGs). The majority (73%) of the analysis area contained stands having fire regimes I and III (Table 3.52). Long return intervals (fire regimes IV and V) were most abundant in the higher elevations and encompassed ~23% of the analysis area. About 5% of the analysis area had a fire regime characterized by frequent stand-replacement fires typical of grasslands and shrublands (fire regime II).

In general (but not entirely), Dry Upland Forest in the warm-dry plant association groups was divided between fire regimes I and III. Ponderosa pine-dominated stands (i.e., ponderosa pine/pinegrass plant associations) typify fire regime I. Historically, these stands had a fire regime characterized by the presence of frequent low-intensity surface fires with a mean fire return interval of 8-15 years. These frequent fires resulted in a landscape typified as an uneven-aged mosaic of even-aged stands (Agee 1994). Most stands under this regime would be single-aged, would typically be quite small (0.25 to 2 acres), and overstory tree densities were low. Downed wood debris was low and there was vertical separation between surface and canopy fuels. Species were well adapted to survive with the occurrence of the frequent low intensity surface fires. Following fires, fuel re-accumulations were quite rapid and largely consisted of pine litter and perennial grasses. Fuels moisture falls below a threshold of combustion early in the summer and remain so for the duration of the season. As a result, fire recurrence would be possible only one to two years following fire.

Fuel continuity and productivity is limiting in ponderosa pine stands located on shallow, rocky soils with an understory of non-sprouting species such as curl-leaf mountain-mahogany, stiff sagebrush, and low sagebrush. These plant associations were classified as a subset of fire regime III (fire regime III-a), primarily because the presence of these non-sprouting shrub species suggests longer fire return intervals than what would typify a fire regime I community (Agee 1994). In these stands a fire regime typified as a moderate return interval (~35 years) with low intensity surface fire would best describe historic fire regimes.

Douglas-fir and warm-dry grand fir plant associations (life forms CD and CW) were classified as having a fire regime of III. This is a complex fire regime typified by relatively frequent (~35 year MFRI) surface fires with stand-replacing fires every ~100 years. Wildland fires that occur in these forests will usually burn as understory surface fires except under the most severe fire weather conditions when conditions are suitable for severe stand-replacement fires. This fire pattern often created a forest with multiple age classes within the same stand. Landscape heterogeneity would also be quite high. Fuel moisture contents remain high later in the fire season than those of fire regimes I and II. Often forests with a fire regime III will occupy north-aspect slopes while forests on adjacent south slopes have a fire regime of I (the Vance Creek subwatershed is a prime example of this pattern).

Approximately 5% of the analysis area was classified with a fire regime II: frequent fires of high severity (stand replacing fire). These are productive grasslands and shrublands at low elevations. Plant communities dominated by mountain big sagebrush, bluebunch wheatgrass, and Idaho fescue would typify this fire regime. In addition, riparian meadows occupying broad floodplains surrounded by ponderosa pine forest would have this fire regime. Perennial grasses would be the dominant fuel carrying fires in these communities. Neither fuels nor fuel moisture contents limit fire spread for much of the fire season. Fuels loads and continuity rapidly recover given the adaptations of the perennial grasses to rapidly re-grow in the years following fire (Kauffman et al., 1997). Shrubs recover in these sites via re-sprouting or rapid reinvasions from seeds. Colonization by exotic species alters how these stands function with respect to fire. Currently, no data are available as to the content of non-native species in this fire regime for the analysis area.

At higher elevations within the analysis area, snow cover increases while forest (and fuel) productivity decreases. Forests are dominated subalpine fir, lodgepole pine and Engelmann spruce. In these forests, fire regimes fall under a long return interval (>100 years) with severe, stand replacing fires (fire regimes IV and V). Because these stands have such a long fire return interval, stands can contain a variety of structural stages, depending on the age since disturbance. In areas where the forest is continuous with few natural fire breaks (such as rock outcrops), patch-size is usually quite large in area and stands within a patch are typically of the same age. In the highest elevations of the Canyon Creek watershed, rock outcrops help to define small patches.

In fire regimes I and III, tree species have adapted to survive surface fires (i.e., thick bark, self pruning). In contrast, trees in fire regimes IV and V possess adaptations facilitating survival with long return intervals (i.e., thin-bark, no self pruning, shade tolerance, etc). While there have been dramatic changes in the structure and composition of plant communities with historical fire regimes of I – III, there are few differences in stands of fire regimes IV and V (i.e., these stands are not out of the range of natural variability due to land use or fire exclusion). Recently, Keane et al. (2002) described how some landscapes in the Intermountain West have been altered due to fire exclusion. Time since disturbance is an important factor in evaluating the effects of fire exclusion, and it is difficult to evaluate the effects with long return interval fire regimes (IV and V) when fire has been excluded through management for only 1 fire return interval (i.e., since ~1850).

Another plant community under fire regime IV in central Oregon would include those few areas dominated by "old growth" western juniper (i.e., woodlands). In these old stands, fuel loads limit the spread of fire. Only under the most severe of fire weather conditions can fires spread through these stands. It is important to separate these western juniper stands from those where land use and fire exclusion has resulted in the invasion and dominance of juniper within stands formerly dominated by grassland or shrublands.

In summary, the periodicity of fires and their ecological severity is a continuum in western landscapes. Given the heterogeneity in vegetation composition and structure of the Canyon Creek watershed, five categorical fire regimes may be too simplistic for all plant community types within the watershed. This is particularly true for the land areas with fire regime III. Within this regime, there could be "sub-regimes" of moderate return interval stand-replacing fires (35-100 years). This likely would characterize the quaking aspen stands of the Strawberry Mountains. In addition, there are stands with moderate-return intervals (A MFRI of >30 years) and low severity surface fires, such as those ponderosa pine sites where fuel productivity and continuity is limiting by shallow, rocky soils (fire regime III-a). Nevertheless, for the majority of sites within the watershed, historical fire regimes are likely reasonably represented in this analysis.

Table 3.52. Distribution of 5 fire regimes for each of 26 Potential Vegetation Groups (PVGs) and Plant Association Groups (PAGs) within 59,578 acre analysis area.

		Fire Regime I		**Fire Regime II**		**Fire Regime III**		**Fire Regime IV**		**Fire Regime V**	
PVG	**PAG**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**
Cold Upland Forest	Cold Dry							519	0.9%	1,241	2.1%
Cold Upland Forest	Cool Dry							44	0.1%		
Moist Upland Forest	Cool Moist							10,270	17.2%		
Dry Upland Forest	Hot Dry	4,007	6.7%			2,455	4.1%				
Dry Upland Forest	Warm Dry	11,593	19.5%			21,751	36.5%				
Moist Woodland	Hot Moist					103	0.2%	26	0.0%		
Dry Woodland	Hot Dry							168	0.3%		
Cold Upland Shrubland				35	0.1%			404	0.7%		
Moist Upland Shrubland				2,027	3.4%	535	0.9%				
Dry Upland Shrubland						549	0.9%				
Cold Upland Herbland				159	0.3%			9	0.0%		
Moist Upland Herbland				581	1.0%	338	0.6%				
Dry Upland Herbland				37	0.1%	31	0.1%				
High SM Riparian Forest	Cold High SM							12	0.0%		
High SM Riparian Forest	Warm High SM							256	0.4%		
Moderate SM Riparian Forest	Cold Moderate SM							2	0.0%		
Moderate SM Riparian Forest	Warm Moderate SM							26	0.0%		
Low SM Riparian Forest	Cold Low SM					325	0.5%				
Low SM Riparian Forest	Warm Low SM					1,407	2.4%				
High SM Riparian Shrubland								22	0.0%		
Moderate SM Riparian Herbland						41	0.1%				

		Fire Regime I		Fire Regime II		Fire Regime III		Fire Regime IV		Fire Regime V	
PVG	**PAG**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**
Low SM Riparian Shrubland				47	0.1%						
Moderate SM Riparian Shrubland						71	0.1%				
Low SM Riparian Herbland				19	0.0%						
Non Vegetated Land										430	0.7%
Administrative Land		38	0.1%	3	0.0%						
Total Acres		**15,637**		**2,907**		**27,604**		**11,758**		**1,671**	

Table 3.53. Fire regimes found for Plant Vegetation Groups and plant association groups (PAGs) within 34,460-acre Wildland/Urban Interface (WUI) on NFS lands.

		Fire Regime I		Fire Regime II		Fire Regime III		Fire Regime IV		Fire Regime V	
PVG	PAG	Acres	% Area	Acres	% Area	Acres	% Area	Acres	% Area	Acres	% Area
Cold Upland Forest	Cold Dry							47	<1%	90	<1%
Cold Upland Forest	Cool Dry							6	<1%		
Moist Upland Forest	Cool Moist							1,412	4%		
Dry Upland Forest	Hot Dry	3,362	10%			1,844	5%				
Dry Upland Forest	Warm Dry	9,682	28%			12,626	37%				
Moist Woodland	Hot Moist					103	<1%				
Dry Woodland	Hot Dry							162	<1%		
Cold Upland Shrubland				7	<1%			119	<1%		
Moist Upland Shrubland				1,926	6%	457	1%				
Dry Upland Shrubland						533	2%				
Cold Upland Herbland				6	<1%			1	<1%		
Moist Upland Herbland				450	1%	69	<1%				
Dry Upland Herbland				37	<1%	31	<1%				
Moderate SM Riparian Forest	Warm Moderate SM							1	<1%		
Low SM Riparian Forest	Cold Low SM					58	<1%				
Low SM Riparian Forest	Warm Low SM					1,069	3%				
Moderate SM Riparian Herbland						39	<1%				
Low SM Riparian Shrubland				43	<1%						
Moderate SM Riparian Shrubland						54	<1%				
Low SM Riparian Herbland				19	<1%						
Non Vegetated Land										166	<1%

		Fire Regime I		Fire Regime II		Fire Regime III		Fire Regime IV		Fire Regime V	
PVG	**PAG**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**
Administrative Land		38	<1%	3	<1%						
Total Acres (% of WUI)		**13,082**	**38%**	**2,491**	**7%**	**16,883**	**49%**	**1,748**	**5%**	**256**	**1%**

3.2.4.2 Wildland/Urban Interface (WUI)

Within the WUI, fire regimes were biased toward I and III, or those regimes having shorter return intervals with low to mixed severity fires (Table 3.53, Map 3.15). Warm-dry ponderosa pine stands typify the 9,682 acres having fire regime I. The 12,626 acres having a longer return interval (fire regime III) contain mostly Douglas-fir and grand fir communities with a fair component (2,793 acres) of ponderosa pine stands having longer return intervals (i.e., ponderosa pine/ mountain mahogany plant associations).

3.2.5 Live Fuels Condition Classes

The purpose of this analysis was to evaluate the current condition of the vegetation structure and species composition (live fuels) with respect to historic fire regimes. Although live fuels alone are not sufficient for describing fire risk at local and landscape scales, they offer insight as to ecosystem-level changes as a result of fire exclusion and management practices. Dead and downed fuels were not considered in the analysis because data were not available.

In general, live fuels condition classes were assigned according to modified criteria described in the Malheur National Forest Fire Management Plan, and each stand was evaluated as to the degree of departure from historic fire return intervals. Grasslands and meadows were not considered in this analysis because it was not possible to detect shifts in species composition or biomass structure using aerial photographs and no ground-truth data were available. Therefore, 906 acres of upland and riparian herblands (grasslands and meadows) were excluded from the analysis because data were unavailable to properly evaluate condition.

By definition, it is hard to understand why all the stands in fire regime I do not have live fuels with a condition class 3 because it is possible that as many as 10 fire cycles have been eliminated in low elevation ponderosa pine stands. In addition, second growth stands where the forest has developed without surface fires in their history have a structure far outside the historical range of variability (high stand density, high levels of ladder fuels, surface fuels, etc.).

Table 3.54. Description of three live fuels condition classes used to evaluate how stands are functioning within their historic fire regimes.

Condition class	**Attributes**	**Example management options**
Live Fuels Condition Class 1	Fire regimes are within or near an historical range. The risk of losing key ecosystem components is low. Fire frequencies have departed from historical frequencies (either increased or decreased) by no more than one return interval. Vegetation attributes (species composition and structure) are intact and functioning within an historic range.	Where appropriate, these areas can be maintained within the historic fire regime by treatment such as prescribed fire or wildland fire use.
Live Fuels Condition Class 2	Fire regimes have been moderately altered from their historic range. The risk of losing key ecosystem components has increased to moderate. Fire frequencies have departed from historic frequencies by more than one return interval. This change results in moderate changes to one or more of the following: fire size. Frequency, intensity, severity, or landscape pattern. Vegetation attributes have been moderately altered from their historic ranges.	Where appropriate, these areas may need moderate levels of restoration treatments, such as wildland fire use, prescribed fire, and hand or mechanical treatments, to restore historic composition and structure and fire regimes (particularly fire regime I).
Live Fuels Condition Class 3	Fire regimes have been considerably altered from their historical range. The risk of losing key ecosystem components is high. Fire frequencies have departed by multiple return intervals. This change results in dramatic changes to one or more of the following: fire size, frequency, intensity, severity, or landscape pattern.	Where appropriate, these areas need intensive degrees of restoration treatments, such as stage prescribed burning, hand or mechanical treatments. These treatments may be necessary before any wildland fire use is used to restore the historical fire regime.

Source: Adapted from the Malheur National Forest Fire Management Plan, USFS Agency Comprehensive Strategy

Stands most in need of restoration would include those in live fuels condition classes 2 and 3. Stands in condition class 2 can be most easily restored at lower cost that in condition class 3. As a simplification, fuels in ponderosa pine forest in condition class 2 may be effectively reduced via prescribed burning. Stand restoration, particularly in second-growth stands would require thinning to historical stand densities prior followed by the establishment of a prescribed understory burning. The composition and structure of downed and dead fuels is necessary before any concrete recommendations can be made (see *Chapter 5-6*).

Fewer stands in fire regimes III and IV are found with live fuels condition classes 2 and 3. While few stands may be outside their historical range of variability, landscapes are altered in that there are likely fewer naturally established young post-fire stands. However, young stands exist in areas of timber harvest, but these likely have a different size and structure and higher fuel loads than stands established from recent fire.

3.2.5.1 Watershed and Subwatershed Scale

Approximately half of the analysis area had stand composition and structure that was considered to be functioning outside its historic fire regime (Map 3.16, Table 3.55). A total 25,767 acres (43% of the analysis area) had live fuels conditions that were “moderately altered” from historic fire regimes (condition 2) and 5,661 acres had been “considerably altered” (condition 3) in composition and structure from what would be considered historical conditions. These 31,428 acres (or ~53% of the analysis area) are considered to have moderate to severe alterations from historic fire regimes, and it is probable these stands would support uncharacteristically severe fires with elevated levels of mortality (see *Chapters 4, 5-6*).

Table 3.55. Number of acres under each live-fuels condition class within analysis area.

Condition class	***Total acres***	***% Of analysis area***
Condition 1	27,203	46%
Condition 2	25,767	43%
Condition 3	5,661	10%
Administrative Lands (not evaluated)	40	<1%
Grasslands (not evaluated)	906	2%
Total Acres	**59,578**	

At the subwatershed scale, Fawn and Sugarloaf comprise the majority of acres and highest proportion of condition 3 stands (1,679 and 1,650 acres, respectively) (Table 3.56). In both Fawn and Sugarloaf, the majority of the condition 3 stands were warm-dry ponderosa pine stands in the young forest multi-strata (YFMS) structural stage (650 acres in Fawn and 395 acres in Sugarloaf). Old forest multi-strata (OFMS) stands with very high levels of overstocking (condition 3) were also prevalent; 375 and 355 acres were within the OFMS in Fawn and Sugarloaf, respectively. Both of these multi-strata stand structures contained a high proportion of shade-tolerant understory poles and saplings and were markedly altered from what would be expected under their historic fire regime (regime I). A total of 537 acres within Sugarloaf and 133 acres in Fawn had condition 3 stands due to severe degrees of juniper encroachment. A synthesis of how condition classes relate to the risk of catastrophic fire is discussed in *Chapter 5-6*.

Table 3.56. Number of acres and proportion of each subwatershed having different live fuels condition classes within analysis area.

	Condition 1		Condition 2		Condition 3	
Subwatershed name	**Acres**	**% of subwatershed**	**Acres**	**% of subwatershed**	**Acres**	**% of subwatershed**
Berry Creek	3,077	53.3%	2,444	42.3%	94	1.6%
Canyon City	278	45.8%	243	40.0%	74	12.3%
Canyon Meadows	4,099	47.3%	3,745	43.3%	712	8.2%
Fawn	3,182	29.0%	6,024	55.0%	1,679	15.3%
Lower East Fork	3,584	48.7%	3,107	42.2%	399	5.4%
Middle Fork Canyon Creek	4,411	62.3%	2,482	35.1%	67	0.9%
Sugarloaf	1,639	23.7%	3,597	52.1%	1,650	23.9%
Upper East Fork	5,944	73.7%	1,589	19.7%	440	5.5%
Vance Creek	989	23.7%	2,537	60.9%	545	13.1%
Total acres for each condition class	**27,203**		**25,767**		**5,661**	

In addition to Fawn and Sugarloaf, Vance Creek had a large proportion of stands within live-fuels conditions 2 and 3 (Table 3.56). In general, stands within Vance Creek were decadent due to insects and severe infections of dwarf mistletoe; particularly in Douglas-fir dominated stands (Spiegel and Schmitt, 2002). The degree of dead fuels accumulation in these stands is not known but is expected to be very high due to damage from insects and disease. Vance Creek had a considerable land area in YFMS stage (1,644 acres, or 39% of the subwatershed) and 919 acres within the stem exclusion phase (805 acres in SEOC and 114 acres in the SECC stage). In general, these stands are typified by a dense understory that would not be common had fire returned at an interval of 35 to 50 years (fire regimes I and III). The continuity of condition 2 stands intermixed with conditions 3 stands implicate Vance Creek as an area of concern for uncharacteristic fire severity (*see Chapter 5-6*).

3.2.5.2 Wildland/Urban Interface

Approximately two-thirds of the acreage within the WUI was evaluated to have live fuels conditions that were outside their historic range, suggesting fire regimes have been moderately to considerably altered from their historic conditions. A total of 4,563 acres (13% of the WUI) were considered to have a live fuels condition class 3 (Map 3.16, Table 3.57). These values may appear low, considering fire exclusion has been in effect for ~10 fire cycles. However, at the scale of the WUI, the high proportion of condition 2 stands intermixed with condition 3 stands suggest a landscape-level condition that is dramatically altered from historic conditions. In addition, the results suggest the horizontal continuity of fuels is high for stands within the WUI on NFS lands within the watershed. Although quantitative data are not available, aerial photographs indicate conditions on non-federal industrial timberlands in the watershed appear similar if not more severe than neighboring NFS lands. The generally overstocked conditions on federal and non-federal lands underscore the importance of understanding the horizontal continuity of fuels, regardless of designation.

Table 3.57. Condition classes of vegetation stands within 59,578-acre analysis area.

	Condition 1		***Condition 2***		***Condition 3***		***All Conditions***
Area of interest	***Acres***	***% Area***	***Acres***	***% Area***	***Acres***	***% Area***	***Total Acres***
NFS lands within the Wildland/Urban Interface (WUI)	11,785	34%	17,721	51%	4,563	13%	34,460
NFS lands outside WUI	15,418	61%	8,046	32%	1,098	4%	25,118
Entire analysis area	**27,203**	**46%**	**25,767**	**43%**	**5,661**	**10%**	**59,578**

Outside of the WUI but within analysis area, approximately two-thirds of the acreage was found to have vegetation structure that suggests it to be functioning within the expected historic fire regimes (Table 3.58). The discrepancy between WUI and non-WUI stand conditions is largely due to the differences in vegetation types between the two areas and the fire regimes they have historically supported. In the upper elevations outside the WUI, rock outcrops intermixed with subalpine fir/ grand fir community types (Cold Upland Forests) harbor long return-interval fire regimes (ca. 200 years, or Fire Regimes IV-V). Because of their long fire return-intervals, it is difficult to ascertain the degrees of divergence as forest structure data do not predate the 1900s.

Dry Upland Forest types within the warm-dry plant associations (i.e., ponderosa pine, Douglas-fir, and warm grand fir types) are the forest stands of the most concern within the WUI (Table 3.58 and Table 3.59). In general, these forest stands had dense understory structures (i.e., YFMS or SEOC), which suggest a condition beyond those expected under natural fire regimes. In general, condition 2 and condition 3 stands were continuous across the landscape within the WUI, particularly in Vance Creek, the northern section of Fawn, and the southern section of Sugarloaf. Further discussion and recommendations are presented in later chapters.

Table 3.58. Number of acres and proportion of 34,460-acre Wildland/Urban Interface (WUI) on NFS lands within each Potential Vegetation Group (PVG) and plant association group (PAG) within each of three live-fuels condition classes.

		Condition 1		Condition 2		Condition 3	
Potential Vegetation Group	**PAG**	**Acres**	**% of WUI**	**Acres**	**% of WUI**	**Acres**	**% of WUI**
Cold Upland Forest	Cold Dry	136	0.4%	1	0.0%		
Cold Upland Forest	Cool Dry	6	0.0%				
Moist Upland Forest	Cool Moist	998	2.9%	414	1.2%		
Dry Upland Forest	Hot Dry	1,101	3.2%	2,956	8.6%	1,149	3.3%
Dry Upland Forest	Warm Dry	6,669	19.4%	12,963	37.6%	2,677	7.8%
Moist Woodland	Hot Moist	87	0.3%	17	0.0%		
Dry Woodland	Hot Dry	156	0.5%	6	0.0%		
Cold Upland Shrubland		127	0.4%				
Moist Upland Shrubland		956	2.8%	953	2.8%	474	1.4%
Dry Upland Shrubland		533	1.5%				
Moist Upland Herbland				7	0.0%	226	0.7%
Dry Upland Herbland		31	0.1%			37	0.1%
Moderate SM Riparian Forest	Warm Moderate SM	1	0.0%				
Low SM Riparian Forest	Cold Low SM	14	0.0%	44	0.1%		
Low SM Riparian Forest	Warm Low SM	708	2.1%	361	1.0%		
Low SM Riparian Shrubland		43	0.1%				
Moderate SM Riparian Shrubland		54	0.2%				
Non Vegetated Land		166	0.5%				
Total acres (% of WUI)		**11,785**	**34.2%**	**17,721**	**51.4%**	**4,563**	**13.2%**

A total of 391 acres could not be evaluated because they were grasslands or administrative lands.

Table 3.59. Number of acres and proportion of 34,460-acre Wildland/Urban Interface (WUI) on NFS lands within each structural class within each of three live-fuels condition classes.

		Condition 1		Condition 2		Condition 3	
Structural Class	**Description**	**Acres**	**% of WUI**	**Acres**	**% of WUI**	**Acres**	**% of WUI**
OFMS	Old Forest Multi Strata	3,037	8.8%	2,488	7.2%	766	2.2%
OFSS	Old Forest Single Stratum	77	0.2%				
SECC	Stem Exclusion Closed Canopy			1,442	4.2%	910	2.6%
SEOC	Stem Exclusion Open Canopy	5,543	16.1%	5,498	16.0%	679	2.0%
SI	Stand Initiation	26	0.1%	145	0.4%	75	0.2%
UR	Understory Regeneration			12	0.0%	13	0.0%
YFMS	Young Forest Multi Strata	344	1.0%	7,153	20.8%	1,382	4.0%
WOMS	Woodland Old Multi Strata	136	0.4%	17	0.0%		
WSE	Woodland Stem Exclusion	107	0.3%	6	0.0%		
BG	Bare Ground	607	1.8%				
NF	Non-Forested Land	1,909	5.5%	959	2.8%	738	2.1%
	Total Acres (% of WUI)	**11,785**	**34%**	**17,721**	**51%**	**4,563**	**13%**

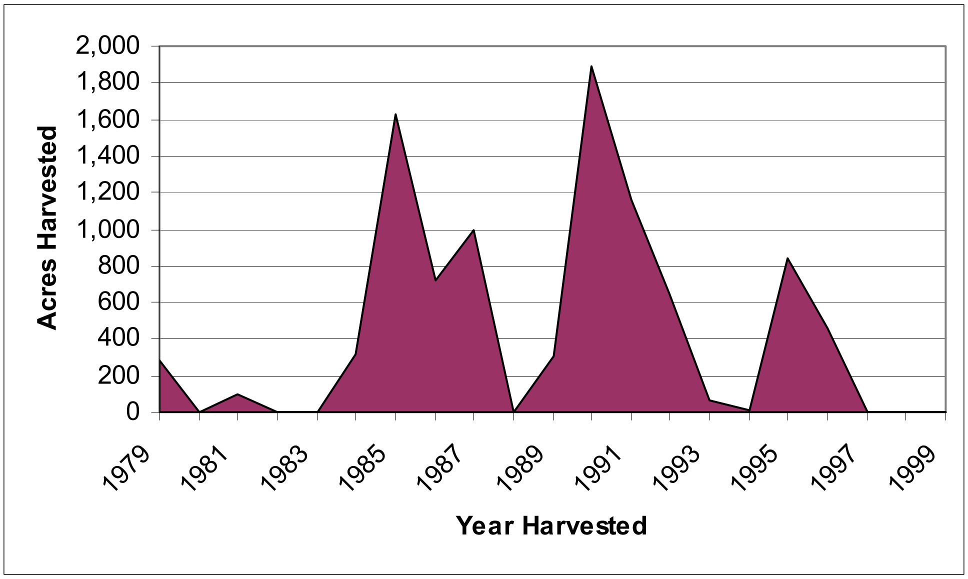
A total of 391 acres could not evaluated because they were grasslands or administrative lands.

3.2.6 Other Factors Affecting Ecosystem Function

3.2.6.1 Timber Harvest

Numerous silvicultural practices have been prescribed in the Canyon Creek watershed. The prescription goals have included commodity production, insect and disease control, and hazardous fuels management. Most prescriptions fit into the broad categories of selective harvest, shelter-wood harvest, thinning, seed-tree cuts, and clear-cutting. The area outside the Strawberry Mountain Wilderness has a high road density indicating that many stands have received silviculture treatments at least once. Ground-based skidding, and cable yarding on steep slopes are common methods used to get harvested wood out of the forest.

The most common silvicultural method employed throughout the watershed has been selective harvest, where mature timber is removed either as individual trees or in small clusters creating an uneven-aged stand. Generally, selective harvests have lead to the removal of large-diameter trees and have a forest structure dominated by a dense layer of smaller diameter trees (overstocking). This harvest method tends to leave trees vulnerable to disease, insect attack, and parasites (especially mistletoe). The combined effects promote live- and dead-fuels conditions that allow for crown fires that are uncharacteristic for the historic fire regimes (usually fire regimes I and III).



(source: USFS Metadata)

Figure 3.11. Frequency of timber harvest on Forest Service land within Canyon Creek watershed.

Data from 1979 through 1999 indicate timber harvest frequencies have been highly variable (Figure 3.11). Since 1979, a total of 9,417 acres were harvested within the analysis area using 11 different harvest methods (Table 3.60). In the southern portion of the watershed, both shelter-wood and seed-tree harvest methods have been used in moderation. Ponderosa pine and Douglas-fir are the primary "leave-tree" species in shelter-wood harvests for use as a partial shelter for seedling establishment and in seed-tree harvest as a seed source. These applications generally reduce the risk of disease, insect attack, and fire hazard. However, both methods reduce the tree crown canopy cover and expose soil to direct contact by rain, which in turn increases the potential for soil erosion and may alter the microclimate conditions of the understory needed for successful seedling establishment.

Clear-cutting involves the removal of all merchantable timber and then replanting to create new, even-aged stands. It has been primarily employed in the western portion of the Canyon Creek watershed as a sanitation-salvage technique on north slopes infected by mistletoe and insects (Spiegel and Schmitt 2002). The intent of the sanitation salvage is the removal of all trees to rid the stand of insects and disease, after which time new seedlings are planted. In practice, however, the trees left between the sanitation-salvage harvest units remain infected with disease and insects. These remnant trees are vectors for disease in the newly regenerating trees in old salvage units.

Table 3.60. Harvest methods used on NFS lands within Canyon Creek watershed from 1979 to 1999.

Activity	Description	Acres harvested
HCC	Clearcut	1,150
HCR	Clearcut with seed trees reserved	234
HFR	Final removal cut	1,545
HOR	Overstory removal cut	1,642
HPR	Partial removal cut	2,499
HSA	Sanitation (intermediate) cut	215
HSH	Shelterwood seed cut	538
HSL	Selection cut	189
HSP	Special uses cut	612
HSV	Salvage (intermediate) cut	314
HTH	Commercial (intermediate) thinning	477
	Total Harvest	**9,417**

Source: USFS harvest data

Pre-commercial and commercial thinning occur throughout the watershed. On south-facing slopes dominated by ponderosa pine, commercial thins have resulted in widely spaced second growth stands that resist insects and disease. Thinning can be an effective tool in restoring these south-facing ponderosa pine stands to their historic fire regimes.

3.2.6.2 Insects and Disease

Timber harvest, overstocking, and the removal of fire in fire-dependent communities have resulted in environments where pathogens (insects and diseases) have played a major role in defining forest structure and health. Understory densities of late seral species (Douglas-fir and grand fir) increased with timber harvest practices, and the absence of understory burning favored their establishment. The net result in many of these stands was a shift from single-stratum structure of ponderosa pine to a multi-strata structure of late seral species. The change in forest structure and species composition provided ideal feeding ladders for budworm larvae to infect all strata within the stand (Powell 1994).

Because of their life cycle and dependence on shade and mesic microclimates, the overstocking of late-seral species in understory strata makes forest stands more subject to climatic variation, especially drought stress. Drought conditions and growth stagnation from competition weakens the late-seral species and results in a stand that is more susceptible to insect and disease attacks. At the landscape-scale, these shifts in composition and structure have promoted an increase in favorable conditions for insect and disease outbreaks, and the continuity of stands that are susceptible for attack is high across the landscape. On balance, insects and disease have shifted from creating a localized disturbance to landscape-level, catastrophic outbreaks. This shift in the ecological role of pathogens from a "secondary" disturbance factor to a "primary" disturbance mechanism in the Blue Mountains is arguably a symptom of removal of keystone disturbances (fire), exacerbated by timber harvest practices that favor overstocked conditions (Powell 1994).

Two major outbreaks of western spruce budworm (*Choristoneura occidentalis*) occurred on the Malheur National Forest in the past century. The first occurred between 1944 and 1958, and culminated in ~460,000 acres affected by defoliation. The second outbreak was more recent and severe: a sharp increase in budworm affected ~1.3 million acres between 1980 and 1991, with a major peak in 1986. The Canyon Creek watershed was not immune to these outbreaks. Although not specific to the Canyon Creek watershed, the Malheur National Forest lands reviewed (Powell 1994) found an increase in tree mortality from 6% to 21% between 1980 and 1989 due to spruce budworm. Recently, Spiegel and Schmitt (2002) outlined the serious insect and disease problems in areas of the Canyon Creek watershed. These areas were: northerly aspects dominated by Douglas-fir and grand fir, southerly aspects dominated by ponderosa pine, Canyon Meadows Campground and Buckhorn Meadow Trailhead, Designated Old Growth areas, Crazy Creek, and Table Mountain.

3.2.6.2.1 Northerly Aspects

In the Douglas-fir dominated stands on north slopes, dense multi-layered canopies have undergone mortality from western spruce budworm and Douglas-fir beetle (*Dendroctonus pseudotsugae*). These conditions have increased the susceptibility to budworm, Douglas-fir engraver (*Scolytus unispinosus*) and pole beetle (*Pseudohylesinus nebulosis*). Moderate to severe dwarf mistletoe infestations in combination with severe insect damage have led to dead fuels conditions that would promote crown fires. Commercial thinning has been attempted in heavily infected stands with dwarf mistletoe (e.g., Vance Creek), resulting in rapid enlargement and proliferation of mistletoe brooms, declines in growth rates, and high incidence of mortality. Following thinning, the mistletoe has responded to increased light on understory firs, compounding mortality and fuels loading.

In ponderosa pine stands where understory-stocking levels are high with Douglas-fir and grand fir (condition 2 and 3 stands), mortality from western pine beetle (*Dendroctonus brevicomis*) in the large pines has increased with increasing understory basal area. It has been suggested that many of these stands are good candidates for commercial thins to reduce understory biomass and promote pine and larch dominance (Spiegel and Schmitt 2002). Heavy fuel loading is also common in these stands from insect damage and thinning.

3.2.6.2.2 Southerly Aspects

Many of the lower elevation ponderosa pine stands (i.e. those found in the WUI) on the north side of Canyon Creek watershed are second-growth communities. As identified in earlier sections of this chapter, these stands are in a stem-exclusion phase and are overstocked. Dwarf mistletoe and bark beetles are the two pathogens currently affecting these stands; both of which contribute to fuels loading and an increased probability of lethal crown fires. Use of controlled burn prescriptions in conjunction with thinning can promote OFSS stand structure. However, the loading of fuels (both live and dead) is a concern in these forest types.

3.2.6.2.3 North Aspect Grand Fir Communities

Many of the cooler grand fir stands may have been dominated by ponderosa pine in the past. Ponderosa pine was selectively removed from many sites, sometimes more than once. With increased densities of shade-tolerant species, larch dwarf mistletoe (*Arceuthobium laricis*) outbreaks have dramatically altered the population structure; high levels of larch mortality due to mistletoe have removed larch as a notable component of these systems. It is probable insects and disease have extirpated many of the seral species and, barring large disturbance events, dominance is unlikely to shift back toward ponderosa pine and western larch.

3.2.6.2.4 Other Areas

In the Canyon Meadows Campground and Buckhorn Meadows Trailhead areas, there are well-established understories of grand fir with only minor components of large-diameter ponderosa pine trees. Insect, fungus, and disease responses to aforestation are prevalent. Indian paint fungus (*Echinodontium tinctorium*) decay is present in grand fir, as are several root diseases (e.g., annosus root disease—*Heterobasidion annosum*). The main concerns in this area are the hazard trees generated by disease.

Crazy Creek contains mixed conifer stands, with mature western larch, ponderosa pine and Douglas-fir in the overstory and Douglas-fir, lodgepole pine and grand fir dominating the understory. Lodgepole pine mortality associated with the mountain pine beetle outbreak in the 1970s has created heavy ground fuels loading. The overstory larch and Douglas-fir is infected with dwarf mistletoe. Low to moderate levels of bark beetles and budworm damage is present.

Table Mountain contains well-spaced second growth ponderosa pine at low to medium risk for mountain pine beetle. Ground fuels from past timber harvest are considered to be high. In these multi-strata stands, the dense stocking of ~12” grand fir (180 ft^2/ acre BA) in combination with dwarf mistletoe in Douglas-fir could promote crown fires.

3.3 TERRESTRIAL SPECIES AND HABITAT

The Canyon Creek Watershed currently supports a wide range of wildlife habitat and species. A selected group of species was focused on for this analysis. The species were selected for one of the following reasons: it has federal threatened, endangered, proposed or sensitive status; it is a Malheur National Forest MIS; or it is an LRMP Featured Species or species of interest. MIS are identified to indicate effects of management activities on other species or major biological communities.

As stated in *Chapter 1*, the watershed contains a variety of vegetative types and successional stages that have been altered from historic conditions by both human and natural processes. Currently, 17 percent of the watershed is considered to be mature coniferous forest that may be late successional habitat. The wilderness provides high elevation alpine vegetation. Unique habitats, identified in the LRMP, include meadows, rimrock, talus slopes, cliffs, animal dens, wallows, bogs seeps and springs, and quaking aspens stands (USFS 1990). These areas would provide habitat for a variety of wildlife species in the watershed but the quantity and quality of this habitat was not available for this analysis. Habitat conditions for each proposed, endangered, threatened, and sensitive species MIS, featured species and species of interest are discussed below by grouping the species that are most likely to occur in similar vegetation types.

3.3.1 Proposed, Endangered, Threatened and Sensitive Species

3.3.1.1 Shrubland and Herbland Associated Species

3.3.1.1.1 Pygmy rabbit

This species is associated with habitats dominated with big sagebrush on deep, friable soils. Habitat suitability is related to the availability of forage (primarily big sagebrush), security from predation, and ease of burrow construction. Shrub cover and height are much greater in occupied verses unoccupied sites (Verts and Carraway 1998). There are no historic occurrences of this species documented in Grant County (Csuti et al. 1997). There are over 2500 acres of big sagebrush dominated shrublands within the watershed most of which occurring in the Fawn subwatershed It is unknown if these shrublands provide the suitable soils required by this species. There are no documented occurrences of this species in the watershed (USFS 2002c).

3.3.1.1.2 Western sage grouse

Sage grouse are obligate residents of the sagebrush ecosystem, usually inhabit sagebrush-grassland or juniper-sagebrush-grassland communities. Sagebrush is a crucial component of the diet of this species year-round, and they select sagebrush almost exclusively for cover. Courtship display areas usually occur in open areas such as swales, irrigated fields, meadows, and roadsides, and areas with low, sparse sagebrush cover. Sage grouse prefer relatively tall sagebrush with an open canopy for nesting. This species has declined primarily because of loss of habitat due to the conversion of sagebrush habitat to grassland (Howard and Bushey 1996-98). 65% of the total acres of big sagebrush shrublands are distributed within the Fawn subwatershed but is unknown if this sagebrush habitat provides the suitable habitat conditions for sage grouse. Habitat conditions on private lands are unknown. There are no documented occurrences of this species in the watershed (USFS 2002c).

3.3.1.1.3 Upland sandpiper

Upland sandpipers breeding habitat is restricted primarily to extensive, open tracts of short grassland habitat. They nest in native prairie, dry meadows, and pastures, and are also known to nest in dry patches of wet meadows (Carter et al. 1992). Preferred habitat includes large areas of short grass for feeding and courtship interspersed with tall grasses for nesting and brood cover (Carter et al. 1992). The estimated breeding population in Oregon is less than 100 birds, most of which breed in Logan and Bear Valleys (Csuti et al. 1997). There are no large open short grassland habitats within the Malheur National Forest. The private lands within the watershed are utilized for agriculture and are unlikely to provide habitat for this species. The dry meadow habitats within NFS lands are small, ranging from less than one acre to eight acres, and scattered and therefore unlikely to provide breeding habitat for this species. There are no documented occurrences in the watershed (USFS 2002c).

3.3.1.1.4 Gray flycatcher

This species is most abundant in extensive tracts of big sagebrush. It prefers relatively treeless areas with tall sagebrush, bitterbrush or mountain mahogany communities. This species can also occur in these communities within open forests of ponderosa or lodgepole fine or juniper woodlands with sagebrush understory (Csuti et al. 1997). This species territory has been reported to vary from three to nine acres with a home range of about 10 acres (Csuti et al. 1997). The mountain mahogany and sagebrush shrublands scattered throughout the watershed may provide habitat for this species. This species is not known to occur within the watershed (USFS 2002c).

3.3.1.1.5 Bobolink

Bobolinks are associated with open prairies, grasslands, wet meadows, and pastures. In Oregon, there are only a few disjunct populations that breed in wet, grassy meadows with local growths of forbs and sedges (Csuti et al. 1997). Small colonies are known to exist near Prairie City and John Day (Gilligan et al. 1994). Moist meadow habitat, which is preferred by this species, is very limited. This habitat is located in a four-acre and 27-acre meadow behind the dam in Canyon Meadow subwatershed and in a three-acre meadow in the Lower East fork subwatershed. The minimum grassland size utilized by this species is five to ten acres, but may be larger if the grasslands are fragmented (Jones and Vickery 1997). This species may use the meadow located behind the dam, but the suitability of this meadow as nesting habitat is unknown.

Due to the lack of suitable habitat, this species is not expected to occur in the watershed. The suitability of the pastures on private land to provide habitat for this species is unknown but this species is know to respond positively to properly timed burning, mowing and moderate grazing. There are no documented occurrences in the watershed (USFS 2002c).

3.3.1.2 Late and Old Structure Forest Associated Species

3.3.1.2.1 Bald eagle

The bald eagle is found along the shores of saltwater and freshwater lakes and rivers. Nests are usually located in mature or old growth trees that are the dominant or co-dominant tree in the overstory. Nest trees are usually live, but often have a dead or broken top with a limb structure to support the nest (Rodrick and Milner 1991). The nest tree usually has an unobstructed view of nearby water, and has stout upper branches that form flight windows large enough to accommodate the bird's large wingspan (Grubb 1976). Three main factors affecting distribution of nests and territories are proximity to water and availability of food; suitable trees for nesting, perching, and roosting; and the number of breeding-age eagles (Stalmaster et al. 1985). The old forest stands located along Canyon Creek may provide nest structures for bald eagles. However, forage is limited and bald eagles are unlikely to nest within the watershed. Several winter roosts are documented in Bear Valley, which is just south of the watershed. Peak winter use is from November to March (USFS 1999). Bald eagles have been sighted in the Fawn subwatershed near Highway 395 during the nesting season (USFS 2002c). However, no nests are known to occur in the watershed (Schuetz, pers. comm. 2002). Bald eagles have been observed during the winter in the Fawn, Lower East Fork and Vance subwatersheds.

3.3.1.2.2 Pacific fisher

In the interior Columbia basin, fishers occur primarily in the Cascade Range and Rocky Mountains (Witmer et al. 1998). The fisher inhabits dense coniferous and mixed coniferous/deciduous forests with extensive and relatively high, continuous canopy (Witmer et al. 1998). Old-growth or mature forests are generally preferred due to the increased availability of cover and den sites that these stands afford; however, second-growth forests with good cover are also used (Verts and Carraway 1998). Fishers occur at low to mid-elevations. Deep snow accumulation, such as typically occurs at higher elevations, appear to limit fisher movements and distribution. Riparian corridors are an important habitat that serves as travel corridors and provide productive habitat for fisher prey. In the lower elevations in Sugarloaf, Fawn and Lower East Fork subwatersheds, fishers may occur in the old-growth and mature forests. 17% of the watershed is in OFSS and OFMS structural stages with the majority of the stands occurring in the Sugerloaf subwatershed. OFSS and OFMS stands that are generally above 4,000 feet may limit fisher use of these areas due to deeper snow accumulations. The lower elevations within the watershed are in private ownership which would not provide suitable habitat for this species. There are no documented occurrences of fisher in the watershed (USFS 2002c).

3.3.1.3 Wide-ranging carnivores

3.3.1.3.1 Gray wolf

Gray wolves require a sufficient year-round prey base of ungulates and alternate prey, suitable and somewhat secluded denning and rendezvous sites, and sufficient space with minimal exposure to humans (USFWS 1987). Most wolf dens are in remote areas away from recreation trails and backcountry campsites. Dens are usually located on low-relief slopes with southerly aspects and well-drained soils, usually within close proximity to surface water and at an elevation overlooking surrounding low-lying areas (FWS 1987). Vegetation, elevation, climate, and other habitat variables are unimportant to the wolves as long as they have food and security. Forested cover provides security from human disturbance. Although minimal exposure to humans is not as important to wolf habitat as originally thought (USFWS 1993), it is a factor in maintaining high-quality big game habitat and reducing the risk of incidental wolf mortality. The Strawberry Wilderness could provide denning and rendezvous sites for wolves. Elk and mule deer occur in the watershed year-round and would provide a potential prey source for the wolves. Although the wolf is considered extirpated in Oregon, there have been several confirmed and many unconfirmed sightings with the Blue Mountains (Schuetz, pers.comm. 2002). Recent wolf sightings may be of wolves that originated from the experimental populations of wolves released into the Selway-Bitterroot and Frank Church River of No Return Wilderness areas of central Idaho. There are no known wolf sightings in the watershed (USFS 2002c).

3.3.1.3.2 Canada lynx

Historically, the Canada lynx (*Lynx canadensis*) ranged across most northern states in the contiguous United States, as well as throughout Alaska and much of Canada (Ruediger et al. 2000). The range of the lynx has been divided into geographical areas and subdivided into provinces and sections. The Malheur National Forest, Grant County, Oregon, is in the Northern Rocky Mountains Geographic Area, Middle Rocky Mountain Province, Blue Mountains Section (USFS 2003). This determined the direction in the Canada Lynx Conservation Assessment and Strategy (Ruediger et al. 2000) that was used to develop lynx analysis units (LAUs) and to assess the effects of USFS land management projects on lynx and their habitat.

The analysis area is within the Strawberry LAU, one of three LAUs on the Malheur National Forest. In the southern portion of their North American range, lynx are associated with boreal forests typically found in higher elevations of montane regions (Witmer et al. 1998). Lynx habitat includes subalpine fir, moist grand fir and moist Douglas-fir habitat types where lodgepole pine is a major seral component (Ruediger et al. 2000). A common component of natal denning habitat appears to be large woody debris, either down logs or root wads. Den sites may be located in regeneration stands older than 20 years or in mature conifer or mixed conifer-deciduous forest (Ruediger et al. 2000). Lynx require a mosaic of forest seral stages connected by forested stands suitable for travel cover; foraging habitat is usually near den sites. Home range sizes of lynx are quite variable but, generally, home range sizes at the southern extent of lynx range are larger than in northern boreal forest, due to lower prey densities and inherent habitat patchiness. Studies in Washington and Montana found home range size for males from 27 to 47 square miles and from 15 to 17 square miles for females. Large home range sizes indicate that lynx were required to travel extensively to locate sufficient prey resources (Ruediger et al. 2000). Lynx are highly dependent on snowshoe hares as prey, especially during the winter (Witmer et al. 1998). Snowshoe hares are associated with dense thickets of young conifers, especially firs and western larch with lower branches touching the ground, interspersed with small clearings vegetated by grasses and forbs (Verts and Carraway 1998). During the summer, snowshoe hares forage on a variety of forbs, grasses, and small shrubs. During the winter, food is limited to twigs and stems that are within reach above the snow surface. Lodgepole pine was found to be an important browse species for hares in Washington (Ruediger et al. 2000). Lynx at the southern periphery of the range may prey on wider diversity of species because of differences in small mammal communities and lower average hare densities as compared with northern habitats. Red squirrels have been shown to be an important alternative prey species, especially when the snowshoe hare population is low. Levels of grazing use, by livestock and/or wild ungulates, may increase competition for forage resources with lynx prey. By changing native plant communities such as aspen and high elevation riparian willow, grazing can degrade snowshoe hare habitat.

Lynx habitat occurs primarily in the cold/dry and cool/dry PAG's of the cold upland forest PVG, which is predominantly the lodgepole pine plant association. Currently, 25% of the LAU is classified as lynx habitat. The LAU extends well beyond the boundary of the watershed. All of the wilderness area within the watershed is included in the LAU but there is no opportunity to enhance habitat within a wilderness area. A portion of the LAU does extend into the general forest area of the watershed outside the wilderness area. The exact amount of acres in this area was not calculated for this analysis but management activities could be done at the project level to enhance habitat. Subalpine fir and Englemann spruce make up the remainder of the habitat (USFS 2003). The lodgepole pine plant association group is only dominant in 1% of the NFS lands in the watershed. There are no documented occurrences of lynx in the watershed (USFS 2002c). Lynx may use riparian corridors and ridges as travel corridors through the watershed. There have been 12 museum-documented occurrences of lynx in Oregon from 1897 to 1993, three of which were in the Blue Mountains. The occurrences in Oregon are likely from individuals that immigrate from occupied areas farther north and persist for a short time (Verts and Carraway 1998). ODFW confirmed that a lynx was trapped south of the Malheur National Forest boundary near Drewsey in 1995. The lynx was trapped in a juniper/sagebrush/shrubland/grassland habitat complex. Lynx surveys were conducted in the Strawberry LAU in 1999, 2000, 2001; no lynx were detected in these surveys (USFS 2003).

3.3.1.3.3 California wolverine

Wolverines are usually found in high elevation temperate coniferous forest, from mid-elevation (around 4,000 feet) to moderate high elevation (above timberline), depending on the season. Wolverines are found in subalpine dominated forests with medium to low canopy closure. They rarely use dense young timber, burned areas or wet meadows (Witmer et al. 1998). Wolverines use a variety of habitat features for dens, including exposed tree roots, rock piles, caves and log falls. Females were found to use subalpine talus sites for natal dens in Idaho (Witmer et al. 1998). Wolverines are believed to prefer secluded areas with minimal human disturbance. In northwestern Montana, average home-range areas were documented as 160 square miles for males and 150 square miles for females (Verts and Carraway 1998). Wolverines are known to occur in the Strawberry Mountain Wilderness. The most recent sighting was on Canyon Mountain in 1999 (USFS 2000c). Other sightings within the watershed include the carcass of a juvenile wolverine discovered in the wilderness along the Tamarack Trail in 1992 and an unconfirmed, although reliable, sighting of a wolverine in 1991 near Rattlesnake Ridge just outside the wilderness (USFS 2002c). The wilderness provides the best habitat for wolverines (including travel, forage, and denning), in the watershed. However, wolverines may use other areas in the watershed outside the wilderness.

3.3.1.4 Miscellaneous Habitat Associated Species

3.3.1.4.1 Bufflehead

Buffleheads nests near mountain lakes with permanent water surrounded by open woodlands containing snags. This species are usually cavity nesters and use abandoned woodpecker nests or natural holes. The preferred nest tree is aspen, but they will also nest in ponderosa pine or Douglas-fir. Buffleheads defend a territory around the brood, which results in t he spacing of family groups around the lakeshore. This species will use artificial nest boxes and it is thought most pairs nesting in Oregon use these boxes (Csuti et al. 1997). Buffleheads winter primarily along the coast and near Klamath Falls with smaller numbers wintering along major rivers (Csuti et al. 1997, Gilligan et al 1994). There is a lake located on private land, but the suitable nesting habitat conditions around this lake are unknown. Within NFS lands, the watershed does not provide suitable nesting as the Canyon creek reservoir does not sustain permanent water or wintering habitat for this species. There are no documented occurrences of this species in the watershed (USFS 2002c).

3.3.1.4.2 Peregrine falcon

Peregrine falcons are limited to areas that contain suitable nest ledges. Cliffs and bluffs typically found along river courses and other large bodies of water usually provide habitat for nesting peregrines. Falcons prefer to nest where the concentration of prey, generally smaller birds, is high and where habitat characteristics may increase prey vulnerability. A 1992 survey identified cliffs on Canyon Mountain as having medium potential for reintroducing peregrine falcons. Additional cliffs may exist elsewhere in the watershed (Schuetz, pers. comm. 2002). There are no large bodies of water to provide high concentrations of prey for this species within the watershed. There are no known occurrences of this species in the watershed (USFS 2002c).

3.3.1.4.3 Tricolored blackbird

This species generally prefers to breed in freshwater marshes with emergent vegetation or in thickets of willows or other shrubs. In Oregon, this species has bred in tangles of Himalayan blackberry growing in and around wetlands. Tricolored blackbirds are often found breeding in the company of red-winged blackbirds (Csuti et al. 1997). The moist meadows and riparian habitat could provide suitable habitat for this species. The quality of the habitat for breeding is unknown. There are no confirmed occurrences of this species on the Malheur National Forest (Schuetz, pers. comm. 2002).

3.3.1.4.4 Columbia spotted frog

Spotted frogs are highly aquatic and are rarely found far from permanent water. Breeding habitat is usually in shallow water in ponds or other quiet waters along streams. Breeding may also occur in flooded areas adjacent to streams and ponds. Adults may disperse overland in the spring and summer after breeding. Habitat has most likely been degraded by past management activities, such as livestock grazing, road construction along streams, and timber harvest adjacent to streams, lakes ponds, springs, and marshes The spotted frog is considered present in all subbasins on the Malheur National Forest (USFS 2002c). It is assumed this species is widely distributed in the analysis area. No habitat surveys have been conducted specifically for spotted frogs; however, habitat probably exists along most perennial and some intermittent streams (USFS 2002c).

3.3.1.5 Management Indicator Species (MIS)

3.3.1.5.1 Elk

Elk are thought to be well distributed and abundant in the watershed. The watershed is in winter range and summer range, with 26% of the watershed in winter range and the remaining in summer range. Winter range is primarily below 5,200 feet in elevation (USFS 1990). Elk typically move below 5,500 feet during the winter depending on the snow levels. Elk and mule deer utilize the watershed throughout the year. The LRMP identifies three habitat types: satisfactory cover, marginal cover, and hiding cover. Satisfactory cover is defined as a stand of coniferous trees 40 or more feet tall with multi-strata structure, with or without large-diameter trees, that have a canopy closure of 50% or greater for ponderosa pine or 60% or greater for mixed conifer. Marginal cover is defined as a stand of coniferous trees ten or more feet tall with a canopy closure greater than 40% (USFS 1990). Marginal cover can occur in old forest or young forest with multi-strata structure and stem exclusion with closed canopy stand structures. Hiding cover is defined as vegetation capable of hiding 90% of a standing adult deer or elk from human view at 200 feet. Hiding cover can occur in multi-strata with and without large trees and in stem exclusion closed-canopy stand structures. The minimum forest standards for elk cover in winter range is 10% for satisfactory and 10% for marginal cover; in summer range, 12% for satisfactory and 5% for marginal cover. Total cover minimum in both winter and summer range is 25% (USFS 1990). Currently in winter range, satisfactory cover is 3% and marginal cover is 19% (Table 3-61 and Map 3.14). In summer range, satisfactory cover is 10% and marginal cover is 19%. The total cover in both winter and summer range is 52%. All cover data displayed in the following table is based photo-interpreted stand conditions. For site-specific project analysis, this data should be validated with ground surveys. For this reason, the Habitat Effectiveness Analysis (HEI) model (Thomas et. al. 1988) for estimating elk habitat effectiveness on a landscape level was not conducted for this analysis. The HEI model will need to be conducted at the project level analysis to comply with LRMP Forest-wide Standards 28-31.

Table 3.61. Elk winter and summer range cover.

Subwatershed	Winter range satisfactory cover	Winter range marginal cover	Summer range satisfactory cover	Summer range marginal cover
Canyon Meadows	1% (75 ac)	14% (1,178 ac)	10% (872 ac)	25% (2,169 ac)
Fawn	3% (366 ac)	36% (3,925 ac)	1% (140 ac)	9% (1,036 ac)
Middle Fork Canyon Creek	1% (49 ac)	3% (187 ac)	16% (1,145 ac)	23% (1,619 ac)
Sugarloaf	12% (854 ac)	34% (2,372 ac)	3% (196 ac)	5% (341 ac)
Upper East Fork	1% (113 ac)	3% (245 ac)	23% (1,877 ac)	33% (2,663 ac)
Lower East Fork	6% (458 ac)	13% (983 ac)	14% (1,045 ac)	28% (2,064 ac)
Berry Creek	2% (143 ac)	18% (1,064 ac)	14% (781 ac)	18% (1,058 ac)
Canyon City	1% (8 ac)	22% (131ac)	5% (32 ac)	27% (164 ac)
Vance Creek	1% (36 ac)	33% (1,391 ac)	0% (0 ac)	9% (378 ac)
Total	3% (2,104 ac)	19% (11,478 ac)	10% (6,089 ac)	19% (11,492 ac)

In the watershed, calving and fawning habitat is generally located near high-quality forage and ground based hiding cover on gentle slopes (less than 15%). Calving and fawning habitat has been identified in portions of Middle Fork Canyon Creek, Canyon Meadows and Vance Creek subwatersheds. The majority of the 1,036 acres of calving and fawning habitat identified is located in Vance Creek. The majority of the slopes in the watershed is greater than 15% and may not provide ideal habitat. The flatter terrain in the watershed can be found in Fawn and Lower East Fork subwatersheds. Calving and fawning habitat may occur along the lower gradient streams that have a more developed floodplain, which may provide quality forage and hiding cover. Current forage habitat is thought to be less abundant than historical levels. The higher canopy closures of the mixed conifer stands provide less forage compared to the open ponderosa pine stands. Lack of fire in the watershed may also have impacted forage levels as the absence of fire can lead to overstocked stands and reduce the availability of forage. In addition, the long-term heavy use by domestic livestock and elk has caused the moderate to severe reduction of shrubs and forage productivity in the watershed (Irwin et al. 1994).

High open road densities increase the potential to disturb elk, which could reduce the use of preferred habitats. Within the watershed all motorized vehicle use is restricted within winter range between December 1 and April 1 to minimize disturbance to big game and other wildlife. The wilderness is closed to all motor vehicles including power and mechanical equipment year-round. The forest standards for open road density are 2.2 miles per square mile in winter range and 3.2 miles per square mile in summer range. The open road density by subwatershed is shown in Table 3.62. The Middle Fork Canyon Creek is the only subwatershed that meets the forest standard for road density in winter range. Even when the wilderness is included in the open road density calculations in Canyon Meadows the forest standard for winter range is exceeded. The open road density standards for summer range are exceeded in Canyon Meadows, Middle Fork Canyon Creek and Vance Creek subwatersheds. Road closures that use sign, guardrails, or other methods that leave the road accessible to motorized vehicles may not be effective at reducing human disturbance behind these closure types. Obliterated roads are the most effective closure type to benefit wildlife.

In summary, satisfactory cover in winter range is lacking and below LRMP minimum standards in all subwatersheds except Sugarloaf. Marginal cover in winter range is mostly above forest standards except in Upper East Fork and Middle Fork Canyon Creek. Open road density (Table 3-62) exceeds LRMP standards in all subwatersheds except those that are totally within the wilderness. Winter range for elk in the watershed is therefore negatively impacted by a lack of satisfactory cover and a high open road density. The marginal cover in the winter range may mature into satisfactory cover over time but the condition of this cover has not been field verified to assess the rate of that maturity.

Elk summer range also has a lack suitable satisfactory cover in all subwatersheds except for those in the wilderness area however marginal cover exceeds LRMP standards in all subwatersheds. Open road densities are above minimum standards in most subwatersheds so as is the case in the winter range, elk in the watershed are negatively impacted by a lack of satisfactory cover and a high open road density.

Table 3.62. Elk Winter and Summer Range Open Road Density.

Subwatershed	Winter range open road density (miles/sq. mile)		Summer range open road density (miles/sq. mile)	
	Including wilderness	Excluding wilderness	Including wilderness	Excluding wilderness
Berry Creek	0	0	0.3	0.7
Byram Gulch	1.0	3.2	0	0
Canyon Meadows	2.6	3.7	0	5.9
Fawn	N/A	2.3	N/A	3.0
Lower East Fork	0	N/A	0.23	0.8
Middle Fork Canyon Creek	0.66	1.7	0	3.5
Sugarloaf	N/A	3.3	N/A	4.1
Upper East Fork	0	N/A	0	N/A
Vance Creek	N/A	6.3	N/A	3.8

3.3.1.6 Late and Old Forest Associated MIS

Late and old forest habitat is currently provided in both multi-strata and single-stratum stand structure. There are approximately 10,085 acres of old-forest multi-strata and 201 acres of single stratum or approximately 17 percent of the NFS lands within the watershed. The old forest multi-strata stands are primarily located in the Sugarloaf subwatershed but is well distributed in the Lower East Fork and portions of Fawn subwatersheds. These stands are dominated by ponderosa pine, Douglas-fir and warm grand fir warm-dry plant associations. The OFMS stands throughout the watershed appear to be well-connected to one another through stands in the SEOC, SECC and even YFMS stand structure classes. The condition of these stands would need to be field verified to assess their effectiveness but it can be assumed that these stand structures, which dominate over 71% of the analysis area, are providing dispersal and forage opportunities for species traveling between OFMS stands.

The LRMP identified Dedicated Old-Growth (DOG) and Replacement Old-growth (ROG) management areas to provide habitat for wildlife species dependent on mature and/or overmature forest conditions (see Map 3.17). These areas were designed to provide habitat for pileated woodpecker and/or pine marten. However, the current condition of the vegetation structures (i.e., snags and down wood) in these management areas are unknown and may not support old growth dependent species at this time. There are nine DOG management areas in the watershed, which total 3,675 acres and two ROG management areas, totaling 475 acres. The DOG and ROG areas incorporate approximately five percent of the watershed. They occur primarily within the Strawberry

Wilderness, with only two DOG and two ROG areas located outside the wilderness. These management areas occur in the mixture of dry upland forest and moist upland forest PVGs. The moist upland forest would provide more favorable habitat conditions for both pileated woodpeckers and pine martens. The moist upland forest are primarily located within the wilderness. The dry upland forests could provide habitat for these species where true fir species and large snags and down wood are present. The dry upland forests are typified by a combination of ponderosa pine, Douglas-fir, and warm grand fir plant associations. The DOG areas are primarily located in young multi-strata forest with areas in old-forest multi-strata and stem exclusion open canopy stand structures. As is the case with the OFMS stands the DOG's and ROG's are also well connected to one another by SECC, SEOC and YFMS stands discussed above. The watershed only contains 11% (6,530 acres) that are non forested or in the early stand initiation condition. It can be assumed that is ample cover for species to travel and forage between stands with more complex structure.

3.3.1.6.1 Pileated woodpecker and pine marten

Pileated woodpeckers are associated with old-growth ponderosa pine-mixed conifer forests, mature grand fir/mixed conifer, and mature ponderosa pine-dominated mixed conifer vegetation types, almost exclusively within the multi-strata stand structure. Large-diameter snags are an important habitat component for this species (Csuti et al. 1997). In the mixed conifer forests of eastern Oregon, pileated woodpeckers were found to nest in snags greater than 20 inches dbh. This species is associated with a snag density of 6.8 to 7.7 snags per acre (Bull 1997). Pileated woodpeckers have large home ranges that can vary from 500 acres to over 1,000 acres (USFS 1998). Pine martens prefer mature, mesic coniferous forest, with high structural diversity in the understory (Witmer et al. 1998). Pine martens have large home ranges, with the female home range varying from 24 to 445 acres and the male home range varying from 220 to 1,000 acres (Verts and Carraway 1998). Large diameter snags (greater than 21 inches) are an important habitat component for this species (Csuti et al. 1997). The old forest multi-stratum stands within the Sugarloaf, Fawn and Lower East Fork may provide habitat for both of these species. These areas are primarily in the dry upland forest. As stated above the moist upland forests located in the wilderness would provide more favorable habitat conditions. The availability of snags and down wood within these stands is unknown and therefore the distribution of these species is difficult to determine. Pileated woodpeckers are known to occur in the Fawn, Lower East Fork, Sugarloaf, and Vance subwatersheds (USFS 2002c). The only documented occurrence of pine marten is in the Vance Creek subwatershed in 1989 (USFS 2002c) but it can be assumed that pine marten also occurs in the Fawn, Lower East Fork, and Sugarloaf, subwatersheds due to the presence of suitable habitat.

3.3.1.6.2 Northern goshawk

The goshawk was not identified in the LRMP as an MIS species, but rather is listed in Amendment 2 of the LRMP as a species of interest and is known to use late and old forest habitats (USFS 1995). This species nests are primarily associated with mature and young, multi-storied ponderosa pine stands, or ponderosa pine-dominated mixed conifer stands in the watershed. Although these habitat types are not considered preferred nesting habitat, nests have been found in old-growth mixed conifer and true fire habitats. The old forest multi-strata stands are well distributed in the Sugarloaf, Fawn and Lower East Fork subwatersheds, Map 3.13).

There are four documented goshawk nesting territories located in the watershed and a portion of a nesting territory located in an adjacent watershed. Amendment 2 of the LRMP (USFS 1995) states that 30 acres of suitable nesting habitat should be established around occupied and historical nest sites that have been occupied at some time during the past five years. In addition to the nesting habitat a 400-acre post fledgling area should be established around active nest sites. There are two territories within the Vance subwatershed, Vance and Starr Camp. The Vance territory was first documented in 1987 and was last documented as successfully fledging young in 1995 (USFS 2002c, USFS 2003a). This territory has been unoccupied since 1996 (USFS 2003a). The nests in this territory have been located in ponderosa pine and dense fir young multi-strata stands. The post-fledging area consists of young multi-strata, stem exclusion open canopy and old forest multi-strata stands in dry upland forest. The Starr Camp nest is located in the adjacent watershed with a portion of the post fledgling area located in this watershed. This nesting territory has been occupied since 1993 and successfully fledged young for nine years (USFS 2003a). The post-fledging area within the watershed is primarily old forest multi-strata and young multi-strata dry upland forest. The Fawn nest territory was first established in 1994. This territory is located in old forest multi-strata ponderosa pine stand. The post-fledging area is dominated by young and old multi-strata forests. Of the nine years this territory has been surveyed it has successfully fledged young four times (USFS 2003a). The Big Canyon territory is located in Canyon Meadows subwatershed. A portion of the post-fledging area is located in an adjacent watershed. This territory was last documented as active in 1999 and was successfully fledged young three times since 1994 (USFS 2003a). The nests were found in an old forest multi-strata stand that is surrounded by stem exclusion open canopy upland dry forest. The Table Mountain territory successfully fledged young in 1992 but has been unoccupied since that time. A post-fledging area has not been established for this territory.

3.3.1.6.3 Three-toed woodpecker

Three-toed woodpeckers are associated with higher elevation (above 4,500 feet) lodgepole pine and mixed conifer forests with a lodgepole pine component. This species uses mostly pole-sized trees for nesting and foraging and prefers areas with a higher snag density (Csuti et al. 1997). Lodgepole pine is a minor component of the grand fir vegetation type as a seral species. This species preferred habitat is in the cool moist upland forest in old forest multi-strata stand structure or multi-strata lodgepole pine stands. The moist upland forest occupies approximately 10,800 acres or 21 percent of the watershed and is located primarily in Berry, Upper and Lower East Fork subwatersheds.

However, the majority of this area is in young multi-strata stand structure. Lodgepole pine dominated stands are scattered across the watershed in the moist and cold upland forest in Berry, Upper and Lower East Fork, Canyon Meadows and Middle Fork Canyon Creek subwatersheds. These stands are all young forest in either multi-strata or stem exclusion stand structure. These stands may provide suitable habitat for this species. There are no documented occurrences of this species in the watershed (USFS 2002c).

3.3.1.6.4 White-headed woodpecker

This species is closely associated with ponderosa pine forest or mixed conifer forest dominated by ponderosa pine. This woodpecker prefers open stands with 50 % or less canopy closure (Marshall 1997). Nesting habitat is associated with large-diameter ponderosa pine with moderate to extensive decay and with broken tops (Dixon 1995). Amendment 2 of the LRMP (USFS 1995) identified the white-headed woodpecker as a species known to be associated with late and old forest habitats. This species is associated with large diameter snags (greater than 21 inches) at a snag density of 1.6 snags per acre (Dixon 1995). Studies in Oregon show abundance of this species is positively associated with increasing abundance of large-diameter ponderosa pines (Marshall 1997). Suitable habitat was historically found in the old-forest single-stratum ponderosa pine found in the dry upland forests within the watershed. Currently this OFSS habitat is virtually non-existent within the watershed. This small, fragmented patch of suitable habitat is unlikely to support nesting white-headed woodpeckers in the watershed as the home range size has been documented at 250-500 acres (Csuti et al. 1997). This species was observed in the Fawn subwatershed near Canyon Creek in 1992 (USFS 2002c).

3.3.1.7 Deadwood Associated MIS

A majority of wildlife species relies on moderate to high levels of snags and down wood during some stage of their life cycle for nesting, roosting, denning and/or feeding. Large-diameter snags and down wood are important components of late and old structural forest. Amendment 2 of the LRMP states that all timber sale activities will maintain snags and green tree replacement trees greater than 21 inches dbh, when available, to meet 100 % of the potential population of primary cavity excavators. To meet the interim wildlife standard of 100 % population levels, 2.4 snags per acre are needed (USFS 1995). Large-diameter snags and green replacement trees have been greatly reduced by past management practices, which make meeting this standard difficult in the watershed. Smaller diameter snags may be present in the dry upland forests due to high stocking density cause by mortality. Insects and disease may also create patches of small or large diameter snags within the watershed. Severe insect infestations and damaged have been documented within the forested uplands within the watershed. The current snag and down wood density and distribution within the watershed is unknown and cannot be derived from the PI data. Discussions with FS staff indicated that, in general, large snags (over 21 inches DBH) are lacking in harvest units and dry forest types as past harvest practices and overstocking has resulted in younger structural stages. Small diameter snags may prevalent in these stands due to insect and disease outbreaks. The Strawberry Mountain wilderness area most likely has higher levels of snags in all size classes. It can be expected that large diameter snags persist due to a lack of past timber harvests and it can also be expected that small diameter snags persist from several fires and insects and disease. Similarly down wood levels are above LRMP standards except in prescribed units. Overstocking within the WUI has also resulted in high level of small diameter down wood creating a fire hazard of finer fuels. Down woody levels are also thought to be high in the wilderness for the same reason as stated above for snag levels.

3.3.1.7.1 Lewis' woodpecker

Lewis' woodpecker is associated with open forest and nests in open oak or oak-conifer woodlands, cottonwood, and logged or burned ponderosa pine forests. It usually nests in large snags in cavities created by other woodpeckers or in very soft snags. Since this species is an aerial feeder it needs open areas for foraging. Lewis' woodpecker also forages on the ground and in brush. This species utilizes burned areas after the brush layer has developed and nesting cavities are available (Knotts 1998). The recently burned area in the wilderness may provide habitat for this species after the brush layer has developed. Open and deciduous habitat preferred by this species is lacking in the watershed. Large-diameter and very soft snag habitat may occur in the wilderness. There are no documented occurrences of this species in the watershed (USFS 2002c).

3.3.1.7.2 Black-backed woodpecker

Black-backed woodpeckers are attracted to forests that contain large numbers of wood-boring larvae, its primary food source. This habitat type, with dead, insect-infested trees, is usually found in areas associated with large-scale disturbances such as fire or windthrow, or in mature or old growth stands. This species prefers to nest in smaller (average 12-inch dbh) recently dead trees in areas that contain the highest density of snags. Black-backed woodpeckers have been found to be relatively restricted in distribution to early post-fire conditions. Conditions in burned areas usually become less suitable for this species five to six years after a fire (Knotts 1998). The recent High Roberts Fire in 2002 adjacent to the watershed and several recent smaller-scale fire in the wilderness near Indian Creek Butte that may provide suitable habitat for this species. Potential habitat may also occur in the old multi-strata forest in the dry upland forests within Sugarloaf, Lower East Fork and portions of Fawn subwatersheds. The high insect-infested habitat component preferred by this species may be lacking in this potential habitat. The introduction of fire suppression has reduced the occurrence of suitable habitat conditions preferred by this species in the watershed. The only documented occurrence of the black-backed woodpecker in the watershed is a pair using a burned ponderosa pine area in the Canyon Creek subwatershed in 2000 (USFS 2002c).

3.3.1.7.3 Williamson's sapsucker

Williamson's sapsucker uses mature higher-elevation coniferous forest for nesting and feeding. Open ponderosa pine forest is the preferred habitat but this species may use lodgepole pine, grand fir, Douglas-fir and aspen (Csuti et al 1997). This species nests in large (greater than 20-inch dbh) trees that are live or dead (Knotts 1998). Large-diameter snags are generally lacking within the watershed due to previous logging practices. The old multi-strata forest in Sugarloaf, Lower East fork and Fawn may provide habitat for this species. Suitable habitat may also occur in the old forest stands within the wilderness where management activities may not of limited large-diameter snags. This species was documented in the Sugarloaf subwatershed in 1993 (USFS 2002c).

3.3.1.7.4 Downy woodpecker and red-naped sapsucker

The downy woodpecker and red-naped sapsucker are associated with riparian habitats but will use coniferous habitats. The downy woodpecker is mostly found in cottonwood and aspen and prefers soft, smaller (10- to 12- inch dbh) snags for nesting (Knotts 1998). The red-naped sapsucker prefers to nest in aspen but will use ponderosa pine (Csuti et al. 1997). There are small fragmented stands where aspen is the dominate species in Canyon Meadows and Middle Fork Canyon Creek that provide approximately one acre of habitat. Aspen is component of some of the coniferous stands within the watershed. Overall deciduous forests are generally lacking within the watershed. The downy woodpecker is known to occur in the Canyon Creek subwatershed and there is no known occurrence of red-naped sapsucker in the watershed. Hairy woodpecker and northern flicker

Both the hairy woodpecker and northern flicker use a variety of habitats but tend to prefer open habitats. The hairy woodpecker nest in snags with a minimum dbh of 10 inches (Thomas 1979). The northern flicker nests in large, well-decayed snags, but may dig a hole in a dirt embankment, especially in eastern Oregon (Csuti et al 1997). Both species forage on the ground but the hairy woodpecker spends more time foraging on tree trunks. They will also use burned areas but are not dependent on them (Knotts 1998). Open forest habitat is limited, but since both species use a variety of habitats they may be well distributed within the watershed. The hairy woodpecker has been observed in a burned area in the Canyon Creek subwatershed and both species have been seen in the Fawn and Sugarloaf subwatersheds (USFS 2002c).

3.3.1.8 LRMP Featured Species

The LRMP identifies the following six species, for which management activities will be conducted to promote and enhance habitat: osprey, bighorn sheep, upland sandpipers, sage grouse, blue grouse, and pronghorn (USFS 1990). These species occupy a variety of stand structures and biophysical environments. Upland sandpipers and sage grouse are discussed above in the Proposed, Threatened, Endangered and Sensitive Species section of this chapter. The LRMP also discusses protecting active raptor nests. Known raptor use of the watershed is discussed below.

3.3.1.8.1 Osprey

Osprey require large, dead trees suitable for nesting adjacent to or near large rivers or lakes. Most of the ospreys diet consists of fish but will prey on birds, reptiles and small mammals (Csuti et al. 1997). This species has adapted to artificial nesting structures. The LRMP states that large snags and green replacement trees suitable for nesting should be maintained and created 0.5 miles from streams, lakes and reservoirs that are currently being used by osprey. Preference should be given to large trees (30 inches or greater dbh and 60 foot minimum height) that have broken tops of large branches (USFS 1990). Generally, these snags should be located in areas of solitude. In Oregon, this species is considered abundant and well distributed in areas with large water bodies. In the watershed, there is one known nest located in the Canyon Meadows watershed. This nest was first located in 1990 and successfully fledged young in 2002 (USFS 2003b). The only other sighting in the watershed was in 1994. An osprey was observed foraging in Canyon Creek in the Fawn subwatershed. The watershed does not have a high density of large, fish bearing water bodies, so this species is not expected to be abundant in the watershed.

3.3.1.8.2 California bighorn sheep

Bighorn sheep primary habitat is open areas on rocky slopes, ridges, rimrocks, cliffs, and canyon walls with adjacent grasslands or meadows but few trees (Verts and Carraway 1998). Habitat for this species is located in the wilderness and was last observed in 1998 (Schuetz, pers. comm. 2002). Twenty-one sheep were re-introduced on Canyon Mountain in 1971, but the population has remained static or decreased since the release. ODFW considers the re-introduction effort a failure since the population is not self-sustaining or expanding in population. ODFW believes the main reasons for the failure are limited satisfactory winter habitat, excessive predation of all age classes and that portions of the wilderness are too steep, leading to accidental falls (Schuetz, pers. comm. 2002). Habitat for bighorn sheep is unlikely to occur outside of the wilderness area in the watershed.

3.3.1.8.3 Blue Grouse

Blue grouse is found in coniferous stand dominated by Douglas-fir or true firs. Within those forests they seek out areas with thickets of deciduous species such as willow, alder, and aspen. In winter they move upslope to more open coniferous forest, and in spring they move to the lower edge of the forest, where there is cover of deciduous trees and shrubs (Csuti et al. 1997). The LRMP states that winter roost habitat should be maintained. Preferred habitat is clumps of mistletoe infected Douglas-fir tops or upper slopes of ridges (USFS 1990). Blue grouse winter roosting habitat was mapped by the FS in subwatersheds in which field verification of habitat has occurred. This field verification occurred in three subwatersheds (Vance Creek, Middle Fork Canyon Creek, and Crazy Creek). Douglas-fir dominated communities located on the northerly aspects were identified as having substantial areas of moderate and severe levels of dwarf mistletoe and can serve as suitable habitat. 355 acres of field verified winter roosting habitat is located in the Vance subwatershed with scattered patches of roosting habitat located in the Middle Fork Canyon Creek and Crazy Creek subwatersheds. Field verification has not occurred in the remaining subwatersheds however Douglas-fir dominated stands comprise 30% of the analysis area (18,095 acres) and it can expected that a majority of these acres are infected with mistletoe and providing habitat for blue grouse. This species has no federal or state status. Blue grouse have been documented in Sugarloaf and Vance subwatersheds (USFS 2002c). The current distribution and abundance of this species in the watershed is unknown.

3.3.1.8.4 Pronghorn

In Oregon, this species is associated with open grassland, sagebrush flats and shadscale-covered valleys of the central and southeastern part of the state. Low sagebrush (*Artemisia arbuscula*) is an important habitat component (Csuti et al. 1997). There are no open grassland or sagebrush flats (i.e., greater than 500 acres) within the NFS lands to support this species. The private lands within the watershed are primarily used for agriculture and are unlikely to provide habitat for this species. There are no documented occurrences of pronghorn in the watershed (USFS 2002c).

3.3.1.8.5 Neotropical migratory land birds

A wide variety of land birds, including neotropical migrant birds, use habitats available within the analysis area. Habitats include a mixture of conifer forest, hardwood habitats, riparian areas and meadow habitats. Nesting, foraging and cover security needs are generally provided. The abundance of conifer habitats, present in a variety of stand structures and vegetative compositions, provides suitable habitat for most of the conifer habitat dependent species. Those species heavily dependent upon riparian or hardwood habitats such as aspen, cottonwood or willow stands are not adequately provided for due to generally poor riparian habitat condition and distribution. Species such as the red-naped sapsucker (also MIS), hermit thrush, red-eyed vireo and olive-sided flycatcher are likely affected. Grassland/meadow habitats are also on the decline as conifers continue to encroach into previously non-forested areas.

A conservation plan for land birds has been drafted by Partners in Flight. According to this report, current vegetation in the Blue Mountains has changed substantially due to a number of factors associated with human occupation of the area. Coniferous forest still dominates the landscape, but the composition of forest types and conditions has changed from anthropogenic factors rather than the natural forces that used to maintain the landscape. These include fire suppression, intensive forest management, grazing, and widespread development of roads associated with development, recreation, and timber harvest (Hann et al. 1997). Associated consequences from these activities that impact the current landscape include exotic species invasion, alteration of natural disturbances, and fragmentation and isolation of habitat patches. Fragmentation resulting from timber harvesting can have several negative effects on landbirds such as insufficient patch size for area-dependent species, and increases in edges and adjacent hostile landscapes, which can result in reduced productivity through increased nest predation, nest parasitism, and reduced pairing success of males. Additionally, fragmentation has likely altered the dynamics of dispersal and immigration necessary for maintenance of some land bird populations at a regional scale.

3.3.1.8.6 Raptors

The LRMP provides direction to protect active raptor nests. The nest trees of active raptor nests and habitat immediately surrounding the nest should be protected from adverse impacts from management activities during the nesting season. Where possible, retain trees with inactive nests that maybe important to secondary nesters such as the great gray owl. For bald and golden eagles the LRMP refers to the Pacific Bald Eagle Recovery Plan for Protection of Bald and Golden Eagles for direction. All management activities that could alter site characteristics or disturb these birds will be suspended until the nest sites are evaluated by a wildlife biologist. Table 3.63 identifies the raptor species that are known to nest within the watershed or have been observed in the watershed.

Table 3.63. Raptor Locations in the Canyon Creek watershed.

Species	***Subwatershed with occurrences***	***Comments***
Golden eagle	Fawn and Vance	Primarily a winter visitor to watershed with only one observation during breeding season. Seven documented observations from 1992 to 1999.
Red-tailed hawk	Canyon Meadows, Fawn, Sugarloaf, and Vance	Documented nests located in Sugarloaf and Canyon Meadows. Nests were active in 1994 and 1998. Potential nest on private lands in 1993. This species is a common year-round resident in the watershed.
Cooper's hawk	Fawn and Vance	Observations documented in summer of 1993 and 1994. May nest in watershed.
Prairie falcon	Middle Fork Canyon Creek and Vance	Nest located in Middle Fork Canyon Creek was active in 1992. Nest documented as gone in 1998. Single observation in Vance in August 1994.
Flammulated owl	Sugarloaf	No information is available for this nest.
Northern pygmy owl	Middle Fork Canyon Creek and Vance	Observations in 1994, 1995 and 2001. May nest in watershed.
Kestrel	Vance	Two birds observed in August 1994. May nest in watershed.

3.4 HUMAN USES

The current human uses in the Canyon Creek watershed include grazing, mining, recreation, and special uses, and involve issues of water and treaty rights. These activities and issues have influenced the patterns and opportunities of other human uses and environmental conditions in the watershed. The evaluation of current human uses provides insight into the cultural forces in the Canyon Creek watershed.

3.4.1 Grazing

For this analysis, no data were available that would describe the intensity and magnitude of livestock grazing within the Canyon Creek watershed. There are, however, 4 active range allotments in the Canyon Creek watershed (Sugarloaf, Seneca, Pearson, and Fawn Springs allotments), and the presence of livestock grazing in the watershed can be readily observed in both upland and riparian zones. Although specific data were not available for this watershed analysis, generally livestock grazing is the most widespread land use in the intermountain west. As a disturbance caused by management methods, livestock grazing has been attributed to changes in the structure, composition, and diversity of ecosystems, particularly in riparian zones.

The effects of livestock grazing in riparian zones were recently investigated in floodplain meadows of the Middle Fork, John Day River (Kauffman et al. *submitted*), an area approximately 30 miles away (by air) from the analysis area. The study was a comparison between grazed and ungrazed meadows (exclosures) and determined significant differences in total biomass (i.e., the living plant tissue above and below ground), soil bulk density, and water infiltration rates. Overall, the results demonstrated statistically significant differences between grazed and ungrazed meadows. Biomass in ungrazed meadows was between 61% and 71% higher than grazed meadows, which has direct effects on soil stability and site productivity. Soil compaction was 49% higher in grazed meadows than ungrazed meadows, and water infiltration rates reflected this with ungrazed areas having between 3 and 11 times more water traveling subsurface rather than overland. All of these effects of grazing have long-lasting impacts to the stability of riparian ecosystems in the Blue Mountains, and may be more or less pronounced within the Canyon Creek watershed.

In upland grasslands and shrublands, water and quality forage are generally less available, and in the Canyon Creek watershed, the steep topography of the rangelands likely further encourage livestock to migrate to riparian zones in the valley bottoms. However, evidence of livestock grazing in upland grasslands and shrublands exists in the analysis area, and the secondary effects of grazing in these environments are also visible. Introduction of annual cheatgrass and reductions of biomass and fine fuels are two noticeable effects in the Canyon Creek watershed, although the extent and magnitude of the effects have not yet been quantified.

3.4.2 Mining

According to USFS records, there is one potentially active mining claim in the analysis area. Claim number 0006379 is in Township 14 South, Range 32 East, Section 18. It is referred to as the Iron King Mine or the Billie Girl Mine and it contains chromite. The claim has been current since the 1930s. The owner has been attempting to make the mine operational for the past several years and anticipates operations to commence in 2003. The USFS has completed a mineral examination and determined that the claim is legitimate. In general, mineralization in the region is to the east, northeast, and southwest of the watershed area (Tay, pers. comm. 2003).

The BLM database lists many active mining claims in the analysis area. However, the database does not include information about type of mineral or contamination problems.

3.4.3 Treaty Rights

Two treaties reserve Native American rights in the Canyon Creek watershed: the 1855 treaty with the Walla Walla, Cayuse, and Umatilla Tribes, and the 1855 treaty with the Tribes of Middle Oregon. The Burns Paiute have tribal sovereignty status and resource interest in the watershed. As a result of the 1855 treaties, the Confederated Tribes of Warm Springs and the Confederated Tribes of the Umatilla Indian Reservation have reserved rights to take fish, hunt, gather, and pasture stock in the Canyon Creek watershed. These treaties specifically state that:

> The exclusive right of taking fish in the streams running through and bordering said reservations is hereby secured to said Indians, and all other usual and accustomed stations, in common with citizens of the United States and of erecting suitable buildings for curing the same; also the privilege of hunting, gathering roots and berries, and pasturing their stock on unclaimed lands, in common with citizens, is secured (USFS 1990).

The Confederated Tribes of the Warm Springs Reservation are represented by the 1855 treaty with the Tribes of Middle Oregon (USFS 1997). The entire area of the John Day River Basin is located within the boundaries of the Warm Springs treaty-ceded area (USFS 1997). The Warm Springs Tribes regulate the fishing activities of members on and off reservation lands. Currently, no specific fish harvest management goals or deferments exist between the tribes and the USFS (1997). The Umatilla Tribes adopt and enforce regulations on fishing activity, and are involved in the management of fish resources and implement management practices to protect the resources (USFS 1997).

3.4.4 Recreation

The main types of recreation in the analysis area are hiking, fishing, camping, hunting, horseback riding, and cross-country skiing.

USFS developed sites are listed in Table 3.64 below. Campgrounds are open generally between May 25th and October 31st. None of the campgrounds have trailer or RV hookups. There are five designated horse camps in the analysis area: East Fork Canyon Creek trailhead, Joaquin Miller horse Camp, Parish Cabin Campground, Table Mountain trailhead, and Wickiup campground. The only area plowed open for cross-country skiing within the watershed analysis area is at the Canyon Mountain trailhead.

In the Strawberry Mountain Wilderness, camping and horseback riding are allowed, but no mechanized devices are permitted, including bicycles. Camping is allowed anywhere off the trails in the wilderness. The lakes in the Prairie City Ranger District, east of the analysis area, are stocked with fish. The Wilderness is used most between July and November.

Table 3.64. Developed USFS recreation sites in watershed analysis area.

Name	Facility type	Facilities	Activities/ attractions
Canyon Meadows	campgound	18 tent/trailer campsites, 20 picnic sites, piped water	hiking, hunting, fishing, picnicing, wildlife viewing, wild flower viewing, Wilderness access
East Fork Canyon Creek	trailhead	undeveloped camping, 6-horse tie stall with manger, horse unloading ramp, hitch rail	
Joaquin Miller	horse camp	15 camp sites, 4 corrals, 6 toilets, 2 hitch rails, well with handpump	
Parish Mountain	campground	20 tent/trailer campsites, 1 group camping area, 1 picnic site, 6-horse tie stall, toilets, piped water	stream fishing, hunting, picnicing, wildflower viewing
Starr	campground	8 tent/trailer campsites, 5 picnic sites	snow play area, hunting, snowmobiling, cross-country skiing
Table Mountain	trailhead	undeveloped camping, 6-horse tie stall with manger and hitch rail,	
Wickiup	campground	4 tent sites, 9 tent/trailer sites, corral, 4 picnic sites, 1 group picnic site, toilets, water	stream fishing, hunting, picnicing, historic sites

Source: USFS, 2003

There are several private recreation facilities as well, including J-L Ranch, Ray Cole Camp, Williams Ranch, Yokum Corrals Camp, and Hotel Dekum Camp.

There are three areas within the analysis area that are closed to all motor vehicles except on open roads between December 1^{st} and April 1^{st}, because they are big game winter ranges.

There are approximately 36 miles of mountain bike trails in the analysis area. The trails are on both open and closed roads, which range from paved and graveled to native surface. Most trails are rated in the more difficult and most difficult categories.

There are approximately 36 miles of groomed snow mobile trails in the analysis area. Grooming consists of compacting snow in a 10- to 12-foot-wide trail. Grooming does not disturb soils or impact fish because it is done when the ground is frozen, when the snow is a minimum of one to two feet deep, and it does not remove or side-cast material. At stream crossings, groomers fill streams with snow. The only area plowed open for cross-country skiing within the watershed analysis area is at the Canyon Mountain trailhead.

There are three areas within the analysis area that are closed to all motor vehicles except on open roads between December 1st and April 1st, because they are big game winter ranges. In the Malheur NF, all paved roads (hard surface, single or double lane) and all double lane gravel roads are closed to ATVs (USFS 2003).

The Strawberry Mountain Wilderness with a ROS class of WROS has a pristine and primitive opportunity class. The area within pristine is located around Canyon Mountain in the northwest portion of the wilderness. An extensive unmodified natural environment characterizes the pristine area. Natural processes and conditions have not and will not be measurably affected by the actions of users. Terrain and vegetation allow extensive and challenging cross-country travel. The primitive areas are characterized by essentially unmodified natural environment. Concentration of users is low and evidence of human use is minimal.

In the Wilderness, camping and horseback riding are allowed, but no mechanized devices are permitted, including bicycles. Camping is allowed anywhere off the trails in the wilderness. The lakes in the Prairie City Ranger District, east of the analysis area, are stocked with fish. Under the code-a-site system, 232 dispersed camps have been identified in the Wilderness, although it is unknown how many are within the analysis area. Other than trails, there are no developed facilities in the Wilderness. There are six trailheads in the analysis area with trails that lead into the Wilderness. They are the Road's End, Buckhorn Meadows, Table Mountain, East Fork Canyon Creek, Joaquin Miller, and Canyon Mountain trailheads. There are approximately 42 miles of trails in the Wilderness within the analysis area (Table 3.65, Map 3.18). Most are rated in the more difficult and most difficult categories. Trail facilities found on or adjacent to trails include wooden bridges, wooden footbridges, culverts, and retaining structures. The major maintenance problems for the majority of the trails is due to the large amount of dead and dying trees adjacent to the trail system. General maintenance concerns include drainage structures to protect the trail. There are no current outfitter/guide permits issued for the Strawberry Mountain Wilderness within the planning area. Interest in obtaining a permit is high; until capacity for this wilderness is determined, no permits will be issued.

Table 3.65. Recreational trail networks within watershed boundaries on NFS lands for Canyon Creek watershed.

Trail name	Length of trail	Trail name	Length of trail
Buckhorn Meadows Trail	2.55 miles	Pine Creek Trail	2.99 miles
Canyon Mountain Trail	2.79 miles	Slaughter	0.45 miles
Crazy Creek #17 Bike Loop	6.82 miles	Starr	0.04 miles
Eagle	0.11 miles	Starr Ridge #18 Bike Trail	4.42 miles
East Fork Canyon Creek Trail	9.47 miles	Table Mountain #16 Bike Loop	4.51 miles
Geary Snowmobile Trail	1.28 miles	Table Mountain A Trail	0.86 miles
Indian Creek A Trail	0.001 miles	Table Mountain Trail	6.26 miles
Joaquin Miller Trail	5.56 miles	Tamarack Creek Trail	1.75 miles
Malheur Snowmobile Trail	2.40 miles		

Note some trails cross into neighboring watersheds.

3.4.5 Wilderness

A wilderness area has been historically described as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

The Strawberry Mountain Wilderness is a diverse, high-country rugged wilderness that comprises 44% of the watershed and contains five of the seven major life zones in North America. Glaciations hollowed out beds in U-shaped valleys that today hold seven alpine lakes, rare treasures in Oregon's arid west. Elevation ranges from about 4,000 feet to 9,038 feet atop Strawberry Mountain in the east-central portion.

A ~700-acre Research Natural Area (RNA) was established on August 2, 1960 within the wilderness area of the Canyon Creek watershed (Map 3.18). The RNA varies from 4,700- to 5,900-ft elevation and is situated on a gently south facing enclosed basin that rises from Canyon Creek to moderately steep ridges on the northern and western edges. Slope aspects are east, south, and west. The purpose of the Forest Service RNA designation is to provide areas where certain natural features and ecological processes are maintained in their natural state for educational, ecological and scientific purposes. They are used to provide three main functions: (1) As baseline areas against which effects of human activities can be measured; (2) sites for the study of natural processes in undisturbed ecosystems; and (3) gene pool preserves for all types of organisms, especially rare and endangered types.

The RNA has had a fire history discernible from numerous fire scars, primarily on ponderosa pine. This record shows that low intensity ground fires were quite common at 15- to 20-year return intervals until 1910, when a fire suppression program was initiated. Other disturbances include the presence of sheep grazing until 1946 when the practice was discontinued. Currently there is moderate to high usage of the RNA for grazing by game species, which has resulted in moderate to severe hedging of palatable browse plants.

Currently there are no known ongoing research programs being conducted on the Canyon Creek RNA. A few areas of potential research opportunities have been suggested, including long-term studies of natural forest succession since fire control, the evaluation of seed sources in relation to the distribution of fir reproduction, the effects of various soils and topography on biomass production under a rather homogenous macroclimate, and evaluation of game use on vegetation.

4 REFERENCE CONDITIONS

4.1 AQUATIC SPECIES AND HABITAT

4.1.1 Water Quality

4.1.1.1 Water Temperature

No information is available on natural or reference water temperatures for streams within the Canyon Creek watershed. As discussed in *Chapter 3*, several streams within the watershed are listed as water-quality limited for water temperature, including the East Fork Canyon Creek within the Strawberry Mountain Wilderness. Current water temperature standards are based on the biological requirements of cold-water fish, not on the physical processes (e.g., elevation, groundwater influence, geomorphic stream characteristics, potential stream shading) that control water temperature. Consequently, current water quality standards are poor indicators of reference conditions with respect to water temperature. The U.S. Geological Survey is currently working on models that will help estimate natural, or reference, maximum water temperatures in small streams in western Oregon (USGS 2003). The current work involves developing neutral network models that are capable of describing the complex nature of natural systems. Similar studies are needed for Eastern Oregon streams to better understand reference water temperatures.

One of the principal factors affecting water temperatures is riparian shading. Current shade levels are reported in *Chapter 3* of this report. Based on estimated historic or reference riparian vegetation conditions (reported elsewhere in this chapter), it is reasonable to assume that historic riparian shading was probably higher.

One final factor that undoubtedly had a strong historical influence on stream temperatures in the Canyon Creek watershed is beaver. Anecdotal evidence suggests that beaver were abundant in the watershed prior to the arrival of fur trappers in the area. The hydrogeomorphic effects of beaver ponds has been well-documented (e.g., Meentemeyer and Butler 1999). Beaver dams trap sediment, reduce water velocity, and can redistribute water as hyporheic flow. However, by removing sediments, beaver dams also have the potential to increase the erosive potential of streamflow downstream of the dams. With respect to water temperatures, the conventional wisdom has been that beaver ponds raise water temperatures through increased surface area, often accompanied by a reduction in riparian shading. Recent work in Bridge Creek, a tributary of the John Day River near Mitchell (Lowry and Beschta 1994) suggests that the net effect of beaver dams may be to lower water temperatures by increasing bank storage, which leads to increased base flow levels.

4.1.1.2 Sedimentation

4.1.1.2.1 Surface Erosion

No quantitative estimate of natural, or background, surface erosion is available for the Canyon Creek watershed. Surface erosion potential has been mapped for all NFS lands within the Canyon Creek watershed (Map 3.6). Surface erosion potential within the watershed is highest in the Vance Creek subwatershed and lowest in the Middle Fork Canyon Creek subwatershed (Figure 4.1).

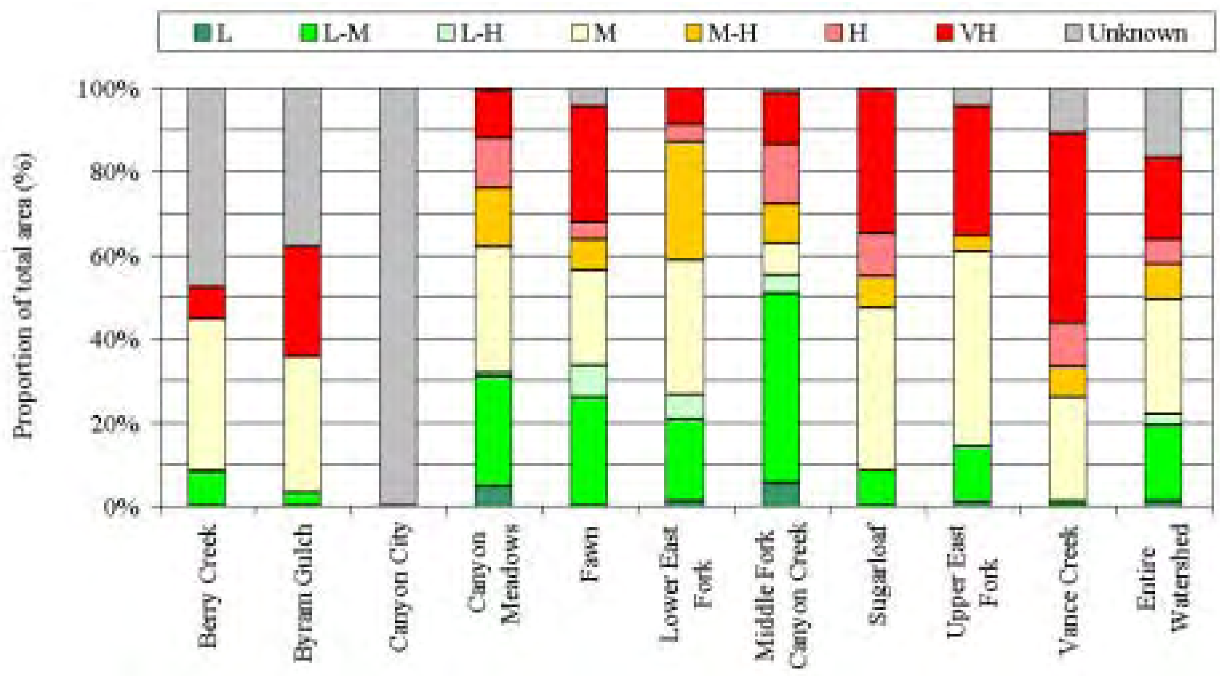


Figure 4.1. Summary of surface erosion potential within the Canyon Creek watershed.

Actual rates of surface erosion that occurred on any given unit of land would have been a function of both the erosion potential, and the sources of disturbance that were present. The relative difference between current and historic surface erosion can be assessed by evaluating changes in the disturbance sources. The two primary disturbance mechanisms that would have contributed to sediment production prior to European settlement were wildfire and grazing.

Wildfires within the watershed would have had a higher frequency of occurrence prior to European settlement of the area, but fires would generally have been of lower intensity than under a fire-suppression strategy. Sediment inputs would probably have been more frequent due to this fire pattern but would have been short-lived as vegetation returned quickly to the burned areas. Historically, there was no cattle grazing within the watershed and sediment delivery due to disturbance by cattle would have been non-existent. However, large elk or deer populations would have created similar disturbance, although the relative magnitude of the associated sedimentation is unknown.

4.1.1.2.2 Mass Wasting

As described in *Chapter 3* of this report, current rates of mass wasting appear to be very low within the Canyon Creek watershed and do not appear to be management-related. Although no quantitative data is available, it is unlikely that historic mass wasting rates were much different than under current conditions. The areas containing currently-active deep-seated failures are located in close proximity to mapped Holocene-Pleistocene landslide and debris-flow deposits within the watershed (Map 1.2).

4.1.2 Water Quantity

4.1.2.1 Low Flows

Historic patterns of low flow within the watershed are unknown. However, there are several factors that could have resulted in relative differences between historic and current conditions.

Regional climate trends were discussed in *Chapter 1* of this report. Results of that analysis indicate that a relatively warm/dry period appears to have prevailed from at least the late 1800s through the late 1930s. This in turn was followed by a relatively cool/wet period that lasted through the mid-1980s. Similar cyclical patterns undoubtedly existed in the region prior to climatic record keeping. The majority of stream flow data available for Canyon Creek and vicinity is from this relatively cool/wet period. Consequently, average low flow conditions may be somewhat lower than has been recorded locally.

As discussed in *Chapter 3*, low flows would be expected to vary in response to watershed-scale vegetation conditions. If forest vegetation was historically less dense than it currently is, due to a higher fire frequency, then relatively higher low flows would be expected historically, given lower evapotranspiration.

As discussed in *Chapter 3*, there has likely been (although not yet quantified) a loss of wetlands within the watershed, due to stream incision and down-cutting. A greater area of wetlands historically would have resulted in greater water storage within wetland areas, and relatively higher summertime flows relative to current conditions.

The final factor that historically would have resulted in higher summertime flows was the abundance of beaver within the watershed. As discussed above, beaver dams have the potential to redistribute water as hyporheic flow, which increases bank storage and results in increased base flow levels.

4.1.2.2 Peak Flows

As discussed in *Chapter 3*, the density of the forest canopy influences snow accumulation and melt rates during rain-on-snow peak flow events. Conceptually, to the extent that forested areas within the watershed were more open (due to a higher fire frequency), one would expect peak flows to have been historically higher then they currently are. The actual difference between current and historic peak flow magnitudes has not been evaluated.

4.1.3 Physical Stream Channel Characteristics

Historical conditions of stream channels within the watershed are unknown. However, certain assumptions can be made about historical conditions based on current channel conditions. *Chapter 3* of this report identified the Rosgen level I steam classification for the principal streams within the watershed. The majority of the mainstem of Canyon Creek, and the lower mainstem of Vance Creek, were identified as currently being in a "gullied" condition. These areas are typified as having a low width-to-depth ratio, are incised in alluvial or colluvial materials, and are generally unstable with grade control problems and high bank erosion rates. Historically, these areas are expected to have been less incised with more stable banks and channels, having conditions typical of Rosgen type "C," and in some cases type "B" channels.

4.1.4 Riparian Areas

Prior to Euro-American settlement of the Canyon Creek area, riparian habit conditions were markedly different than they are today. The lower gradient streams and tributaries were most likely stable with abundant summer flow and high quality water. Heavy riparian cover made up of dense alder, willow, cottonwood, and some aspen stands helped to moderate high summer temperatures by providing shade (Wissmar et al. 1994). Periodically, trees from the dense canopy fell and contributed large wood to streams that helped to diversify and stabilize the channels. Large, deep pools were probably common in the streams and few barriers to fish passage other than beaver dams and waterfalls were present.

4.1.4.1 Beaver Activity

Channel complexity and quality was augmented through the work of beavers. Estimates of beaver populations prior to the 1830s range from ten to sixty animals/mile of stream (Parker et al. 1985). Beaver dams functioned to elevate water tables and enhance riparian vegetation development. These effects improved water quality by trapping nutrient and sediment runoff. Beaver ponds improved water storage and stabilized stream flow through drought periods and added cool water from bank storage during summertime. Fish directly benefited from beaver activity through use of deep pools and cool water refugia (Olson and Hubert 1994). Deep pools were also refugia for over wintering fish. Beaver populations began to be depleted as early as 1820 by fur trapper exploitation.

4.1.4.2 Aquatic Dependent Species

Like beaver, salmon and trout were abundant in the watershed. Prior to Euro-American settlement, an estimated 10 to 16 million salmonids returned annually to the Columbia River (Behnke 2002). Historically, the John Day River was one of the most productive anadromous fish-producing rivers in the Columbia River basin (CRITFC 1995). Today, the John Day River spring Chinook salmon and summer steelhead populations are two of the last remaining intact wild populations of anadromous fish in the Columbia River basin. Historically, spring Chinook salmon probably reared and spawned throughout the larger streams in the watershed. Steelhead/redband are found throughout the Canyon Creek watershed (*Chapter 3*). Current steelhead/redband population within the watershed is considered to be a fraction of the historic population (ODFW 2002). Although there appears to be no conclusive evidence, bull trout are believed to have once inhabited Canyon Creek and its tributaries. Bull trout prefer steeper, high elevation streams and tributaries which are plentiful in the watershed. Apparently, the last bull trout found in the watershed was in a trap during the 1980s (Edwards, pers. comm. 2002). Westslope cutthroat trout, now considered to be a resident form in Canyon Creek, may have once been a fluvial form migrating between tributaries within the watershed. Cutthroat trout populations within Canyon Creek watershed are known to be functioning at a much lower capacity than historic populations (Shepard et al. 2002). Because brook trout were historically absent from Canyon Creek, competition between these non-natives and native salmonids was historically not a factor in limiting populations.

4.1.4.3 Anthropogenic Disturbance

After the beaver were trapped out, settlers established homesteads and ranches on the river corridor, where fertile bottomlands could be farmed and water was available for irrigation and livestock. Though the intensity and history is unknown, cattle grazing near fish-bearing streams contributed to degradation of water quality and fish habitat.

The discovery of gold in Canyon Creek in 1862 resulted in rapid population growth and further disturbance to the aquatic ecosystem. Miners used two different methods for extracting gold: hard rock and placer mining. Hard rock mining left mine tailings piled across the hillsides, resulting in surface runoff from the tailings and increased sediment loading to the streams. Placer mining directly impacted streams and riparian areas because miners built trails and cleared riparian vegetation to access streams. Placer mining extracted alluvium directly from the channel and adjacent floodplain. Streams became contaminated with mercury used in the mining process. In-stream water levels were altered when water was used to pan and sluice gold from dirt in the alluvial deposits. Fish habitat was either degraded or destroyed by mineral extraction.

4.2 VEGETATION

No historical data were available to quantitatively describe the composition or structure of vegetation within the Canyon Creek watershed. The Historical Range of Variability (HRV) for upland forest types described for the Umatilla National Forest was utilized for reference conditions to describe the historical range of vegetation structure within the Canyon Creek watershed (Powell 1998). This classification and analysis was designed for land areas larger than 15,000 to 35,000 acres (Powell 1998). The following is an analysis of the HRV for the 51,878 acres of upland PVGs NFS lands, or the "analysis area," of the Canyon Creek watershed. In assessing the HRV for the analysis area, the following general assumptions were made:

- The Historic Range of Variability (HRV) for the Canyon Creek watershed is similar to that of the Umatilla National Forest and accurately represents pre-1850s conditions (Powell 1998).
- Potential Vegetation Groups (PVGs) and plant association groups (PAGs) identified from analysis of aerial photographs are within an acceptable range of variability (*Chapter 3*).
- Forest structural classifications (i.e., OFSS and OFMS) have been similarly classified and described for the Canyon Creek watershed (*Chapter 3*) and for the Umatilla National Forest (Powell 2001).
- Forest structural classifications identified by aerial photograph analysis are within an acceptable range of variability (*Chapter 3*).

The objectives of this chapter are to describe the historic array and pattern of plant communities within the analysis area and to describe what processes defined these patterns for upland forest, riparian zones, shrublands and grasslands.

4.2.1 Upland Forests

4.2.1.1 Dry Upland Forests

Dry Upland Forests dominate the vegetation types in the study area, especially ponderosa pine plant associations. Historically, these forests had a single stratum of large, old trees (i.e., old forest, single stratum, OFSS) (Table 4.1). Two groups of ponderosa pine plant associations were present: warm-dry (e.g., ponderosa pine/pinegrass) and hot-dry types (e.g., ponderosa pine/mountain big sagebrush). Low intensity fires occurred frequently in these stands (fire regime I), limiting aboveground tree biomass, moderating and localizing the degrees of infection by insects and mistletoe, and maintaining relatively low levels of ground fuels. Typically, grasses or long needles would carry fire in these systems and the resistant bark of large ponderosa pine, western larch, and large Douglas-fir trees would promote "park-like" forest settings of large-diameter trees with minimal understory growth (Table 4.1).

Other warm-dry plant associations were present in the watershed, including Douglas-fir and warm grand fir forest types that were supported by a moderate-frequency, mixed-severity fire regime (fire regime III). Discontinuous patches of ground fuels and pathogens (particularly mistletoe) helped moderate fire behavior. Historically, these disturbances promoted an uneven mosaic of even-aged stands or stands that had experienced ground-based and crown fires within the same stand or in adjacent stands. As a result, the historic structure for the Canyon Creek watershed had sizable components of stand initiation (SI), stem exclusion (SEOC and SECC), young forest (YFMS), and old forest structures (OFMS and OFSS) (Table 4.1).

Table 4.1. Current and historic ranges of variability among structural classes for Dry Upland Forest types within Canyon Creek watershed with emphasis on analysis area.

Description	Structural class	Warm-Dry PAG		Hot-Dry PAG	
		Current	Historic	Current	Historic
Stand Initiation	SI	<1	5 –15	1	5 – 15
Stem Exclusion Open Canopy	SEOC	35	5 – 20	66	5 – 20
Stem Exclusion Closed Canopy	SECC	11	1 – 10	4	0 – 5
Understory Regeneration	UR	<1	1 – 10	<1	0 – 5
Young Forest Multi Strata	YFMS	26	5 – 25	20	5 – 10
Old Forest Multi Strata	OFMS	26	5 – 20	8	5 – 15
Old Forest Single Stratum	OFSS	<1	15 – 55	1	20 – 70
Bare Ground	BG	2	0	0	0

After Powell 1998.

Today these stands differ markedly from the expected historic range of variability. In general, the lower elevation ponderosa pine stands having OFSS structure comprise only a fraction of the land area (less than 1%) within the study area instead of the historic range of about 15% to 55%. Timber harvest targeted toward large-diameter trees as well as the disruption of frequent burning have resulted in higher proportions of young forest (YFMS) and stem exclusion (SEOC and SECC) stage stands. These stands tend to have increased stem densities and lower base to live crown heights, which contributes to an increased continuity of vertical fuels. It is expected the increased ground fuels and vertical fuels structure would result in a higher proportion of mixed- and lethal severity fires (crown fires), which are uncharacteristically severe for fire regime I stands.

Timber harvest has altered the historic structure and composition of dry upland forests. Targeting ponderosa pine and other commercial species has led to an increase in stocking levels of late seral species, particularly Douglas-fir and grand fir. These changes are evident in the watershed with higher levels of stem exclusion stage Douglas-fir/grand fir stands with few large-diameter ponderosa pines and western larch trees remaining in the overstory (less than 10% cover). The absence of fire in these stands has further promoted increases in shade-tolerant species and increases in conditions that support pathogens, particularly western dwarf mistletoe. Sanitation thinning without the addition of fire has been prescribed in areas where severe mistletoe infection has occurred, of which the effectiveness for long-term forest health has not yet been evaluated.

4.2.1.2 Moist Upland Forests

The historic disturbance regimes of Moist Upland Forests (i.e., cool grand fir and lodgepole pine communities) have promoted multi-strata forest (YFMS and OFMS), with post-disturbance patches of stem exclusion closed canopy (SECC) and understory regeneration phase (UR) (Table 4.2). These forests have historically undergone a series of complex interactions among beetle activity, disease, and fire at moderate to long return intervals. The combined effects of disturbance have promoted multi-cohort stands, not all of which are dependent upon fire (Agee 1994). A general description of this disturbance regime involves beetle attack of large trees followed by a high probability of stand-replacing fires because of increased fuels loading. The "jackstraw pattern" of large wood produced by beetle attacks also promotes smoldering ground fires which in turn encourage future beetle attacks. These complex interactions promote stands of multi-aged structure.

Table 4.2. Current and historic ranges of variability among structural classes for Moist Upland Forest types within Canyon Creek watershed with emphasis on the analysis area.

Description	Structure class	Current Cool/Moist PAG	Historic Cool/Moist PAG
Stand Initiation	SI	1	1 – 10
Stem Exclusion Open Canopy	SEOC	36	0 – 5
Stem Exclusion Closed Canopy	SECC	<1	5 – 25
Understory Regeneration	UR	0	5 – 25
Young Forest Multi Strata	YFMS	61	40 – 60
Old Forest Multi Strata	OFMS	<1	10 – 30
Old Forest Single Stratum	OFSS	1	0 – 5

After Powell 1998.

The current structure of Moist Upland Forests is within the expected range of young forest (YFMS) but well outside the expected range of other structural classes, especially stem-exclusion (SEOC), understory regeneration phase (UR), and old-forest structural stages (OFMS and OFSS) (Table 4.2). The extent of SEOC structure in moist forest types is evidence to the effects of timber harvest and fire exclusion. Overstocked conditions and the absence of moderate return-interval stand replacing fires have led to increased levels of insect and disease outbreaks (Powell 1994). Because stand-level survey and downed fuels structure data are not available, the extent and effects of management are not clearly understood for these forest types.

4.2.1.3 Cold Upland Forests

Cold Upland Forest types in the Canyon Creek watershed are located in the upper elevations (ca. 6,000 feet). These forests experience long to very long fire return intervals with near-complete stand-level mortality (fire regimes IV and V). Subalpine fir, cool grand fir, and lodgepole pine dominate this low productivity, community type. After fire, shrubs dominate and may persist for decades before tree re-establishment. At the timberline, whitebark pine is a co-dominant with subalpine fir. The landscape features are typified by rock outcrops, which act as horizontal barriers to fire spread. Consequently, fires remain small and localized. Few large and drainage-size fires occur in this vegetation type.

Table 4.3. Current and historic ranges of variability among structural classes for Cold Upland Forest types within Canyon Creek watershed with emphasis on the analysis area.

Description	Structure class	Current Cold/Dry	Historic Cold/Dry	Current Cool/Dry	Historic Cool/Dry
Stand Initiation	SI	2	1 – 20	0	5 – 30
Stem Exclusion Open Canopy	SEOC	58	0 – 5	70	0 – 5
Stem Exclusion Closed Canopy	SECC	1	5 – 20	0	5 – 35
Understory Regeneration	UR	0	5 – 25	0	5 – 20
Young Forest Multi Strata	YFMS	28	10 – 40	30	5 – 20
Old Forest Multi Strata	OFMS	<1	10 – 40	0	1 – 20
Old Forest Single Stratum	OFSS	1	0 – 5	0	1 – 10
Bare Ground	BG	10	0	0	0

After Powell 1998

Because sites are marginal for tree establishment and growth, forest structure is highly dependant upon the time since disturbance. In the analysis area of the Canyon Creek watershed, only about 1,800 acres contain Cold Upland Forest, which is limited for making historical comparisons (Powell 1998). On the basin scale, Cold Upland Forests had predominantly multi-strata structure, especially in those areas with 100 and 200 years between fire events. Open canopy stem exclusion (SEOC) was the most common structural type in the study area and exceeded the historic ranges of 0% to 5% for cold-dry plant association groups (e.g., subalpine fir/elk sedge and grand fir/grouse huckleberry) (Table 4.3). This shift in forest structure away from other structural types is likely due to the time since disturbance. No information exists about stand-level fires before Euro-American settlement (~1850s) for the Canyon Creek watershed. The most recent fire affecting the cold upland forests of the watershed was from the "Wildcat Fire" crossing into the Canyon Creek watershed in 1996. After about five years, these stands are largely composed of subalpine grasslands, shrublands, and regenerating forest (i.e., less than 10% canopy cover).

4.2.2 Riparian Zones

No quantitative data exist on the historic stand composition and structure of riparian zones for the analysis area or for the Canyon Creek watershed as a whole. While only a minor component of the land area (about 3%), riparian zones are important for aquatic species and wildlife. Riparian zones are unique in their composition and structure from surrounding upland areas because of their proximity to water and their topographic position. Canyon relief allows for cool-air drainage at night, and fuels moisture is generally higher than in the adjacent uplands. These changes in microclimate support plant communities that are often found at higher elevations (Franklin and Dyrness 1973). Consequently, riparian zones respond differently to fire than adjacent uplands, often with longer fire-return intervals having lower fire severity. As a result, riparian zones have a direct influence on landscape-level fire behavior and fire spread (Agee 1994). Considering the divergence from historic conditions in the upland forest structure and composition, it is probable riparian zones have experienced effects of fire exclusion, particularly decreased nutrient cycling and shifts towards lower abundances of hardwoods.

4.2.3 Grasslands and Shrublands

In addition to fire suppression, livestock grazing has been a contributor to the decline of wildland fires in the intermountain west. Rangelands under intensive grazing rotations by cattle or sheep typically do not have the fine fuels structure that would carry fire with the intensity typical of a fire regime II (frequent, stand-replacing fires with low flame height). Grazing of grasses and forbs limits the aboveground biomass that carries the fire, as well as limits the aboveground litter sources that are essential for fire ignition (Covington and Moore 1994). The combined effects of minimizing fire disturbances and the competition by grasses allows for rapid establishment of conifers within grasslands; conifer encroachment further limits grass production from shade competition and ultimately can shift the grassland environment to a forested environment. Exotic species are also a concern for grasslands and shrublands. Annual cheatgrass (*Bromus tectorum*) is a common invasive species that has gained dominance in many community types within the Blue Mountains, and (while not known) the Canyon Creek watershed is probably no exception (Keane et al. 2002).

The current status and historical trends of grasslands and shrublands within the Canyon Creek watershed is not known. Other than classifications from aerial photographs, no site-specific or landscape data exist for rangelands, including degrees of exotic species invasion, site productivity, livestock use, or plant associations.

4.3 TERRESTRIAL SPECIES AND HABITATS

In general, historical vegetation conditions prior to Euro-American settlement are thought to have been old forest single-stratum stands, dominated primarily by mature ponderosa pine/dry upland forests with warm/dry to hot/dry plant associations. Frequent fires of low intensity and severity would have kept finer fuels to a minimum and maintained large, open "park-like" stands. Frequent fires would have prevented encroachment into grassland and shrublands, making these areas more extensive historically. Historically, beavers were likely more abundant, which would have caused meadows to be wetter and possibly larger where dams were located. Riparian shrub vegetation was probably more prevalent along streams. Aspen was probably more abundant historically in the watershed.

4.3.1 Proposed, Endangered, Threatened, and Sensitive Species

4.3.1.1 Shrubland and Herbland Associated Species

4.3.1.1.1 Pygmy Rabbit

As stated in *Chapter 1*, there are no historic occurrences of this species documented in Grant County (Csuti et al. 1997). It is unknown if big sagebrush dominated shrublands within the watershed historically provide the habitat features required by this species.

4.3.1.1.2 Western Sage Grouse

Sage grouse, an obligate resident of the sagebrush ecosystem, were probably never abundant in the watershed due to limited big sagebrush-bunchgrass and juniper-sagebrush plant associations in the watershed. Sagebrush communities may have occupied the transitional zone between the ponderosa pine and Douglas-fir plant series and the scattered grasslands in the watershed. Potential habitat is currently limited to mainly the Fawn subwatershed and probably was almost as limited historically.

4.3.1.1.3 Upland Sandpiper

Upland sandpipers breeding habitat is restricted primarily to extensive, open tracts of short grassland habitat in Logan and Bear Valleys. There are no large open short grassland habitats within the forest boundary of the watershed. The private lands within the watershed might have provided suitable habitat before they were converted to agriculture uses, but it is not likely that upland sandpipers were distributed historically in the watershed.

4.3.1.1.4 Gray Flycatcher and Bobolink

As there are currently acres of big sagebrush in Fawn subwatershed and it could be assumed that such acres of sagebrush existed there historically, it is not known if these acres would provide the suitable nesting habitat for gray flycatchers. The mountain mahogany shrublands scattered throughout the watershed may have provided dispersal and/or foraging habitat for this species.

Moist meadows, the preferred habitat of the bobolink probably existed at least seasonally on lands in the watershed that eventually fell into private ownership. The extent of this assumption is unknown for the purpose of this analysis. Within NFS lands, it is assumed that suitable habitat existed historically in the Canyon Meadow and Lower East Fork subwatersheds, because currently there are larger sized meadows in these subwatersheds. The distribution of these species and their habitat were probably historically low in the watershed as higher quality habitat exists in Bear Valley.

4.3.1.2 Wide Ranging Carnivores

4.3.1.2.1 Gray Wolf

The historic range of the gray wolf was most extensive of any wild animal in North America (Verts and Carraway 1998) Poisons, trapping, and shooting, spurred by federal, state**,** and local government bounties, resulted in its extirpation from more than 95 percent of its range in the 48 contiguous States.

Wolves are considered extirpated from Oregon. Historically, the wolf was considered to occur mainly in the Willamette Valley and west to the coast, at European settlement, and to continue to occur west of the Cascade Range during the first third of the 19th century (Bailey 1936). In 1999, one radio-collared, female wolf from the experimental Idaho population traveled through portions of the three Blue Mountain Forests. The female was trapped in the vicinity of the Upper Middle Fork Watershed and returned to Idaho. In 2000, a male wolf was killed on Interstate 84 near Baker City, Oregon. These incidents indicate that the Blue Mountains probably provide suitable habitat for wolves. Over time, wolves dispersing from the growing experimental, non-essential Idaho population could return to the Blue Mountains and establish breeding territories.

4.3.1.2.2 Canada Lynx

Historically and in general, self-maintaining lynx populations have been considered unlikely to exist in Oregon (Witmer et al. 1998). The watershed, which is on the extreme southern portion of their range, probably had few, if any, Canada lynx populations due to the lack of habitat. Under natural fire regimes, the lower reaches of the watershed, outside the wilderness area, was probably dominated by open ponderosa pine stands in warm/dry hot/dry PAGs, which are not conducive to lynx habitat. Habitat may have occurred as it does today in the cool/dry cold/dry PAGs found in the wilderness area. Lynx may have passed through the area or foraged in the area, but self maintaining populations is unlikely to have occurred in the watershed.

4.3.1.2.3 California Wolverine

Wolverine populations are thought to have occurred at low densities before Euro-American settlement (Witmer et al. 1998). Historically, the wilderness area most likely provided suitable habitat. Wolverines probably traveled through the lower reaches of the watershed as there were no roads and little fragmentation when moving between suitable habitats located outside the watershed.

4.3.1.3 Miscellaneous Habitat Associated Species

4.3.1.3.1 Tricolored Blackbird and Bufflehead

As stated in *Chapter 3*, these species generally prefer to breed in freshwater marshes with emergent vegetation. The moist meadows and riparian habitat could have provided suitable habitat for these species. The quality of the historical habitat for breeding is unknown.

Historically, within NFS lands, the watershed does not appear to have had provided suitable nesting or wintering habitat for buffleheads. Suitable habitat is defined as nests near mountain lakes surrounded by open woodlands containing snags. There is a lake located on private land, but the current or historical suitable nesting habitat conditions around this lake are unknown.

4.3.1.3.2 Peregrine Falcon

There is limited suitable nesting habitat in the watershed and it is limited mainly to the cliffs of Canyon Mountain. This habitat has remained unchanged through the years, but foraging habitats have been altered by agricultural activities on private land. Peregrine falcons may have historically occurred in the watershed, assuming forage opportunities existed in the lower riparian reaches.

4.3.1.3.3 Columbia spotted frog

Historic habitat for spotted frogs was most likely well distributed through areas of the watershed with permanent water. Although current habitat has been degraded by past management activities, historic habitat probably persisted except through extreme drought events.

4.3.1.3.4 Elk

Elk herds, which are thought to have existed in relatively low numbers prior to Euro-American settlement, were decimated by the late 1800s. Rocky Mountain elk were translocated from Yellowstone National Park in 1913 to repopulate the area (Irwin et al. 1994). Forest Service annual game counts on the Malheur National Forest in 1929 recorded that 47 elk occurred on the forest (Bailey 1936). Hunting restrictions resulted in increasing herds until herds grew to high-density levels by 1980 (Irwin et al. 1994). However both deer and elk are quite vulnerable to human disturbance. Scientific research shows that higher open road densities reduce deer and elk habitat effectiveness (Thomas et al 1990). Roads open to motorized traffic allow people easy access to big game habitat. Motor vehicles and associated human activities can stress big game animals, causing them to avoid use of available habitat and unnecessarily expend energy. Habitat for elk and deer was probably better prior to settlement by Euro-Americans than today because there were more open stands with native grasses and healthy fires adapted shrubs for forage, plus a good distribution of cover for thermal regulation. More importantly, roads and associated human access were much more limited prior to settlement, and consequently elk and deer were not impacted by human disturbance to the extent that occurs under present conditions. Although, American Indians had some effect on the populations of these animals prior to Euro-American settlement, it is unknown what extent, or degree this effect occurred. Actual numbers of elk on the National Forest may have been lower than the present numbers. This is because elk probably used more of the lower elevation foothills and valleys on what are now, non-National Forest lands. Human development in these bottomlands has pushed more elk up onto National Forest lands. Open ponderosa pine forests dominated the warm/dry and hot/dry plant associations and provided high-quality grass and shrub forage. Thermal and hiding cover was probably located in the mixed conifer stands found in the moister sites in the warm/dry plant associations.

4.3.1.4 Late and Old Structure Forest Associated Species

The V*egetation* section describes the historic condition of habitat for these species in the context of the HRV analysis. To summarize, the OFSS stands within the dry upland forest types are below the historic range of variability in both the hot and warm-dry PAG's. The OFMS stands throughout the watershed are within this range of variability. By contrast, the OFSS and OFMS stands within the moist upland forest types are well below the historic range of variability in cool-moist PAG's as well as in the cold and cold-dry PAG's in the cold upland forests.

4.3.1.4.1 Bald Eagle

Historically, the old forest stands located along Canyon Creek may have provided nest structures for bald eagles. A reduction in the number of large-diameter trees in the watershed, quality of riparian areas, and peak flows of Canyon Creek has altered habitat for this species range-wide.

4.3.1.4.2 Pacific Fisher

Suitable habitat would have been very limited in the watershed but may have been found in the moister warm/dry plant associations in the grand fir multi-strata vegetation types. Historically and currently, riparian corridors serve as travel corridors and provide productive habitat for fisher prey. As stated in *Chapter 3*, in the lower elevations of Sugarloaf, Fawn and Lower East Fork subwatersheds, fishers may occur in the old-growth and mature forests. However, these stands are generally above 4,000 feet, and snow accumulations may limit fisher use of these areas. The lower elevations within the watershed, in private ownership, probably did not serve as suitable habitat for this species

4.3.1.4.3 Pileated Woodpecker and Pine Marten

In general, woodpecker habitat is thought to have been more abundant historically than it is currently. Pileated woodpeckers are associated with moist forest types (which comprises 20% of the analysis area) because they need the high canopy for nesting. Populations of woodpecker species have probably fluctuated over time with large-scale fires and insect and disease mortality and most recently with timber management.

Pileated woodpeckers are associated with old-growth ponderosa pine-mixed conifer forests. Historically the OFMS stand condition was more prevalent throughout the watershed. The hot-dry and warm-dry plant associations in the moist upland forests would have provided habitat where large snags, down logs, and high canopies were present. As mentioned above, frequent fires would have created small patches of old forest multi-strata stands surrounded by old forest single-stratum forests (a stand structure that is virtually non-existent in the present-day watershed condition). Suitable habitat for this species was more prevalent historically than the current day levels. It can be assumed that this species was present in the watershed perhaps even well distributed given the amount of habitat.

Pine martens have similar habitat requirements to the pileated woodpecker but since the marten does not require large diameter trees the YFMS stand structure can provide suitable habitat for this species. Current structure stage percentages are in excess of the estimated HRV for YFMS but as is the case with pileated woodpecker habitat, pine marten habitat was also prevalent in the watershed.

4.3.1.4.4 Northern Goshawk

Old forest multi-strata structural stands were historically present in the watershed and would have provided habitat for the goshawk. Frequent fires would have created very fragmented small patches of old forest multi-strata stands surrounded by old forest single-stratum forests (this stand structure is nearly absent currently). This species is thought to use open, park-like stands for foraging, and the old forest single-strata stands may have provided this type of habitat. This combination of nesting and foraging habitat may have supported more nesting territories historically than the four territories currently found in the watershed.

4.3.1.4.5 Three-Toed Woodpecker

Lodgepole pine is an important habitat component for the three-toed woodpecker. Historically, lodgepole pine was the co-dominant species within the grand fir vegetation type, but distribution of these forest types was limited in the watershed.

4.3.1.4.6 White-Headed Woodpecker

This species utilized the old forest single-strata stand structure that dominated the warm/dry and hot/dry plant associations. The warm/dry and hot/dry plant associations occur in over half of the watershed. This species was probably relatively well-distributed, since this habitat type was well distributed in the watershed.

4.3.1.5 Deadwood Associated MIS

4.3.1.5.1 Lewis' Woodpecker

The Lewis' woodpecker needs open areas for foraging since it is an aerial feeder and also forages on the ground and in brush. The open ponderosa pine forests in the warm/dry and hot/dry plant associations would have provided habitat for this species. As mentioned above, this habitat type was abundant and well-distributed in the watershed. Cottonwood galleries probably were more abundant historically and would have provided habitat.

4.3.1.5.2 Black-Backed Woodpecker

Large-scale stand-replacement fires that would provide habitat for this species were not common in the watershed. This species is foraging for wood boring larvae so in the absence of intense stand replacement fires or if the fires were mainly cooler understory fires the black-backed woodpecker would seek stands with high snag density and decay to find suitable forage habitat. Mature and old-forest stand structures were probably more common throughout the watershed and may have provided habitat for these species.

4.3.1.5.3 Williamson's Sapsucker

This species uses mature higher-elevation coniferous forest for nesting and feeding. It prefers open ponderosa pine forest but may use lodgepole pine, grand fir, Douglas-fir and aspen forests (Csuti et al. 1997). There was probably more suitable habitat for this species in historical conditions, especially in the open ponderosa pine forests.

4.3.1.5.4 Downy Woodpecker and Red-Naped Sapsucker

The downy woodpecker and red-naped sapsucker are associated with riparian habitats but will use coniferous habitats. Historical riparian communities probably consisted of a mixture of grasses, shrubs, and hardwoods. Hardwoods may have included alder, willow, dogwood, cottonwood and aspen that would have provided habitat for both of these species. Aspen is an important habitat component for both species. Historically it is likely that aspen groves extended from the riparian areas and other moist areas in the watershed. This habitat was probably limited but well distributed in the watershed.

4.3.1.5.5 Hairy Woodpecker and Northern Flicker

Both the hairy woodpecker and the northern flicker use a variety of habitats but tend to prefer open habitats. As mentioned above, open forest habitat conditions were historically more abundant throughout the watershed.

4.3.1.6 LRMP Featured Species

4.3.1.6.1 Osprey

Historical habitat probably occurred along the Canyon Creek in the Fawn subwatershed as it does currently. Because the watershed does not have a high density of large, fish-bearing water bodies, this species was probably not abundant or well distributed in the watershed. Salmonids were present in the watershed historically and probably provided seasonal forage for this species. There is very little information on the abundance of salmon in the watershed but Native American fishing use in the valley suggest that there was an abundance of fish.

4.3.1.6.2 California bighorn sheep

Bighorn sheep were extirpated from Oregon by the mid-1940s. Historic records indicate that bighorn sheep were known to be present in the watershed. The size of the population throughout the Blue Mountains is not known but they were probably at higher numbers than the re-introduced population that occupy the Blue Mountains today. The last recorded native bighorn sheep in the John Day area was around 1915. Historical information suggests that one of the major causes for the demise of this species was a combination of contact with domestic sheep and unregulated hunting (ODFW 2001).

4.3.1.6.3 Blue Grouse

Hardwood thickets and aspen were more abundant historically in the watershed; however, Grouse also prefer large mistletoe-infected Douglas-fir trees for winter roosts. Historically, mistletoe was present in the watershed but was moderated by disturbance such as frequent fires. Currently, mistletoe infestation is much more abundant than historic levels with the absence of frequent fires in watershed. The historic distribution and abundance of this species in the watershed is not known.

4.3.1.6.4 Pronghorn

In Oregon, this species is associated with open grasslands, precludes it's presence in the analysis area. Outside of the watershed, it's has been documented that approximately 500 pronghorn occurred in Logan Valley (USFS 1971). Distribution of this species was probably concentrated outside of the watershed in Logan Valley and perhaps Bear Valley.

4.3.1.6.5 Neotropical migratory land birds

Neotropical migratory landbirds probably had access to a greater quantity of available habitats than the current situation. Studies have shown a slow but study decline of habitats through the range of these species especially in riparian areas. Riparian areas throughout the Interior Columbia River Basin, including those within the analysis area, have been severely degraded from its historic condition by over-grazing, timber management, climatic changes, and water diversions.

The following is a summary from the Partners in Flight Landbird Conservation Plan for Eastern Oregon. Landbird conservation faces numerous obstacles, either directly or indirectly arising from conflicts with human economic issues. The principal post-European settlement conservation issues affecting forest bird populations are habitat alteration due to suppression of fire and timber harvesting. Physical consequences of these alterations include changes in structural diversity, reductions in habitat patch size and increases in fragmentation, and reductions in the amount of old forest. Consequences for bird populations vary by species; favoring those associated with younger and denser forests and adversely affecting those associated with older forests and more open conditions.

Fire suppression and timber harvesting has blurred the relatively distinct historical elevational zonation of forest vegetation. Douglas-fir, grand fir, and Englemann spruce have expanded their range to lower elevations beyond their normal mesic locations. Old-growth stands of ponderosa pine have been harvested, and fire suppression and encroachment of other species has resulted in denser thickets of fir-dominated forest where ponderosa pine used to occur. Estimates of the extent of alteration vary. In the Blue Mountains, the proportion of forestland dominated by ponderosa pine has declined from 80% in 1936 to 25% in 1992. In the 1930s approximately 60% of the original low elevation old-growth ponderosa pine in the Blue Mountains still existed; by the early 1990s, only 20-25% still existed. Most of the remaining patches are less than 100 acres and likely too small to maintain ecosystem processes and many old-growth dependent species. For example, habitat for white-headed woodpecker, a species dependent on late-seral ponderosa pine forest, has declined by more than 60% from historical to current periods, and been completely eliminated in more than 40% of the watersheds within the ICBEMP (Wisdom et al. in press).

The effect of extensive road development networks also has adversely affected wildlife. Based on an extensive synthesis of the literature, Wisdom et al. (in press) identified 13 direct or indirect factors associated with road development that impacted greater than 70% of the 91 vertebrate species analyzed (includes many landbirds). Additionally, the adverse effects on wildlife from road-associated factors may be additive to that of habitat loss and alteration (Wisdom et al. in press).

In addition to forest ecosystems, other ecosystems have been degraded to the point of reduced functional integrity. For example, in lower elevation subalpine parkland, fire suppression has likely altered patterns of succession that favor a denser tree canopy and changes in species composition (Franklin and Dyrness 1973). There also has been a extensive invasion of meadows with tree species throughout the analysis area (Franklin and Dyrness 1973), perhaps due to climatic change in the last 50 years.

4.3.1.6.6 Raptors

The quality and quantity of habitat in the analysis area that was historically present for the seven species of raptors referenced in Table 3-63 is not known. It can be assumed that species that are more generalists in terms of their habitat preference such as red-tailed hawks, Cooper's hawk, and prairie falcons were probably well-distributed so long as prey items were readily available.

Northern pygmy owls, flammulated owls and even kestrels would have had ample habitat of snags and natural cavities to nest in historically as the HRV analysis indicates that more of this type habitat was available in the watershed.

The historic presence of golden eagles in the watershed is more difficult to determine. They have been documented at low breeding pair density of 4 to 5 pairs per 40 square miles in eastern Oregon (Csuti, et al. 1997) which would indicate that they have rather large home ranges spread over a large geographic areas.

4.4 HUMAN USES AND CULTURAL RESOURCES

4.4.1 Prehistoric Land-Use Patterns (11,000 – 400 years Before Present)

The archaeological record suggests that hunter-gatherer land-use practices in the Blue Mountains generally intensified as populations and competition for available resources increased on the Southern Columbia Plateau over time (Burtchard 1998).

Land use in the Canyon Creek area at the end of the Pleistocene was undoubtedly ephemeral. Hunter-gatherers operating in higher elevation mountains prior to the eruption of Mount Mazama (ca. 7,000 BP) foraged for a broad spectrum of resources over extensive ranges and had low population densities (Schalk and Cleveland 1983). An archaeological site in the upper portion of the watershed provides evidence of cultural presence in the watershed prior to the eruption of Mount Mazama at 7,000 BP (Rotell and Hann 2003).

As climactic aridity increased in the mid-Holocene and lowland habitats became degraded, it became more likely that hunter-gatherers from the Great Basin and Columbia Plateau made extended forays into the Blue Mountains (Burtchard 1998). Foraging strategies for groups that would have exploited resources in Canyon Creek between approximately 6,000 and 4,000 BP have been characterized as seasonally sedentary, highly mobile, with limited mass procurement of locally abundant resources and limited use of resource storage systems.

At approximately 2,500 BP, most of the interior Pacific Northwest experienced its peak prehistoric population density. Complex pithouse villages were established on the lower John Day River, the Deschutes River, and in lakeside environments within Harney Basin (Schalk and Atwell 1994, Aikens and Greenspan 1988, Minor and Toepel 1988) during this period. Large, socially complex, semi-sedentary groups situated on the Columbia Plateau and northern Great Basin at this time probably considered the southern Blue Mountain region and the Canyon Creek area hinterlands. Data from an archaeological site provides evidence that hunter-gatherers were harvesting and processing big game in the watershed at ca. 2,000-25,00 BP (Hann 1997).

After roughly 400 BP, aboriginal land-use systems were impacted both by the horse, which permitted long-distance transport of commodities, and by the introduction of New World diseases. During the ethnographic period, the primary occupants of the watershed were the Northern Paiute who wintered near Canyon City; although tribes from the Columbia Plateau such as the Umatilla, Tenino, Cayuse, Walla Walla, and Nez Perce also periodically visited the area (Blyth 1938, Stewart 1939, Suphan 1974). Cultural groups based in the Columbia Plateau and northern Great Basin gradually began to participate in Euro-American and European economies at this time.

4.4.2 Cultural Fire

Anthropogenic, or cultural, fire would have been the primary cultural mechanism of landscape transformation prior to Euro-American settlement of the area in the mid-19th century. Although assigning origins to fire ignitions that occurred in the prehistoric or early historic past remains an imprecise task, it is safe to say that the combination of cultural and natural fire had a considerable effect on vegetation patterns in Canyon Creek before hunter-gatherer burning waned. Intentional burning of Blue Mountain forests has probably occurred since the end of a middle Holocene thermal maximum (Altithermal), which occurred approximately 4,000 BP.

Historic and ethnographic records indicate that fire was routinely deployed by hunter-gatherers in nearly every ecosystem in North America for achieving both long and short-term goals (Lewis 1973). Hunter-gatherers would likely have used fire for most if not all of the following purposes: warmth, resource processing, creating or maintaining open ponderosa pine parklands, burning off dry brush and stimulating the growth of deer/elk browse, creating or maintaining higher elevation openings better suited for root crop and huckleberry production, mass driving of big game, forcing bears out of winter dens to be killed, improving open qualities of forested areas to facilitate travel, long-distance communication with other groups, creating fuel breaks around habitation or other special areas, and impeding the pursuit of enemies. The earliest settlers in the Middle Fork of the John Day River subbasin continued to burn the woods for similar and different reasons.

In other regions of Oregon, forests were burned in the historic-era to enhance ground visibility during gold prospecting and to permit unhampered travel (Lalande 1995). Burning may have also been employed in the historic period to improve cattle and sheep grazing in certain areas.

The burning patterns of the Indians of the inland Pacific Northwest were quite distinct from the indigenous groups of southwestern Oregon and the western flank of the Cascades (Agee 1994). The tribes to the east of the Cascade Range foraged within "classic fire environments" that were well suited for widespread underburns nearly every year (Agee 1994). Burning by hunter-gatherers most likely occurred in the spring and fall when fire intensity could most easily be controlled. Virtually all elevations in the watershed may have been burned intentionally by hunter-gatherers at some time; however, most burning during the prehistoric period probably was concentrated in the lower elevation areas of the Galena watershed. In the Southeast Galena planning area, stands of mixed conifer would have been the most likely candidates for the application of cultural fire. Coniferous stands of higher elevations may have been burned occasionally to create or maintain mosaic forest/meadow patterns (Lewis 1973).

Newspaper articles, diary and journal entries, and recorded personal recollections all provide evidence that Indians altered the local environment through burning. Early fur trappers and explorers of the Columbia River such as Lewis and Clark, Peter Skene Ogden, Benjamin Bonneville, and John Kirk Townsend all noted the application of fire to grasslands and forests by Indians in the early 19th century (Langston 1995). None of the evidence is specific to the Canyon Creek watershed, it is entirely anecdotal, and much of it is ambiguous. However, collectively it suggests that Indians commonly treated the landscape with burning in the mountains near Grant County into the latter years of the 19th century. Newspaper accounts of intentional fire deployment within or near Grant County include:

> In the fall of 1888, it was observed by the Grant County News (09/06/1888) that Indians were torching forests and grasslands in the County. The reporter observed that, "There is considerable fire in the mountains around Bear Valley. We passed through one fire but it was not burning very briskly. This intolerable firing of timber should be looked after by someone. If the Indians are to run off and kill all the deer and then burn up all the timber it is time something was done. . . . A band of noble red men are in the mountains – in fact several bands are roaming over the country killing the white man's game and burning off his winter stock range."
>
> The Grant County News (09/12/1889) reported in September of 1889 that, "A gentleman saw an Indian setting fire to the timber south of here, and knew of them setting fire a distance of thirty miles in one day for the purpose of corralling the deer for one great slaughter. . . . This smoky atmosphere and the destruction

of our game is bad enough, but to have the red devils destroy the best timber in the state is worse."

A year later the Grant County News (09/11/1890) again complains of the use of fire by the Indians, "Up to this time this summer Grant County was free from forest fires, but now the scenery is hid by smoke. Indians in the mountains as usual are setting fires to corral the game."

Phil Metschan, of the Oregon Inn-Side News (01/03/1947), referred to the days in Grant County when ". . . magnificent forest surrounding town was scarcely touched; when, following the custom of the Indians, the dry grass and debris were burned every year, and consequently there was no underbrush, no forest fires, giving the forest a park-like appearance."

4.4.3 Fur Trapping and Early Exploration (1826-1831)

Several European-sponsored forays were made into the Upper John Day River subbasin between 1826 and 1831 (Davies 1961). Peter Skene Ogden and John Work pursued a "fur desert" policy of the Hudson's Bay Company as they led trapping brigades through the Blue Mountains. The intent of this strategy was to trap beaver and river otter to the point of eradication in the area south of the Columbia River in an effort to deter American fur and settlement interests from becoming established in areas north of the Columbia River. John Work most likely traveled north through the Canyon Creek watershed in July of 1831 as his party trapped their way from the Silvies River to the John Day River.

4.4.4 Mining and Euroamerican Settlement (1862-1942)

The Canyon Creek watershed witnessed the familiar phases of boom and bust mining activity that were recurrent throughout the West. At the point of discovery in 1862, mining focused on excavating and washing the alluvial gravels of Canyon Creek. Soon after, prospectors, suppliers, and camp followers rushed to the area and the mining camp on Canyon Creek grew to a population of nearly 5,000 people.

George Hazeltine, who arrived at the Canyon Creek mining camp during the initial gold rush, anecdotally described the watershed prior to modification by settlers and miners in a letter to his wife dated August 17, 1862. According to Hazeltine:

> "...we are camped [in a crude brush shelter] on the bank of a creek called Canon Creek. The banks are covered with birch wood trees, with a heavy undergrowth of rose, gooseberry and currant bushes and the undergrowth is very hard to get through, of course. ...I started for the creek to wash my face and hands and get some water. Now there is a regular trail through the bushes to the water, that everybody traveled, but for some ... reason I did not take the trail but went scrambling through the bushes now diving under, now jumping over the tangled vines...the vines were more matted and tangled than any I had seen...".

The discovery of gold in Canyon Creek also stimulated the building of roads throughout the region. The Dalles Military Road was constructed in 1867 and it connected the city of The Dalles with Fort Boise via Canyon City. In later years, the town of Canyon City was established and it served as a central supply hub for miners and mining operations located throughout the watershed and all of Grant County. Canyon City was repeatedly destroyed by fires in 1870, 1898, and 1937 (Oliver 1961, Lewis 1950).

By the late 1860s, the infrastructure was in place to allow for large-scale hydraulic placer mining of high terrace deposits of gold. By 1871, over 50 miles of ditches had been built to supply placer claims with adequate water from Canyon Creek and tributaries of the John Day River to the east (Rossiter 1871). The Humboldt ditch was the most substantial ditch in the watershed. It was approximately eight miles long and was capable of delivering 24 cubic feet of water per second (cfs). Important placer mines in the watershed included the Humboldt and the Marysville claims (Lindgren 1901). Many ethnic Chinese miners purchased claims or found employment with hydraulicking companies during this period. Mining technologies utilized in the watershed had made the transition to principally hard rock or quartz techniques by 1900. Gold and chrome ore were removed from lode mines in the Canyon Creek area such as the Miller Mountain mine, the Little Canyon Mountain mine, and the Iron King Mine (DOGAMI 1941). A floating dredge also worked the alluvial gravels between the John Day River and Canyon City after the turn of the century (Mosgrove 1980). The Timms Gold Dredging Company dredged the bottomlands near the mouth of Canyon Creek for placer gold between 1900 and 1916. Sporadic hard rock and placer mining continued in the watershed until gold mining was essentially abolished by the federal government with the onset of World War II in 1942.

4.4.5 General Land Office Surveys (1869 and 1880)

The first direct information on vegetation in a broader sense comes from General Land Office (GLO) survey notes. These notes are taken by land surveyors walking a grid system projected on the land surface while describing landforms, vegetation, and water bodies on the various cardinal directions. The descriptions are necessarily brief and focus on aspects of economy (i.e., landforms, vegetation, soil). There are two sets of notes relevant to this analysis. David, Pengra, and Thompson (GLO 1869) conducted the first survey of the analysis area, seven years after the discovery of gold. Robb (GLO 1880) conducted a second survey of the planning area. Their notes describe a frontier environment for the watershed.

General descriptions include:

> "…the south boundary runs along the foot of rough and rugged mountains covered with scrubby pine timber. Most of this township is occupied by settlers and miners – Aug 23 1869"(GLO 1869, for T13S, R31E).

> "This Township is on south slope of mountain. The south half is rolling with soil 2nd rate and fine grass. The north half is on rugged steep broken hills and the soil is worthless."(GLO 1869, for T14S, R31E).

> "…The country is rolling Prairie covered with fine grass and is well watered and has large numbers of settlers. I think there are within 12 miles of the line on the south side near five hundred settlers with three considerable towns – Canyon City, John Day City and Dixie. (The first named place containing a population of about one thousand inhabitants, the two latter places from one to three hundred/ Canyon City is the County Seat of Grant County.

> "There are many fine farms in this vicinity and the country since the termination of the American War (one year ago) is rapidly settling up. The Blue Mountains are to the east and south of the settlements and afford abundance of fine fir and pine timber for buildings, fences and fuel." (GLO 1869, general description including Ranges 31 and 32).

Specific descriptions along section lines relevant to the analysis area include:

> "Land rough and broken, Soil 2nd rate, fine grass, Aug 22 1869" (GLO 1869, from Canyon City east one mile).

> "Heavy pine timber. Dense undergrowth of buck brush, willows. The line runs close to Canyon Creek" (GLO 1869, approximately one mile east of Canyon Creek).

In a later survey of the same area, GLO (1880) provides general and more detailed descriptions.

> "General Description - This Township is mountainous and rough and broken. The narrow valley and foothills toward the north are adapted to agriculture. The southern portion is covered with heavy timber pine, fir, tamarack and juniper and mahogany." (GLO 1880, for T14S, R31E).

For the northern boundary of township T14S, R31E, GLO (1880) details the following:

> "Country rough and mountainous, Soil 3rd rate, July 29 1880" (GLO 1880).

> "This line runs close to Canyon Creek is very rough and was projected with much difficulty. Pine timber, willows along creek. Buck brush on slopes. Soil 1st and 3rd rate" (GLO 1880).

> "This line runs along the north slope of Canyon City Mountain. The timber has all been cut off and there is a dense growth of brush and small pine. The country

is very rough, rocky, mountainous and broken, Soil 2nd rate." (GLO 1880, southern boundary section 1).

"a pine 24 in dia"

"Country fearfully rough broken mountainous and rocky. Soil 3rd rate. Pine timber. Dense buck brush and willows." (GLO 1880).

"Cross Canyon Creek"

"a juniper 14 in dia"

"a juniper 8 in dia"

For the eastern boundary of township T14S, R31E, GLO (1880) notes:

"Country very rough mountainous and broken, Soils 2nd rate. Dense growth of buck brush, willow and sarves bushes. Line runs close along the breaks of Canyon Creek." (GLO 1880).

"It being impossible to run the east boundary of Township 14S Range 31E on account of the line running along the west slope of Canyon Mountain which breaks off almost perpendicular towards Canyon Creek. I begin at the cor. to secs. 35 and 36 on the south boundary of the Township, and run north between secs. 35 and 36. Country very rough and rocky and mountainous, Soils 1st and 3rd rate." (GLO 1880).

For the southern boundary of township T14S., R32E., GLO (1880) reports:

"Country very rough and mountainous, dropping off E + SE rapidly toward Canyon Creek. Not much good timber, but an immense quantity of fallen tamarack. Very dense buckbrush. Soils 3rd rate."

"Country most fearfully rough, rocky, and mountainous. Fallen timber – Buckbrush of gigantic size. Timber scattered pine, fir, and hemlock."

For the western boundary of township T15S., R32E., GLO (1880) describes:

"Country rough and mountainous. Soils 3rd rate. Pine timber – dense sagebrush."

"Canyon Creek, 30 links wide, flowing northwest. … Country is broken and mountainous. Soils 3rd rate. Heavy pine and fir timber. Dense buckbrush." (Near confluence of Road Gulch and Canyon Creek).

"Set post on bald ridge for cor. To secs 24, 25, 19 & 30. with pits and mound as per instructions. Country rough, broken and mountainous. Heavy pine and fir timber. Buck brush very dense in pockets." (On boundary between townships 15/31 and 15/32 near Hunters Cabin Spring).

4.4.6 Early Forest Service Administration and Fire Suppression (1906-1942)

In 1906, the Forest Reserve system was established under the supervision of Gifford Pinchot to manage the resources in the forests of Canyon Creek and the entire Blue Mountain region. Management of forests was largely custodial through the 1920s because fighting forest fires and administration of grazing were the chief concerns. Some large fires burned the watershed in the Fawn Springs and Wall Creek drainages between 1910 and 1920 but apparently they were not especially destructive. Malheur National Forest Supervisor Cy Bingham reported to the Regional Office, "3000 acres burned, no damage, no expense" (Schouten 1991).

The emphasis on fire suppression greatly increased in the 1930s, and it was a primary mission of the Forest Service by the time the Civilian Conservation Corps (CCC) was created in 1933. By 1935, the Forest Service had its "10 AM" policy in place. This policy mandated that all fires were to be controlled by 10 AM the morning following the report of the fire (Williams 2000). In 1937, the CCC brought 150 enrollees to Canyon Creek and a camp was constructed at the confluence of Vance Creek and Canyon Creek. The CCC began development of National Forest Service lands by constructing roads, fences, lookout towers, corrals, signs, markers and trails (Mosgrove 1980). The CCC also provided the majority of the manpower for National Forest Service fire suppression and timber stand improvement efforts. In the Canyon Creek watershed, the CCC constructed the Fall Mountain Lookout Tower, Wickiup Campground, and several roads.

4.4.7 Logging and Lumbering (1877- Present)

The earliest documented sawmill in the Canyon Creek watershed is the Dore Sawmill, which was in place in Canyon City by 1877 (Bradwell et al. 1958). The Dore Mill was located approximately twelve miles south of Canyon City and it supplied miners and settlers with lumber for buildings and timbers from mines. Between 1877 and 1906, six sawmills operated in the Canyon Creek watershed (Morrisette, pers.comm. 2002). The sawmills located near Canyon City at the end of the 19^{th} century were most likely capable of processing only small diameter logs due to technological limitations.

In the 1930s, a spur of the Hines Logging Railroad system was constructed over Starr Ridge and in to the Canyon Creek watershed (Armstrong 1984). The Canyon Creek watershed is located just north of the Bear Valley timber sale that was advertised in 1922. The Bear Valley sale involved 860,000,000 board feet of timber and is one of the largest timber sales ever completed in United States history. The Bear Valley timber sale was closed completely in 1967.

There have been 26 NFS-sponsored timber harvest, thinning, or vegetation management projects in the Canyon Creek watershed since 1970. The most recent vegetation management project in the watershed was the Parish Timber Sale.

4.4.8 Cultural Resources Summary

Since 1980, 197 cultural resource properties (CRPs) have been documented during the ten cultural resource inventories conducted within the Canyon Creek watershed. One hundred and seventy-five of the properties are related to prehistoric occupation of the watershed, twelve are related only to historic period activity, and eight display prehistoric and historic components. Nearly half the CRPs in the watershed are isolated finds (n= 96) that are not eligible for inclusion on the National Register of Historic Places (NRHP). There are 87 lithic scatter sites that are eligible, or are potentially eligible, for an NRHP listing (Keyser et al. 1988) within the watershed. Six historic sites have been identified within the Canyon Creek watershed and only one of these properties has been evaluated as eligible for an NRHP listing. Eight sites in the watershed possess prehistoric and historic components. All multicomponent sites in the watershed have been evaluated as eligible for the NRHP.

5-6 SYNTHESIS AND RECOMMENDATIONS

5-6.1 WILDLAND FIRE AND FUELS, VEGETATION: PLANT COMMUNITIES (ISSUES 1 AND 2)

The effects of wildland fire and vegetation management have altered the structure, composition, and functioning of vegetation within the watershed; therefore, Issue 1 (Wildland Fire and Fuels) and Issue 2 (Vegetation) will be grouped in the S*ynthesis* section of this chapter.

Issues 1 and 2, Key Question 1: What are the landscape level patterns and trends of plant communities and their associated fuel loads within the watershed, and how have these patterns changed through time?

Issues 1 and 2, Key Question 2: What have been the causes of landscape-level changes in the watershed, and how have these changes affected plant species composition, structure, fuel loads and continuity in the watershed?

Issue 1, Key Question 3: How have historic management practices altered the frequency, severity, magnitude, and ignition sources of wildland fires (the fire regime) within the watershed?

Issue 2, Key Question 4: How have historic management practices altered other natural disturbance regimes within the watershed?

5-6.1.1 Synthesis

5-6.1.1.1 Disturbances Defining Vegetation in the Watershed

In the Canyon Creek watershed and elsewhere in the intermountain west, vegetation structure, composition, and functioning have been shaped by a multitude of disturbance factors, all acting as a complex disturbance regime that has changed through time. Before Euro-American settlement, the majority of the Canyon Creek watershed was dependent upon fire and climate as "keystone" disturbance processes, or those processes that drive ecosystem dynamics. Since that time, anthropogenic disturbances, including mining, livestock grazing, and timber harvest, have added to the complexity of disturbances that shape vegetation within the watershed. Within the last 100 years, and more pronounced in the latter half of the century, another form of disturbance has emerged on the landscape that has defined and constrained decision-making by land managers. This "socioeconomic" or "political" disturbance, for ecological benefit and for detriment, has promoted or discouraged natural disturbance processes across the landscape, depending on changing political priorities through time. One key relationship where this disturbance has had the most pronounced effect has been on the exclusion of fire and intensities and methods of timber harvest.

Constraints that have defined timber harvest in the 20th century, through practice and through regulation, have promoted an ecological condition that is more often outside the historic range of variability in terms of structure and composition for the forests of the Canyon Creek watershed. The absence of fire within fire-dependent plant communities, in combination with timber harvest practices, has shifted the species composition and structure in two important ways. Timber harvest has generally led to the removal of fire-resistant overstory species and overstocking in the understory strata; the absence of fire has promoted late-seral, fire-intolerant species that out-compete early-seral, fire-tolerant species. The conditions created with these shifts in species composition and structure have encouraged other natural disturbance processes to manifest with greater severity from what would have been expected prior to the 20th century. Insects and diseases, chiefly spruce budworm and dwarf mistletoe, have increased to epidemic proportions in areas within the Canyon Creek watershed and in the Malheur National Forest as a whole. While important and certainly defining of forest dynamics, insects and disease outbreaks in the majority of the watershed (i.e., ponderosa pine forest potential, fire regime I) are a symptom of the loss of a keystone disturbance process – fire in a fire-dependant community.

5-6.1.1.2 Fire as a Keystone Disturbance Process

Fire is a keystone disturbance process that maintains several critical functions in ecosystems in the Blue Mountains. Fire maintains structural and species diversity, regulates plant succession and regeneration, reduces biomass, controls insects and disease populations, triggers animal-plant interactions, and maintains biological and biogeochemical processes (Crutzen and Goldammer 1993, Keane et al. 2002) (Table 5-6.1). Since Euro-American settlement (beginning in the 1850s), fire exclusion has been a leading cause of alteration in many of these key functions for the Canyon Creek watershed. This chapter presents a synthesis of the degrees by which fire exclusion has affected ecosystem functioning, provides recommendations for addressing important data gaps, and offers passive- and active-management options.

Table 5-6.1. Summary of landscape and stand-level effects of fire exclusion.

Scale	Ecosystem attribute	Fire exclusion effect
Landscape	Composition	Decrease in early seral communities, increased landscape homogeneity, increase in dominance of one patch type, and decreased patch diversity.
	Structure	Increase in patch evenness, patch size, patch dominance, and contagion.
	Disturbance	Larger and more severe fires, increase in crown fires, increased insect and disease epidemics, and increased contagion resulting in more severe insect and disease epidemics.
	Water Cycles	Increased water use, increase in drought, lower stream flows, increased water quality, and decreased stream sediment.
	Resources	Decreased visitation, visual quality, and viewing distance.
Stand	Composition	Increased number of shade-tolerant species, decreased number of fire-tolerant species, decreased forage quality, decreased plant vigor, and decreased biodiversity in plants and animals.
	Structure	Increased vertical stand structure, multistoried canopies, increased canopy closure, increased vertical continuity (fuel ladders), greater biomass, higher surface fuel loads, and greater duff and litter depths.
	Ecosystem processes	Slowed nutrient cycling, greater fire intensities and severities, increased chance of crown fires, increased insect and disease epidemics, short-term increase in stand productivity, decrease in individual plant vigor, and decreased decomposition. Increased leaf area, increased evapotranspiration, rainfall interception, autotrophic and heterotrophic respiration; increased snow losses (ablation).
	Soil dynamics	Decreased nutrient (N, P, S) availability, increased pore space and water-holding capacity, lower soil temperatures, increased hydrophobic soils, and increased seasonal drought.
	Wildlife	Increased hiding and thermal cover, increased coarse woody debris, lower forage quality and quantity, increased insects and disease, and decreased biodiversity.
	Resources	Decrease in aesthetics, increased timber production, decreased visitation, increased risk to human life and property, increased fire fighting efforts, and improved air quality.

Some of these attributes and effects were addressed in this watershed analysis (adapted from Keane et al. 2002)

5-6.1.1.3 Landscape-Level Effects of Fire Exclusion

To understand the extent to which fire severity has diverged from historic levels, the current live fuels condition (live fuels condition classes) of all forested upland and riparian stands was evaluated. In general, live fuels conditions were evaluated as having fires of non-lethal severity, mixed severity, or lethal severity (Table 5-6.2). For example, a stand having ponderosa pine potential (fire regime I) with old forest single-stratum structure (OFSS, condition class 1) would likely be subject to a ground-based fire and would burn with non-lethal severity. In contrast, the same stand having stem-exclusion, closed-canopy structure with a very dense understory of Douglas-fir and grand fir (condition class 3) would likely burn as a crown fire and have lethal severity. As a generalization, "non-lethal severity" fires would be associated with ground-based fires, "mixed severity" fires would have moderate degrees of crown entry, and "lethal severity" fires would be crown fires. Historical fire severity was assumed to be a live fuels condition class 1 for each fire regime (Table 5-6.2).

Table 5-6.2. Severity of fires expected for forested stands within the analysis area.

	Live fuels condition class		
Fire regime	***1***	***2***	***3***
I	Non-Lethal	Mixed	Lethal
III(a)*	Non-Lethal	Mixed	Lethal
III	Mixed	Lethal	Lethal
IV	Lethal	Lethal	
V	Lethal		

Stands were classified as having non-lethal, mixed severity, or lethal fires on the basis of their current live fuels condition classes and their historic fire regimes.

** A Fire Regime III(a) refers to a low intensity, long return interval fire (e,g,, ponderosa pine and low sagebrush).*

It is important to note that this evaluation of fire severity does not take into account downed and dead fuels because these data do not exist for the Canyon Creek watershed. The composition and structure of dead fuels is critical in predicting fire behavior and intensity because these fuels have the lowest moisture content of available fuels and hence directly influence the ignition, spread, and heat (intensity) of fire. An expected outcome of decades of timber harvest, overstocking, increased pathogen damage, and absence of fire is the accumulation of fine fuels, or those fuels less than three inches in diameter. The degree by which fine fuels, litter, and duff has accumulated will have a direct effect on the consequences of prescribed and wildland fire for two reasons: (1) fine fuels directly influence fire behavior and intensity (along with topography and weather) and (2) prolonged smoldering from litter and duff surrounding tree boles can lead to scorching of the cambium (increased tree mortality).

In addition to downed dead fuels data, it is important to consider the horizontal continuity of fuels when addressing fire behavior and severity at landscape scales. This analysis has used a stand-based approach of the expected divergence of historic fire behavior based upon live fuels and species composition only. The condition of neighboring stands has a considerable effect on landscape-level behavior of fire because fuels and topography influence how fire travels from one stand to another under certain weather conditions. This analysis does not address horizontal continuity of fuels because sufficient data were not available to ascertain fire behavior at the stand level. For these important reasons, it must be stressed that the effects of fire exclusion and the changes in predicted fire severity presented in this analysis are conservative estimates.

5-6.1.2 Forested Stands

5-6.1.2.1 Watershed Scale

The forests on NFS lands within the Canyon Creek watershed have moved away from their historic fire regimes (Figure 5-6.1). Current conditions are such that fires would likely burn with non-lethal severity in approximately 7% of the watershed, which is a dramatic decrease from the 37% expected prior to the 20th century. In contrast, current live fuels conditions indicate that about 44% of the watershed could burn with lethal severity crown fires, which is an increase from the historic range of approximately 21% (Map 5-6.1). These results suggest that the exclusion of fire has altered the composition, structure, and functioning of vegetation at the local and watershed scales, and the current conditions would likely support uncharacteristically severe wildland fires.

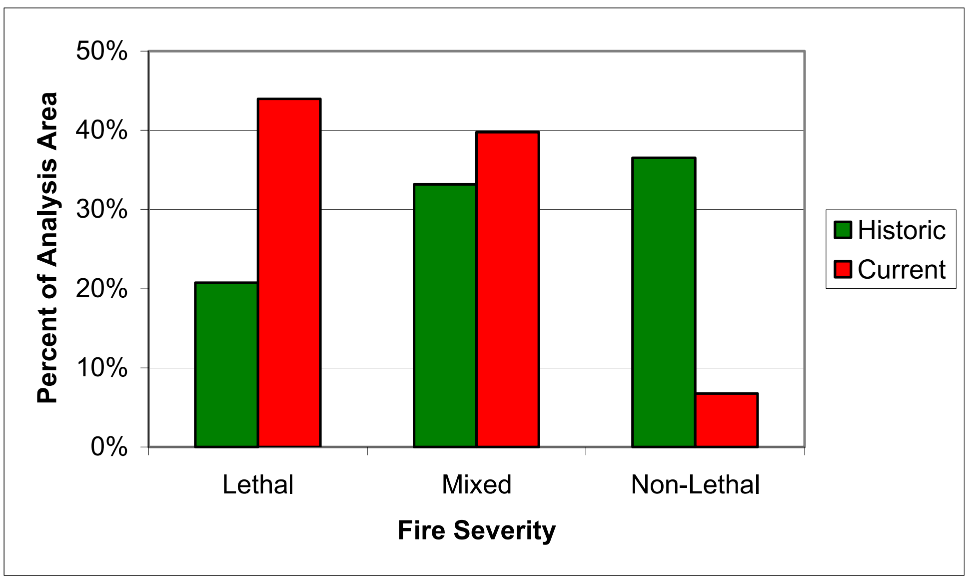


Figure 5-6.1. Expected fire severity for historic (pre 1850s) and current (2001) conditions for 53,906 (90%) acres of the analysis area.

The cumulative effects of management (especially fire exclusion and timber harvest) have resulted a shift in expected fire severity for 46% of the study area (27,108 acres) (Table 5-6.3). This shift has occurred in one of three ways: 1) from historically non-lethal to a mixed severity, 2) from historically mixed severity to a lethal severity, or 3) from historically non-lethal severity to a lethal severity. The majority of the affected stands have changed from potentially non-lethal to a mixed severity fire (13,284 acres, or 22% of the analysis area). In general, these are ponderosa pine stands that have shifted in structure from single-stratum to multi-strata stands, with moderate densities of Douglas-fir and grand fir in the understory strata. The live fuels condition of these stands would suggest moderate crown fire risk. Steep topography, high loads of dead fuels, insect damage, and disease are attributes that would increase the risk of crown fires in these stands.

Approximately 16% of the analysis area (9,374 acres) contains stands that have historically experienced mixed severity fires (fire regime III) but currently contain live fuels conditions that would promote lethal, crown fires (Table 5-6.3). These stands are predominantly Douglas-fir and warm grand fir forest types that are in young forest (YFMS) or stem exclusion structural stages (SECC). Generally, these stands have dense tree covers in the middle and lower strata and have high probabilities of sustained crown fires. Several of these stands also contain minor components of large-diameter ponderosa pine trees, which suggests that timber harvest may have dramatically changed the composition and structure of these stands away from historic ponderosa pine potential stands (fire regime I). Pathogen loads and mortality and fuel loading in these stands are expected to be high. Ground-truth analysis of aerial photograph interpretation as well as stand-specific fuels data and pathogen levels is recommended to clarify the condition of these stands.

Table 5-6.3. Changes in expected fire severity between historic (pre 1850s) and current (2001) conditions for forested stands within the analysis area.

Historic fire severity	***Current fire severity***	***Acres***	***Percent of analysis area***
Non-Lethal	Mixed	13,284	22%
Mixed	Lethal	9,374	16%
Non-Lethal	Lethal	4,450	7%
Total Acres		27,108	46%

Values are for 53,906 acres (90%) of the analysis area.

The most severe changes in live fuels conditions occurred in 4,450 acres (7% of the analysis area) with alterations from historically non-lethal ground fires to a high probability of lethal crown fires (Table 5-6.3). These were primarily ponderosa pine stands that have undergone dramatic changes in structure and species composition. One such change involved the dominance of a very dense understory of Douglas-fir and grand fir in a stem exclusion structural stage (SECC). Another stand type involved ponderosa pine stands that were in fringe environments (i.e., mountain big sagebrush) that have been densely colonized with young ponderosa pine and western juniper in the mid-story stratum. Both of these stand types have undergone changes due to fire exclusion and both have a live fuels condition that would likely support continuous crown fires. It also follows that stands with dense understories of shade-tolerant trees would promote higher degrees of insect and disease infestation and would therefore be at even higher risks for fires of lethal severity. Further site-specific review of fuels composition and structure is recommended to ascertain catastrophic fire risk in these stands.

5-6.1.2.2 Wildland/Urban Interface (WUI)

A total of 30,197 acres of NFS lands were evaluated for changes in fire severity within the Wildland/Urban Interface (WUI, see *Chapters 1 and 3* for more discussion). Similar to the watershed as a whole, the forest environments in the WUI have dramatically changed from the historic species composition and structure that are representative of their historic fire regimes (Figure 5-6.2). The current live fuels conditions suggest a marked decrease in potential for non-lethal fires, from 52% to 8% of the WUI. The potential for lethal crown fires crossing subwatershed boundaries in the WUI has increased from historic conditions. Approximately one-third of the WUI (31%) have live-fuels conditions that would likely promote crown fires, which is a large increase from the 5% of the WUI expected prior to the 20th century. The live fuels conditions within the WUI have been considerably altered from historic conditions, and currently pose a serious risk for catastrophic wildland fires. Considering the extreme divergence from historic conditions, other effects of fire exclusion are likely in the WUI (Table 5-6.3), particularly increased fuels loading and increases in insects and disease.

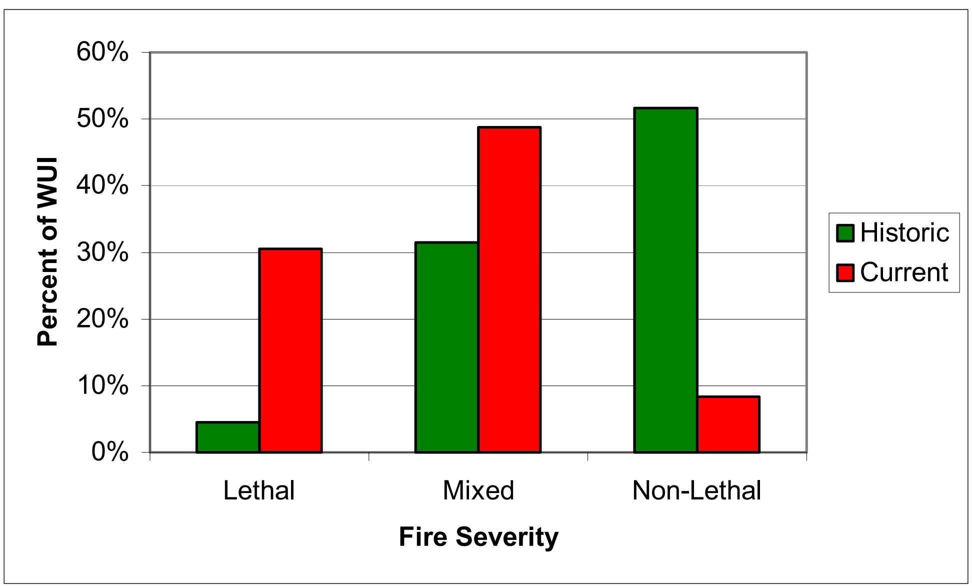


Figure 5-6.2. Expected fire severity for historic (pre 1850s) and current (2001) conditions for 30,197 acres within the 34,460-acre wildland/urban interface (WUI) on NFS lands.

The majority of the WUI has undergone a dramatic alteration of structure and live-fuels conditions to the extent that now 58% of the area (20,419 acres) will no longer support the historic fire regimes without becoming an uncharacteristically severe wildfire (Table 5-6.4). Most of this land area contains ponderosa pine stands with multi-strata or stem exclusion stage structure and contains high proportions of shade-tolerant species (i.e., Douglas-fir and grand fir) in the understory strata. Approximately one-third of the WUI

(11,189 acres, or 32%) are stands with elevated levels of live-fuels that would promote mixed severity fires from historically non-lethal (ground fire) conditions. Expected fuels loading and insects and disease damage associated with dense understory canopies would increase the likelihood of crown fires in these stands. Further site-specific analysis of fuels structure and degree of insect and disease damage is needed to model the fire behavior of these stands to ascertain the risk of catastrophic wildland fires.

Table 5-6.4. Changes in expected fire severity between historic (pre 1850s) and current (2001) conditions for forested stands on NFS lands within the WUI.

Historic severity	Current severity	Acres	% of NFS land within the WUI
Non-Lethal	Mixed	11,189	32%
Mixed	Lethal	5,320	15%
Non-Lethal	Lethal	3,729	11%
Total Acres		20,149	58%

Figures are for 20,149 acres of the 30,197-acre NFS land within the wildland/urban interface (WUI).

Approximately 15% of the WUI (5,320 acres) that has historically experienced mixed severity fires (i.e., Douglas-fir stands on north-facing slopes) currently have live fuels conditions that would support lethal crown fires (Table 5-6.4). In general, these stands have elevated levels of understory biomass in shade-tolerant species that would be typical of a mixed severity fire regime (fire regime III). The cumulative effects of management (fire exclusion and timber harvest) have modified the species composition to contain more grand fir in the understory and an elevated level of dead fuels. Fire exclusion and timber management activities have promoted multi-strata forest structure with high socking levels in the understory. Insects and disease, particularly spruce budworm, bark beetles, and dwarf mistletoe, have contributed to increased fuels loading in these Douglas-fir stands, particularly in the Vance Creek subwatershed (Spiegel and Schmitt 2002). The combined effects of increased live and dead fuels have promoted conditions that would support uncharacteristically severe wildland fires.

Approximately 11% of the WUI has undergone appreciable changes in vegetation structure and composition because of timber harvest and fire exclusion (Table 5-6.4). These 3,729 acres have historically supported non-lethal ground fires and now contain dense live ladder fuels structure that would promote crown fires. Similar to watershed-level patterns, these ponderosa pine stands exhibit one of two major effects of fire exclusion. The first involves a dense understory growth of shade-tolerant species, which contains live fuels structures that are very dense in the understory and have likely encountered moderate degrees of other fire exclusion effects, including disease and insect outbreaks, increased fuels loading, etc. Another stand type involves encroachment of conifers in marginal ponderosa pine stands or fringe shrublands, which is the result of decades of successful regeneration of ponderosa pine and western juniper in the understory, and these stands have undergone conversion from open, "park-like" conditions to dense conifer understory conditions. The abnormally high levels of live and presumably dead fuels in the understory would promote crown fires and a high likelihood of secondary mortality from girdling from smoldering duff.

5-6.1.2.3 Non-Federal Ownership Areas

Although not within the scope of this analysis, the private landholdings within the Canyon Creek watershed have likely undergone similar changes in stand dynamics to what has been described in earlier sections. Management activities on non-industrial forestlands have historically involved large-diameter timber harvest and often have not followed with treatments to avoid overstocking conditions (such as thinning and/or prescribed fire). These types of harvest practices promote high fuels loading, through insect and disease outbreaks (dead fuels) and through the overabundance of regenerating trees with low live crown heights (live fuels). Although private land managers have recently made considerable efforts to minimize fuels loading on privately-held timberlands, the combined effects of historic land management on private and public lands has altered the historic fire regimes to promote more severe fire conditions. Because of their proximity and connectivity to federal lands, the condition of lands under non-federal ownership will have a considerable impact on fire behavior in the WUI.

5-6.1.3 Other Areas of Concern

5-6.1.3.1 Riparian Zones

Although riparian forests were considered in the analysis of landscape-level effects of fire exclusion (previous section), riparian zones are unique in how they respond to fire and in their importance for aquatic resources. Low-intensity ground fires that carry through riparian zones often damage or kill the low-lying aboveground vegetation (i.e., shrubs, deciduous trees, grasses and sedges). These fires act as a stimulus to plant growth, as post-fire conditions result in an increase of available nutrients (particularly nitrogen, phosphorous, and sulfur) and available light resources. In riparian meadow environments, frequent fires moderate the degrees of conifer encroachment from adjacent uplands and retain the connectivity of the riparian floodplain environment. Currently, no data as to the species composition of riparian floodplains exist for the Canyon Creek watershed.

In the process of reintroduction of fire as a disturbance process, it is important to consider that there is an increased risk of stand-replacement wildfires in the watershed. Under these uncharacteristically severe conditions, fires in riparian zones will not likely function as natural firebreaks and hence will experience hot, stand-replacing wildfires. The loss of canopy and riparian shading increases stream temperatures (Beschta and Taylor 1988); both stream temperature and shading have been identified as factors affecting fish populations in the watershed. For the short term, it is recommended that restoration efforts in upland environments do not further degrade the quality of stream shading found in the watershed. Restoration of riparian vegetation is an important long-term goal for the stability and health of aquatic ecosystems.

5-6.1.3.2 Shrublands and Grasslands

No data exist for the historic structure or composition of shrublands or grasslands within the Canyon Creek watershed. Grazing history information was also not available, so history and intensity of livestock grazing and the associated effects on aboveground structure, species composition, or exotic species introduction could not be evaluated.

Forested stands in the Canyon Creek watershed have shown clear evidence of aforestation of late-seral species as a result of management (fire exclusion and timber harvest). Like riparian meadows, conifer encroachment is also a probable outcome in grasslands and shrublands of the Canyon Creek watershed. In the analysis of potential vegetation groups (PVGs), further review of aerial photographs suggested 455 acres of shrublands and 277 acres of grasslands had at least 10% canopy closure of western juniper (see *Juniper Encroachment* section of *Chapter 3*, Table 3-45). Similarly, the forested ponderosa pine stands with marginal cover (~15% canopy closure) in the watershed may have had shrubland or grassland potential vegetation. The degrees of conifer encroachment by western juniper, ponderosa pine, and other conifers is recommended to assess rangeland ecosystem health within the Canyon Creek watershed.

5-6.1.3.3 Quaking Aspen

In general, quaking aspen stands are becoming more isolated and fewer in number, and their distribution has been on the decline in the past century. Because fire is a stimulus for their growth, the absence of fire has limited the production of emerging sprouts. In addition, fire exclusion has allowed for the successful competition of conifers to reach the overstory, limiting light resources for aspen. Grazing of emerging shoots by livestock is another major limiting factor affecting aspen. Exclosures, removal of conifer shade, and the reintroduction of fire in these fire-dependant ecosystems are all pathways to restore quaking aspen in the watershed.

5-6.1.3.4 Federally Listed Plant Species

Although only one plant species was documented in the Canyon Creek watershed, it is likely the topographically diverse landscape and expansive wilderness area could harbor other plant species of interest or concern. A plant survey, required before a substantive ground-disturbing activity takes place, would reveal populations of sensitive species if they are present. Increases in biodiversity is one expected outcome with the reintroduction of natural, keystone disturbance processes in the ecosystem.

5-6.1.4 Summary of Recommendations

5-6.1.4.1 Minimize Risks of Catastrophic Wildfire and Restore Fire as a Disturbance Process

This watershed analysis has presented the combined effects of management at the landscape level, especially how fire exclusion and timber harvest have changed the composition, structure and functioning of forest stands. Management activities have resulted in overstocked understory conditions, with increased dominance of late-seral species, increases in mortality due to insects and disease, and a decline in forest health. Ultimately, these conditions translate to elevated risks for uncharacteristically severe wildland fires (catastrophic wildfire) compared with historic conditions, especially within the WUI. Reintroduction of fire as a keystone disturbance process in the Canyon Creek watershed would have a pronounced beneficial effect on forest health for the long term. However, before historic fire regimes can be properly restored, the current condition of stands must be verified. After which time, answering the question of how fire will behave can be better understood. This understanding can then be applied as prescriptions for healthy forest stands.

The proportion and magnitude of effects of fire exclusion presented in this watershed analysis has been conservative, as many key factors that influence fire behavior – primarily the horizontal and vertical continuity of fuels – have not been addressed because data are not available. The following are data gaps that would increase our understanding of fire behavior in the Canyon Creek watershed.

5-6.1.4.1.1 Data Gaps

- ***Downed and Dead Fuels.*** Quantify the structure and composition of downed and dead fuels, including litter and duff. Sampled stands should be prioritized based on areas of highest concern for catastrophic wildfires identified in this watershed analysis. Horizontal and vertical continuity of fuels is a critical data gap in understanding fire behavior. An analysis of fuels and topography under different weather scenarios is recommended using models to predict fire behavior. Modeling fire behavior on landscape scales (using tools such as BEHAVE and FARSITE) will provide managers with target areas in need of treatments to minimize catastrophic fire risk. It is suggested data collection can be streamlined to select areas needing fuels reduction treatments (particularly in the WUI). However, the efficacy of models predicting fire behavior is dependent upon the intensity of site-specific data collected.
- ***Live fuels structure.*** Although data collected from aerial photographs has provided the information necessary to make coarse structural classifications, it is recommended stand-level inventories be completed for target areas. In addition to downed and dead fuels, live fuels influence the behavior and severity of fires. Variables including base to crown height ("ladder fuels") and validation of plant associations, in addition to stand structure and species composition, are important for predicting the risk of crown fires and the dynamics of stand development. These data

are useful in implementing stand-specific treatments for minimizing fire risk and assuring long-term ecosystem health.

5-6.1.4.2 Restore Stand Structure to Resemble Historical Range of Variability (HRV)

In the process of restoring fire as a disturbance process in the watershed, it is recommended that management focus on reversing the long-term effects of timber management and fire exclusion. Particularly for areas within the WUI, overstocking of shade-tolerant, fire-intolerant species in the understory and subsequent increases in pathogen loading have created conditions that are outside the historical range of variability within the watershed (*Chapter 4*). Although the data gaps mentioned in the previous section are important for quantifying stand-specific treatment alternatives, one of two general recommendations can be made to reduce stands to their historic structural and compositional ranges of variability:

- Prescribed burning to reduce elevated loads of fine fuels that have accumulated over time
- Mechanical reduction of fuels (via thinning, mowing or pruning) to minimize vertical fuel ladders, followed by prescribed burns to reduce ground fuels

The overall goal for these treatments should be to shift the current structural and compositional trends from aforestation of shade-tolerant species (overstocked conditions) to species compositions and structures that are within the HRV for each vegetation type (see *Chapter 4*). One common example that illustrates this condition is to promote old forest single-stratum structure within ponderosa pine stands and reduce the high levels of Douglas-fir and grand fir found in the mid-story strata. In some instances, the use of prescribed fire may be sufficient in limiting understory biomass and fuels; in other instances, mechanical thinning will need to be used before the introduction of fire. Because of the structural, compositional, and topographic diversity of the Canyon Creek watershed, more in-depth analysis and planning are recommended to reduce the risks of catastrophic wildland fire and restore historical conditions.

It is very likely that decades of fire exclusion and multiple management practices have led to an understory structure that has economic value. It is recommended that NFS specialists be engaged with community leaders and the local timber industry to evaluate the economic viability for small-diameter wood products. In addition, any future timber harvest planning should consider the ecological requirements inherent with the historic fire regime for targeted stands. While timber harvests clearly alter the structure of stands, the removal of fire from fire-dependant communities has long-lasting and costly effects that affect forest health and the human environment. In essence, timber harvest acts as a tool and not a surrogate for the restoration of forest stands.

Because of the proximity and continuity of non-federal lands to federal lands within the WUI, it is important to involve these landholders in the greater treatment design. It is recommended that homeowners follow recommendations under the FIREWISE program (www.firewise.org). These include creating a "survivable space" around buildings and structures, where fuels are limited to minimize ignition and risk of fire spread. Non-industrial forest landholders should incorporate the general recommendations presented here in minimizing overstocked conditions and vertical fuel ladders.

5-6.1.4.3 Minimize Conditions that Promote Uncharacteristically Severe Insect and Disease Outbreaks

One of the compounding effects of removing fire from fire-dependant ecosystems is an increase in insect and disease activity (Keane et al. 2002, Powell 1994). An overstocked condition in the understory strata, especially in harvested units, has led to increases in a suite of pathogens, including spruce budworm, bark beetles, and dwarf mistletoe (see *Chapter 3*). Disturbance by insects and diseases are a natural occurrence and help to moderate fire behavior at local scales. However, the severely altered conditions in forest structure and composition have promoted conditions that support landscape-scale outbreaks of pathogens. Treatment options that promote the historic ranges of composition and structure are recommended. However, treatment options are highly site-specific, as pathogens respond differently to like treatments.

- Prioritize stands at risk of elevated insect damage and disease for restoration treatments with the goal of restoring the stand structure and composition described by the HRV for each vegetation type (e.g., favor old forest single-stratum for ponderosa pine stands). Collect data on stand structure, fuels, and pathogen species in these stands and evaluate mechanical treatment options.
- Incorporate the processes that help to maintain HRV structure and composition (use of prescribed fire in addition to mechanical treatments may be necessary to revert pathogen populations to historic levels and distributions)

5-6.1.4.4 Noxious and Exotic Plant Species

Other than potential conifer encroachment, the conditions of grasslands and shrublands are not known, especially for shifts in species dominance away from native species toward complexes of invasive species (especially annual cheatgrass). It is therefore recommended that any and all rangeland condition data be consolidated and evaluated for several factors:

- ***Range condition.*** Address the condition of the shrublands and grasslands within the Canyon Creek watershed for their proportion of exotic species. Evaluate the grazing history and current allotments.
- ***Reduce conifer encroachment into rangelands.*** The reintroduction of fire as an important disturbance process will undoubtedly reduce the levels of conifer encroachment into rangelands, especially young western juniper. It is important, however, to understand the degree of invasion by exotic species (particularly cheatgrass) in the process.

- ***Create a watershed-level inventory*** and map the distribution and abundance of non-native plant species of concern.

5-6.1.4.5 Aspen Stands

- No ground-truth information is known to exist for quaking aspen stands. Thirteen stands were identified from aerial photographs where quaking aspen was present. It is recommended that aspen groves and individual clones be mapped throughout the watershed. Restoration of fire as an historic disturbance process and control of livestock grazing will have a positive effect on quaking aspen. Short-term solutions involve large exclosures and removal of coniferous shade.

5.2 AQUATIC SPECIES AND HABITAT (ISSUE 3)

This section provides a synthesis that answers key questions first listed in *Chapter 2* and repeated below. This section identifies how aquatic habitats differ from reference conditions or from habitat standards determined by the Malheur National Forest. In addition, the synthesis reveals how and where habitat problems exist. Recommendations as to how habitat improvement may occur are listed near the end of the chapter. Finally, data gaps that were identified during this analysis are discussed.

Key Question 1: What are the long-term patterns and trends of the riparian and aquatic ecosystems within the watershed and what factors are limiting to the success of aquatic species?

Key Question 2: What have been the causes of changes in riparian and aquatic ecosystems within the watershed?

5-6.2.1 Synthesis

5-6.2.1.1 In-stream Habitat Characteristics

Federal land managers decide, within the constraints of current laws and under direction of the Aquatic Conservation Strategy, how to manage federal lands to ensure the long-term viability and health of aquatic ecosystems. To that end, the Malheur National Forest Land and Resource Management Plan, Amendment 29 is used as a guide to the range of desired future conditions (DFC) within aquatic ecosystems (Table 5-6.5). Aquatic habitat surveys are conducted to understand the current conditions of aquatic resources and the results of those surveys are summarized to determine if the current conditions meet the DFCs on a pass or fail basis.

For this watershed analysis, aquatic habitat survey data was summarized in SMART and the results were evaluated according to Amendment 29 DFC standards. Attributes that had missing data for a particular reach were reported as unknown. Some inconsistencies occurred when evaluating survey data against the Amendment 29 standard. For example, substrate must be embedded by less than 21% to pass Amendment 29. Yet surveyors rated substrate at a threshold of 35%. Any reach that had less than 35% embedded substrate to pass the standard was considered.

Table 5-6.5. Malheur National Forest Amendment 29 standards used to rate data collected for attributes during early 1990s stream surveys in Canyon Creek watershed.

Attribute	Amendment 29 standard
Bank Stability	> 89%
Cobble Embeddedness	< 21%
Large Wood Debris/mile[1]	80 – 120/mile
Wetted Width/Depth	< 10
Ground Cover	> 89%
% Stream Bank Vegetated	90% of site potential
Shade Canopy Closure	50% - 65% Closure
Instantaneous Temperature	≤ 68^{o} F

Pool frequency (based on bankfull width)

Bankfull width	Pools / mile (to pass)
5	151 – 264
10	75 – 132
20	38 – 66
25	15 – 26
50	10 - 23
75	10 – 23
100	8 - 18
125	6 - 14
150	5 – 12
200	4 - 9

[1] Based upon mixed conifer forest standards.

Canyon Creek Watershed. Six reaches were evaluated using Amendment 29 standards in the main stem of Canyon Creek (Table 5-6.6). Seventy-five percent of the attributes rated along wilderness reaches passed Amendment 29 standards. The reaches outside of the wilderness illustrated generally poorer conditions than the wilderness reaches. Three reaches failed the standard for embedded substrate. These reaches were investigated to determine whether a dense network of native material roads built on highly erosive soils bordered these reaches (Map 3.6). The only reach that failed for embedded substrate and was adjacent to the road condition described above was SMART Reach 3. However, within the rest of the reaches, there is no apparent relation between road density, soil erosive properties, and embedded substrate.

Table 5-6.6. Attributes from the early 1990s stream surveys for Canyon Creek.

	SMART reach number					
Canyon Creek attribute	***1***	***2***	***3***	***5***	***Canyon Wilderness R1***	***Canyon Wilderness R2***
Cobble Embeddedness	Passed	Passed	Failed	Failed	Failed	Passed
Bank Stability	Unknown	Unknown	Unknown	Unknown	Passed	Passed
% Stream Bank Vegetated	Failed	Passed	Passed	Passed	Failed	Passed
Ground Cover	Unknown	Unknown	Unknown	Unknown	Passed	Passed
Pool Frequency	Passed	Passed	Failed	Failed	Passed	Failed
Large Wood Debris	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Passed	Mixed Conifer/ Passed	Mixed Conifer/ Failed
Potential LWD Determined from PI	Failed	Failed	Failed	Failed	Passed	Failed
Shade Canopy Closure	Failed	Failed	Failed	Failed	Passed	Passed
Shade Canopy Determined by PI	Failed	Failed	Failed	Failed	Passed	Passed
Instantaneous Temperature	Failed	Passed	Failed	Passed	Passed	Passed
Width/Depth	Passed	Passed	Passed	Passed	Passed	Passed
% of Attributes Failing Standard	63%	38%	63%	50%	25%	25%
Rosgen Stream Type	G/C	G/C	B	B	A	Aa+
Fish Species Present	ONCL/ONMY	ONCL/ONMY	ONCL/ONMY	ONCL/ONMY/ SAFO	ONCL/ONMY/ SAFO	ONCL/ONMY/ SAFO

Attributes in each surveyed reach were rated according to the Malheur National Forest LRMP Amendment 29 standards to determine if the attribute passed or failed the standard.

Three of six reaches passed the standards for pool frequency. These reaches should provide adequate in-stream diversity for rearing fish. In summer, pools may provide a cool resting area; during winter, fish move into the interstitial spaces within the pools' gravels. The pool frequency agreed in 50% of the reaches with the number of pieces of LWD/mile. Since there is no data to describe pool creators, it is not known how important wood is to forming pools in this system.

Comparisons were made of the field survey of LWD and the remotely sensed LWD survey. There was 83% agreement between these two independent surveys. Also compared were field survey results for shading against the remote survey; 100% agreement was found. Shade canopy closure decreased as the creek flowed downstream away from the wilderness.

A review was made of tree size in terms of LWD recruitment in the two wilderness reaches. Although there was little detectable difference in tree size along either reach, the furthest upstream reach had a lower density of large diameter trees growing along it. The second wilderness reach is near timberline and probably has thinner soils and a reduced growing season, which results in fewer large diameter trees.

Since steelhead/redband, and cuttroat trout pass through all or part of their life cycle in these reaches, further monitoring is needed to determine if these reaches are capable of functioning at the DFC. The habitat within this system illustrates a high degree of fragmentation. One goal of the Aquatic Conservation Strategy is to maintain and restore connectivity to aquatic systems. The reaches outside the wilderness in this subwatershed are not meeting this goal.

Middle Fork Canyon Creek Subwatershed. Six reaches were surveyed along the mainstem of Middle Fork Canyon Creek (Table 5-6.7). The wilderness reach had the least amount of attributes fail Amendment 29 standards (40%) while 57% of the attributes rated in the non-wilderness reaches failed the standard. An investigation was made of the relation between native material roads built on highly erosive soils and embedded substrate; no strong relation between the two was found (Map 3.6). For example, SMART Reach 5 failed for embedded substrate. This reach overlies soil types where the potential erosion factor is considered Low – Moderate and road density is very low.

In pool frequency, all reaches considered in Table 5-6.7 failed the Amendment 29 standards. The number of pieces of LWD/mile also failed for all six reaches. Only the wilderness reach passed the standard for remotely sensed LWD recruitment. An explanation cannot be made concerning the interaction of pools and LWD in these reaches because pool creator data is not available. There was a 67% agreement between the number of pieces of LWD counted in the stream and near-term LWD potential. There was 100% agreement between the field shade survey and the remote shade survey, and only the wilderness reach passed for shading.

The data presented in Table 5-6.7 indicate that the six reaches along the mainstem Middle Fork of Canyon Creek were not functioning well as fish habitat. Few pools, a lack of in-stream LWD, and insufficient shade imply stressful conditions for fish and potential impairment of the long-term survival of the aquatic species within these reaches.

Tributaries to Middle Fork of Canyon Creek. Three of the four reaches evaluated in Table 5-6.8 are tributaries to the Middle Fork of Canyon Creek and are located within the wilderness boundaries. SMART Reach 1 is the exception. Each tributary was surveyed as a single reach.

Thirty percent of the attributes in Tributary 6 failed the Amendment 29 standards. Tributary 7 had the highest percentage of attributes fail (60%). All tributaries passed the standard for embedded substrate.

Each tributary failed for pool frequency, the number of pieces of LWD/mile, and near-term LWD recruitment, while two reaches failed for shade canopy closure. The remote data for LWD recruitment revealed a high quantity of small diameter trees in the riparian zone. These are high elevation streams where stressful conditions, in terms of soils depth and climatic factors, inhibit the growth of large diameter trees. In the absence of pool creator data, no determination can be made of the interaction between LWD and pools in these reaches. There was 100% agreement between the near term remote LWD survey and the LWD field survey, whereas 50% agreement occurred between the remote shade survey and the field shade survey.

Redband/steelhead and cutthroat trout inhabit all these tributaries except for Tributary 1. Tributary 4 and 6 are approaching the DFCs explained in Amendment 29. Tributary 7 is furthest from the DFCs. Pools and the absence of large wood appears to be the limiting factors for fish in these streams. Since these are high gradient streams with step-pool morphology, pool creator mechanisms are probably boulders and rock. Young fish may select these reaches for rearing, and higher gradient reaches like these with clean substrate may be essential spawning habitat. Further monitoring of habitat and fish presence/absence would provide critical data on when and how fish use these reaches.

Table 5-6.7. Attributes from early 1990s stream surveys for Reaches 1 – 5 and the wilderness reach of the Middle Fork of Canyon Creek.

Middle Fork Canyon Creek	***Reach number***					
Attribute	***1***	***2***	***3***	***4***	***5***	***Wilderness reach 1***
Cobble Embeddedness	Passed	Passed	Passed	Passed	Failed	Passed
Bank Stability	Unknown	Unknown	Unknown	Unknown	Unknown	Passed
% Stream Bank Vegetated	Passed	Passed	Passed	Passed	Passed	Failed
Ground Cover	Unknown	Unknown	Unknown	Unknown	Unknown	Passed
Pool Frequency	Failed	Failed	Failed	Failed	Failed	Failed
Large Wood Debris	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed
Potential LWD Determined from PI	Failed	Passed	Failed	Failed	Failed	Passed
Shade Canopy Closure	Failed	Failed	Failed	Failed	Failed	Passed
Shade Canopy Determined by PI	Failed	Failed	Failed	Failed	Failed	Passed
Width/Depth	Failed	Failed	Failed	Passed	Passed	Failed
Instantaneous Temperature	Passed	Passed	Unknown	Unknown	Unknown	Passed
% of Attributes Failing Standard	63%	50%	71%	57%	57%	40%
Rosgen Stream Type	B	B	A	A	A	A
Fish Species Present	ONCL/OMNY	ONCL/OMNY	ONCL/OMNY	ONCL/OMNY	ONCL/OMNY	ONCL/OMNY

Attributes in each surveyed reach were rated according to Malheur National Forest Amendment 29 standards to determine if attribute passed or failed standard.

Table 5-6.8. Attributes from early 1990s stream surveys on Middle Fork of Canyon Creek Tributaries 1, 4, 6, and 7.

Middle Fork Canyon Creek	***Reach number***			
Attribute	***T1***	***T4***	***T6***	***T7***
Cobble Embeddedness	Passed	Passed	Passed	Passed
Bank Stability	Passed	Passed	Passed	Passed
% Stream Bank Vegetated	Passed	Passed	Failed	Failed
Ground Cover	Passed	Passed	Passed	Failed
Pool Frequency	Failed	Failed	Failed	Failed
Large Wood Debris	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/Failed
Potential LWD Determined from PI	Failed	Failed	Failed	Failed
Shade Canopy Closure	Failed	Passed	Passed	Passed
Shade Canopy Determined by PI	Failed	Failed	Passed	Failed
Width/Depth	Passed	Failed	Passed	Failed
Instantaneous Temperature	Passed	Passed	Passed	Passed
% of Attributes Failing Standard	40%	40%	30%	60%
Rosgen Stream Type	A	Aa+	Aa+	A
Fish Species Present	NONE	ONCL	ONCL/OMNY	ONCL/OMNY

Attributes in each surveyed reach were rated according to the Malheur National Forest Amendment 29 standards to determine if the attribute passed or failed the standard.

Vance Creek Subwatershed. Seventy-one percent of the attributes rated in each of the three reaches in the Vance Creek subwatershed failed the DFC standards explained in Amendment 29 (Table 5-6.9)

Two reaches failed the standard for embedded substrate, possibly caused by the dense network of native material along roads that surround these reaches. All reaches met the standard for percent of stream bank vegetated. Anecdotal information describes the streambanks along these reaches as being choked with shrubs.

All streams failed the standard for the number of pools/mile, LWD pieces/mile, and near term LWD recruitment potential. There was 100% agreement between the surveyed LWD data and the remotely sensed LWD data as both failed in each reach. According to the stream survey data for shade canopy closure, all streams failed, while Reach 1 passed for shade canopy closure using the remotely sensed data.

Vance Creek subwatershed has been disturbed by management activities including grazing, diversion boards, road building, and clearcut logging. The cumulative effects of these land use activities has resulted in degraded aquatic habitat. Yet the cool temperatures found in Vance Creek, possibly the result of springs and sub-surface flow, coupled with the closeness in proximity to the mainstem John Day River may create a foundation for restoring these reaches. Simple approaches that increase the number of pools could create better summer rearing habitat. The heavy sediment loading will be difficult to control and may impede efforts to restore these reaches as viable spawning streams.

Table 5-6.9. Attributes from early 1990s stream surveys on Vance Creek tributaries 1, 2, and 3.

Vance Creek	***Reach number***		
Attribute	***1***	***2***	***3***
Cobble Embeddedness	Failed	Passed	Failed
Bank Stability	Unknown	Unknown	Unknown
% Stream Bank Vegetated	Passed	Passed	Passed
Ground Cover	Unknown	Unknown	Unknown
Pool Frequency	Failed	Failed	Failed
Large Wood Debris	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed
Potential LWD Determined from PI	Failed	Failed	Failed
Shade Canopy Closure	Failed	Failed	Failed
Shade Canopy Determined by PI	Passed	Failed	Failed
Width/Depth	Passed	Failed	Passed
Instantaneous Temperature	Unknown	Unknown	Unknown
% of Attributes Failing Standard	71%	71%	71%
Rosgen Stream Type	G/B	G/B	A
Fish Species Present	OMNY	OMNY	OMNY

Attributes in each surveyed reach were rated according to the Malheur National Forest Amendment 29 standards to determine if the attribute passed or failed the standards.

Crazy, Fawn, and South Fork of Vance Creeks. The attributes evaluated in Crazy Creek, Fawn Creek, and the South Fork of Vance Creek failed Amendment 29 standards by 40%, 62%, and 100%, respectively. Each reach considered here failed for embedded substrate. Dense road networks bordered each reach on a variety of soil types.

Pool frequency, LWD pieces/mile, and near-term recruitment potential failed the standard on all reaches in Table 5-6.10. There was 100% agreement between the remote LWD survey and the field LWD survey data in all three reaches. In-stream habitat diversity appears low with too few pools present, while LWD is generally in short supply with little future near-term recruitment potential. Small hardwoods and shrubs provide adequate shade to Crazy and Fawn Creeks, but the South Fork of Vance Creek has little shade.

Fish are not considered to be present in the South Fork of Vance Creek and Fawn Creek. It is assumed that at one time several fish species inhabited these creeks. Yet the current condition of the South Fork of Vance Creek makes it a low priority for restoration. Fawn Creek is a bit closer to the DFCs explained in Amendment 29; however, intense management (timber, livestock) in the subwatershed suggest it also is a low priority for restoration. Further monitoring of these two creeks could help determine if the conditions in these creeks have changed to warrant restoration efforts.

Since Crazy Creek currently supports cutthroat and redband/steelhead trout and 60% of its attributes meet the DFCs of Amendment 29, it may be a candidate for restoration efforts. It is a high gradient stream with a step-pool morphology and the absence of LWD may not be a problem; boulders and bedrock may be the primary pool creators. Step-pools do not often span the channel, so the survey data may not reflect the actual conditions in the creek because survey criteria require that pools are only counted if they span the entire channel. Further survey and monitoring needs to occur to understand the types of restoration projects that would improve the aquatic habitat within these streams.

Table 5-6.10. Attributes from early 1990s stream surveys on Crazy Creek, Fawn Creek, and South Fork Vance Creek.

Creek attribute	***Crazy Creek***	***Fawn Creek***	***South Fork Vance Creek***
Cobble Embeddedness	Failed	Failed	Failed
Bank Stability	Passed	Unknown	Unknown
% Stream Bank Vegetated	Passed	Failed	Failed
Ground Cover	Passed	Unknown	Unknown
Pool Frequency	Failed	Failed	Failed
Large Wood Debris	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed
Potential LWD Determined from PI	Failed	Failed	Failed
Shade Canopy Closure	Passed	Passed	Failed
Shade Canopy Determined by PI	Passed	Passed	Unknown
Width/Depth	Passed	Passed	Failed
Instantaneous Temperature	Passed	Passed	Unknown
% of Attributes Failing Standard	40%	62%	100%
Rosgen Stream Type	A	A	A
Fish Species Present	ONCL/ONMY	NONE	NONE

Attributes in each surveyed reach were rated according to the Malheur National Forest Amendment 29 standards to determine if the attribute passed or failed the standard.

5-6.2.1.2 Deep Pools

During the stream surveys in the early 1990s, pools were measured for their depth. Deep, large pools are important loci for thermal regulation and buffering. Deep pools buffer temperature extremes and provide areas of low stream energy to reduce physiological stress on fish. Deep pools signal a stable river system. In contrast, a lack of deep pools may signal stream aggradation. Aggradation occurs when streams lose the ability to transport sediment out of the system and sediments fill pools and cover substrate. Of the 1,301 pools identified in the Canyon Creek watershed stream surveys, only nine pools were at least three feet deep. All pools listed in Table 5-6.11 were located outside the wilderness boundary. With only one exception, these pools were found in larger C, G, and B stream types. Large pools are essential winter rearing habitat for adult salmonids. Habitat restoration must include the creation of deep pools.

Table 5-6.11. Quantity of pools exceeding three feet in depth.

Stream name	SMART survey reach number	Pool depth (feet)
Canyon Creek	1	3.7
Canyon Creek	1	3.1
Canyon Creek	1	3
Middle Fork Canyon Creek	1	4
Middle Fork Canyon Creek	1	3
Middle Fork Canyon Creek	2	3.3
Middle Fork Canyon Creek	3	3.6
Middle Fork Canyon Creek	3	3
Vance Creek	1	3

Pool measured during stream surveys conducted in early 1990s for selected reaches within Canyon Creek watershed.

5-6.2.1.3 Fish Blocks

Low water flows block fish from accessing critical rearing and spawning habitat. With the exception of waterfalls located in the headwaters of streams identified in the stream surveys, little data exist to determine where fish blockages may exist. The dam at Canyon Meadows acts as a block during low flows. An additional mechanism that may be considered a blockage to fish passage is dewatering of stream channels associated with the use of water rights. As discussed in *Chapter 3*, OWRD estimates that consumptive water use associated with the full use of water rights would not be expected to result in dewatered channels in the East Fork Canyon Creek, Middle Fork Canyon Creek, or Canyon Creek upstream of the East Fork. However, OWRD estimates for the mouth of Canyon Creek indicate that consumptive water use associated with the full use of water rights could result in a dewatered channel during the months of August and September during dry years.

Existing data pertaining to potential fish blocks in the Canyon Creek watershed were not available for this watershed analysis. In the future, however, the existing data should be made available and reviewed to determine where fish blocks occur and what might be done to remove them. One partial barrier has been identified along Vance Creek near the J-L Ranch where boards and rocks have been placed in the stream.

5-6.2.1.4 Non-Native Fishes

Non-native fish are a widespread problem for bull trout and cutthroat trout populations across the inland west. Brook trout are established above the dam on Canyon Creek and have likely moved below the dam since the floodgates were opened. Habitat conditions influence the interactions of cutthroat and brook trout (Shepard et. al. 2002). Brook trout emerge several months earlier than west slope cutthroat trout. Brook trout obtain a competitive size advantage over cutthroat in the same age cohort during the first year of life (Shepard et. al. 2002). When habitat becomes degraded and food supplies limited, brook trout will outcompete cutthroat trout for scant resources. Under stressed conditions, brook trout may actually feed on cutthroat eggs and/or fry. The brook trout population in Canyon Creek poses a clear and present threat to the cutthroat trout population.

5-6.2.1.5 Aquatic Macro-invertebrates

The diversity and quantity of aquatic insects present in streams indicate water quality and substrate condition. The insects also reveal if the stream suits trout. From 1988 to 1991, an aquatic macro-invertebrate study was conducted along portions of Canyon Creek and the Middle Fork of Canyon Creek. The results of the survey reported whether the stream was in poor, fair, good, or excellent condition. The biological surveyors reported that their survey of macro-invertebrates indicated these streams were in good condition overall. The surveyors found good numbers of clean water invertebrate species in Canyon Creek and the Middle Fork of Canyon Creek and this trend continued for the duration of the study. The reports did not include specific geographic information about where the study occurred. The reports failed to describe to what extent of the stream the results applied.

5-6.2.1.6 Canyon Creek Mainstem Outside National Forest System Lands

The lower reaches of Canyon Creek are steep gradient reaches that run through a relatively narrow canyon (*Chapter 3*, Level I Analysis). The wider valley bottoms and historic meandering reaches are found upstream of Berry Creek outside of NFL lands. Historically these mid-creek reaches probably meandered around a dense hardwood and shrub complex. Alder, willow, and to some extent aspen covered the riparian areas, creating a relatively cool valley bottom comprised of a complex vegetation structure. Side channels, oxbows, and wetlands stabilized water flows, and native aquatic species were diverse and abundant. Beaver activity helped to raise water tables and form deep pools.

Today, little remains of this historic ecosystem because of various land-use activities: wetlands were drained, creeks were dredged, and side channels filled. Agricultural practices including plowing and grazing have resulted in overgrazed fields filled with invasive grasses, herbs, and shrubs. Irrigation rights have priority over in-stream fish rights, limiting fish access to rearing and spawning habitat. Species richness and channel diversity has been replaced by a trend toward fewer species and channelization. However, even with the loss of habitat, important aquatic species still use this waterway.

The mainstem of Canyon Creek outside federally managed lands may be the limiting factor to successful aquatic habitat restoration in the upper reaches. Efforts to restore the upper reaches while ignoring the mid to lower reaches may do little to repair the restore the aquatic ecosystem.

5-6.2.1.7 Aquatic Habitat Review

The SMART stream data indicated a mixed report for habitat conditions. The streams appeared fragmented, with little consistency between the reaches. Generally, habitat improved in the upper reaches, while creeks downstream, like the South Fork of Vance Creek and Vance Creek, offered aquatic species little refuge. Based on 1993 and 1994 data

- 64% of the reaches surveyed failed the Amendment 29 standard for stream shading
- 95% of the reaches failed the standard for functional in-stream LWD
- 68% failed for near-term LWD recruitment potential
- 86% of the surveyed reaches failed the standard for number of pools/mile
- 41% failed for embedded substrate using a threshold of 35% instead of 20% as called for in Amendment 29
-

Poor shading meant warmer water temperatures and less cover for all species utilizing the streams. The small number of pools scattered throughout the system and the low potential for LWD revealed the low quality of in-stream habitat for fish. The native fish present in Canyon Creek watershed are threatened by declining habitat conditions and habitat fragmentation. The goals of the Aquatic Conservation Strategy are not being met.

The strategy states that managers must "Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species."

The fragmented habitat within the analysis area disrupts life history requirements of important fish species. For example, aggraded and silted channels provide low quality spawning habitat. Fish that rear in the streams that have high temperatures and low are physiologically stressed. Stressed fish populations will ultimately result in lower individual fish presence in the streams.

An evaluation of the *overall* agreement between the SMART survey data and the remote survey data for LWD recruitment potential and shade canopy indicated an agreement greater than 85% as to whether the Amendment 29 standards were passing or failing for all the reaches surveyed. The strong explanation of variance between the remote shade canopy data and temperature (see *Hydrology* section this chapter), coupled with the agreement between field and remote surveys for LWD recruitment and shading, provide confidence that the remote surveys, while not perfect, did a good job of evaluating conditions within the watershed.

5-6.2.2 Hydrology Synthesis

5-6.2.2.1 Climatic Conditions

Climatic conditions and cyclical changes in climatic conditions are among the primary factors that determine aquatic productivity within a watershed. Precipitation volumes and timing are one of the primary determinates of the carrying capacity for many aquatic and terrestrial species.

Monthly precipitation is highest in November and December (ranging from an average of 2.0 to 4.3 inches per month) and lowest in July (ranging from an average of 0.5 to 0.8 inches per month). Annual precipitation ranges from 16.8 inches per year in the Canyon City subwatershed to 27.7 inches per year in the Upper East Fork subwatershed and is 22.4 inches per year for the entire watershed. In general, Berry Creek, Canyon Meadows, Middle Fork Canyon Creek, and Upper East Fork subwatersheds are below the watershed average for monthly and annual precipitation volumes, and the remaining subwatersheds are above the average.

Air temperatures generally vary with elevation throughout the area, with mean minimum temperatures occurring in December and January (ranging from approximately 10° F to 40° F) and mean maximum air temperatures occurring in July (ranging from approximately 80° F to 90° F).

Snowpack is one of the principal locations where water is stored in watersheds such as Canyon Creek that have very few lakes and ponds and limited wetland areas. Snowfall generally occurs in October through April at all elevations, and snowpack is generally gone by the beginning of May at all but the highest elevations. Maximum snowfall occurs in December and January, and snowpack appears to reach the greatest depths in late February at the lower elevations, and in early April at the higher elevations. No information is available from within the watershed on snowpack trends over time or on land-use effects to snowpack; however, it is possible that snowpack may be reduced under the denser forested canopies that have resulted from fire exclusion. Snow accumulation may be greater within small forested openings than in adjacent forested areas (Toews and Gluns 1986), although there may be a maximum opening size, above which accumulation is the same or even less than the surrounding forest (Golding and Swanson 1986; Troendle 1983).

Climatic cycles, such as the El Niño/Southern Oscillation and the Pacific Decadal Oscillation (discussed further in *Chapter 1*), have been correlated with ecosystem performance, with warm/dry periods being correlated with enhanced coastal ocean productivity in Alaska and decreased productivity off the west coast of the lower 48 states, and cold/wet periods being correlated with the reverse. Consequently, local actions within the watershed that may impair or improve anadromous fish production must be considered relative to these larger-scale climatic cycles. For example, the relatively cool/wet period that occurred from the 1940s to the 1980s may have had a positive influence on anadromous fish populations, while the relatively warm/dry period during the late 1980s and early 1990s may have had the opposite effect, regardless of changes in local habitat conditions during the same period. It is also important to consider that human-caused stresses to the system (e.g., decreased stream flows due to water withdrawals) become an even greater concern to fish survival during these dry cycles.

5-6.2.2.2 Stream Channel Characteristics

Stream channel types within the Canyon Creek watershed reflect the geologic and geomorphic processes active in the region. Stream gradient and valley bottom development is primarily a function of position within the watershed, with the upstream reaches tending to be the steepest and most confined; however, some anomalous situations exist. The lowest-gradient streams flowing through the widest valley bottoms occur along the mainstem of Canyon Creek from the confluence with Berry Creek upstream to the confluence with the Middle Fork of Canyon Creek. The portion of Canyon Creek downstream of Berry Creek to the mouth is relatively steep and confined, due to the greater resistance of the underlying geology.

The principal streams within the watershed were classified using the Rosgen level I classification methodology. Rosgen type “Aa+” streams (greater than 10% channel gradient, confined) are located in headwater areas and make up approximately one-quarter of the principal stream length in the Canyon Creek watershed. Transport processes dominate in these reaches, as they are often source areas for downstream deposition. Rosgen type “A” channels have a slightly lower gradient than the “Aa+” classification (4% to 10%, confined). Type “A” channels make up the largest proportion (40%) of the principal stream length within the Canyon Creek watershed. Type “B” channels, which have a more moderate gradient and may include areas of floodplain development, may be both transport and depositional reaches. Within Canyon Creek, type “B” channels are typically found at the lower end of the larger tributaries and along the mainstem of Canyon Creek downstream of Byram Gulch. Type “B” channels make up 13% of the principal stream length in the watershed.

The majority of the mainstem of Canyon Creek downstream of Vance Creek has been classified as a “G” type channel. Type “G” or “gullied” channels are narrow, entrenched, non-meandering channels that are often downcut within alluvial deposits. Several other stream segments within the watershed exhibit some “G” channel type characteristics, including the downstream portion of Vance Creek (classified as a “G/B” type); the mainstem of Canyon Creek upstream of Vance Creek to Crazy Creek (“G/C” type). Rosgen type “C” channels consist of relatively low-gradient streams with well-developed floodplains and are typically highly responsive to sediment and wood inputs.

It is unlikely that many of the channels currently classified as “Aa+”, “A”, or “B” were much different historically with respect to Rosgen classification type. The morphological characteristics of these channels are dominated by valley slope and confinement, and consequently they are relatively insensitive to anthropogenic effects. The portion of the mainstem of Canyon Creek that is currently classified as “G/C” (i.e., from the confluence of Crazy Creek downstream to the confluence with Vance Creek) was most likely a Rosgen type “E” or possibly “C” channel type prior to disturbance. The pre-disturbance type “E” or “C” channel type probably continued downstream along the mainstem of Canyon Creek to include the area that is currently classified as type “G” from the confluence with Vance Creek down to the confluence with Byram Gulch. The lowermost portion of Canyon Creek that is currently classified as a Rosgen type “B” channel was most likely a type “B” channel prior to disturbance, as was the lowermost portion of Vance Creek which is currently typed as a “G/B” channel. The changes from historic to current conditions is most likely a result of channel down cutting.

Primary erosion sources within the Canyon Creek watershed include mass wasting, road-related erosion, stream bank erosion, and background soil erosion (or surface creep). No quantitative data on erosion rates are available for the watershed, but the relative importance of the different sources was estimated using available data. Very limited areas of mass wasting were observed within the watershed, and based on available anecdotal information it does not appear that mass wasting is a large source of sedimentation. Road-related erosion is generally not notable throughout the watershed; however, localized areas of road-related erosion exist (see Plate 5-6.1). Road-related erosion is an example of the legacy of past management decisions. Many of the road locations within the watershed are immediately adjacent to streams, a practice that would not occur under today’s management direction.

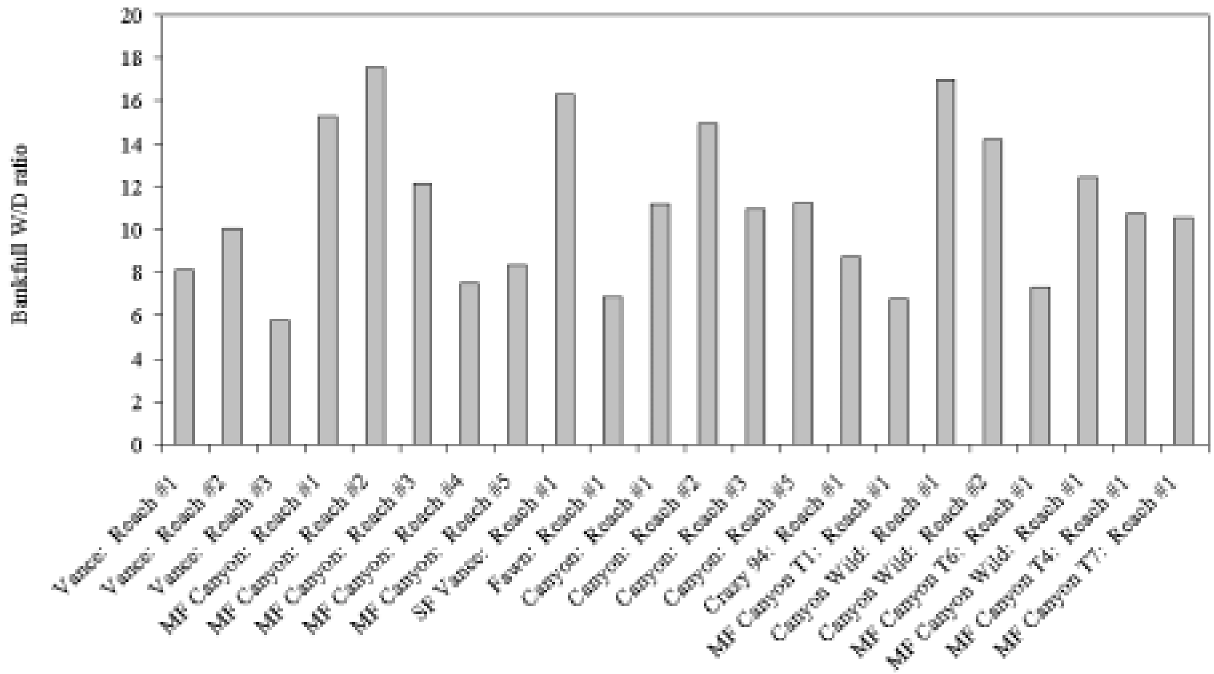


Figure 5-6.3. Bankfull width/depth ratios for streams included in the 1993-94 SMART surveys.

The primary source of erosion (and subsequent sedimentation within stream channels) is most likely the result of streambank erosion, soils within the forested-portions of the watershed being generally permeable, and overland flow being rare. (Although the SMART survey data indicates the reaches meet bank stability requirements, it is important to note that 50% of the reaches measured a decade ago were not measured for bank stability[12]). Much of the bank erosion that is occurring is likely associated with direct disturbance of the stream banks from grazing (see Plate 5-6.2), and channel incision (which is also related to grazing activities).

The only readily available data source for stream characteristics within the Canyon Creek watershed is the SMART database, which consists of several stream surveys conducted within the watershed during the summers of 1993 and 1994. Having data available for only this short time period makes it impossible to discern time-related trends in stream characteristics. Bankfull width/depth ratios for streams included in the SMART surveys are summarized in Figure 5-6.3. Due to the constraints of stream survey protocols, it was

[12] *The Interagency Team established by regional Foresters to monitor PACFISH/ INFISH implementation of effectiveness have found that most methods used to measure bank stability are not easily replicable. New protocols have been established to better detect bank instability during stream surveys. Hence, for the data presented here from past surveys, eroding banks may have been a greater contributor to in-stream sediment than previously recorded (Edwards, pers. comm. 2003).*

not possible to obtain mean wetted width/depth ratios for stream reaches. A wetted width/depth ratio value of less than 10 is required to pass the Malheur National Forest Amendment 29 Standards, and unfortunately, the data do not exist to quantify or evaluate if these streams meet or fail to meet the standards. Grazing pressure (see Plate 5-6.2) and loss of beaver within the watershed (compared to historical population numbers) are also related to changes in channel morphology. Beaver dams were probably responsible for maintaining riparian/floodplain linkages in the low-gradient portion of the watershed (i.e., the mid-portion of the Canyon Creek mainstem; see Plate 5-6.3).

5-6.2.2.3 Water Quality Parameters

The Malheur National Forest has collected summertime stream temperature data at 25 sites within Canyon Creek during the period 1994 to 2002, although not all sites have data for every year. The Oregon Department of Environmental Quality (ODEQ) water temperature standard for salmonid rearing is exceeded when the 7-day average of daily maximum water temperatures exceeds 64˚ F. The annual maximum seven-day moving average of the daily maximum temperature (T_{max}) was calculated for each site and compared to this 64° F temperature standard. The 25 sites within the Canyon Creek watershed can be summarized by four categories given in Table 5-6.12.

Four sites were classified as having two or more years of data and *meeting* the temperature standard in all or most years. All four of the sites were in headwater areas with relatively short upstream stream length. Two of the sites (Site #3, Middle Fork Canyon Creek near Wilderness; Site #20, Canyon Creek above Reservoir) are located downstream of wilderness areas. There were an additional two temperature monitoring sites having only one year of data that *met* the temperature standard; sites #17 (Crazy Creek at mouth) and #19 (Canyon Creek in section 29) were 3° and 5° F below the ODEQ temperature criteria respectively.

Nine sites were classified as having two or more years of data and *failing* the temperature standard in all or most years. All sites with the exception of site #23 (Canyon Creek below Wickiup Campground) exceeded the 64° F T_{max} value by from 1° to 9° F in any given year. Site #23 is an unusual case; T_{max} values at this site range from 0.4° F below the 64° F standard to 19° F above the standard over the five years for which there are data. It is likely that some change in site characteristic (e.g., removal of a beaver dam upstream) is responsible for the dramatic changes in T_{max} values observed at site #23.

Ten temperature monitoring sites having only one year of data *failed* the temperature standard. These sites exceeded the 64° F T_{max} value by from 1° to 10° F. Three of the sites (#11, #12, and #22) had data from the summer of 2002, which was an unusually warm summer (e.g., 2002 had the highest seven-day moving average maximum air temperature on record at the John Day climate station). In a more-typical summer stream temperatures at sites #11, #12, and #22 may be closer to or below the 64° F standard.

Table 5-6.12. Categorization of USFS temperature monitoring sites within Canyon Creek watershed.

	Summary categories	Site number and description	
1	Sites with two or more years of data; meets temperature standard in all or most years	3	M F Canyon Creek near Wilderness
		16	Crazy Creek Sec. 4
		20	Canyon Creek above Reservoir
		25	Vance Creek @ Boundary
2	Sites with two or more years of data; fails temperature standard in all or most years	1	E F Canyon Creek
		2	M F Canyon Creek @ Mouth
		4	M F Canyon Creek, Sec. 30 (#1)
		10	Canyon Creek above M F Canyon
		13	Canyon Creek above Big Canyon
		15	Canyon Creek above Crazy Creek
		21	Canyon Creek @ Boundary
		23	Canyon Creek below Wickiup Campground (at aspen exclosure)
		24	Canyon Creek below Road Gulch
3	Sites with one year of data; meets temperature standard	17	Crazy Creek @ mouth
		19	Canyon Creek Sec. 29
4	Sites with one year of data; fails temperature standard	5	M F Canyon Creek, Sec. 30 (#2)
		6	M F Canyon Creek, Sec. 36
		7	M F Canyon Creek Above Wetlands
		8	M F Canyon Creek Below Wetlands
		9	M F Canyon Creek Below Narrow Canyon
		11	Canyon Creek above M F Canyon @ Draw
		12	Canyon Creek 1,000' below M F Canyon
		14	Canyon Creek below Crazy Creek
		18	Canyon Creek Sec. 31
		22	Canyon Creek @ Wickiup Campground

Regression analysis was used to determine the relationship between T_{max} and the environmental variables most likely to affect water temperatures. The variables considered included: 1) site elevation, 2) riparian shade determined from the remote shade analysis, 3) mean annual air temperature (a surrogate for groundwater temperature), 4) an index value for mean annual stream flow, and 5) distance from the watershed divide (an index of the time that water has been exposed to ambient air temperatures). The regression equation developed using this approach accounted for over 80% of the variability in T_{max} values. This analysis indicates that stream temperature are highly responsive to differences in riparian shade levels, stream temperatures are sensitive to both natural and human-caused variations in summertime stream flow, and inherent differences in site conditions (e.g., elevation, distance from watershed divide, etc.) must also be considered when evaluating T_{max} values.

5-6.2.2.4 Water Quantity Parameters

The primary peak-flow-generating processes active in the Canyon Creek watershed are spring snowmelt and winter rain-on-snow (high-intensity rainfall produced during thunderstorms probably also contributes to localized peak flow events). Consequently, peak flows within the watershed are sensitive to management practices that have the possibility of affecting snow accumulation and melt rates. Mean daily discharge is highest during the late spring/early summer snowmelt season and lowest during late August and early September.

Management activities have the potential to influence peak flows through several pathways. Vegetation manipulation may influence peak flows by changing snow accumulation and melt rates; wetland loss and channel incision may result in decreased detention time of storm runoff and result in flashier peak flows; soil compaction can reduce infiltration resulting in shorter travel time to stream channels and higher peak flow magnitudes; and road drainage networks may intercept subsurface flows and reduce infiltration, resulting in quicker routing of runoff to the stream system.

Almost no quantitative information on how these processes may be affecting peak flows is available for the Canyon Creek watershed. No modeling of vegetation effects on snow accumulation or melt has been conducted. Anecdotal information suggests the likelihood that most streams in the watershed have experienced some level of stream incision and downcutting associated with grazing and fire (Plates 5-6.4 and 5-6.5), and conditions have been exacerbated by the decrease in the beaver population and subsequent loss of beaver dams. Equivalent roaded area (ERA) analyses for a portion of the watershed indicate that compaction is currently below the threshold of concern. Anecdotal evidence suggests that only a very small portion (less than 5%) of most forested areas within the watershed are detrimentally impacted by compaction and that most compaction in forested areas is a legacy of past ground-based logging activities in the 1950s. No information is available for the Canyon Creek watershed on the level of connectivity between the road drainage and stream channel networks; however, the high density of roads in some watersheds (e.g., over five miles/square mile in the Vance Creek subwatershed) indicate that road drainage effects may be a concern.

In addition to the impact on peak flows, channel incision and wetland loss may also be affecting base flow conditions within the Canyon Creek watershed, although no quantitative information is available. One wetland area within the watershed that may be providing base flow augmentation is the Canyon Meadows reservoir area (Plates 5-6.6 and 5-6.7). Despite the fact that the reservoir is no longer filled, it is likely that seasonal inundation of the area results in wetland storage and water release into the summer months.

5-6.2.2.5 Recommendations and data gaps – Aquatic Habitats

The following recommendations are aimed at addressing the impacts to riparian and aquatic ecosystems within the watershed, the factors limiting to the success of aquatic species, and the primary gaps in our understanding of these processes. In assembling these recommendations an effort has been made to emphasize those actions that are the most obvious and that will give the greatest return for the effort expended. Some of the recommendations (e.g., approaches to mitigate for water loss associated with water rights) apply to areas off National Forest lands. These recommendations are included because they address important processes affecting the health of the entire watershed; consequently, they cannot be ignored. Specific recommendations include the following:

5-6.2.2.5.1 Stream habitats and species

Improve our understanding of current fine sediment impacts to spawning areas within the watershed. Information on substrate embeddedness available from the SMART database was insufficient to characterize the impacts of fine sediments on spawning substrate. A more useful approach may be to collect information on the percentage of fine sediment present using techniques such as those described in Schuett-Hames et al. (1999). Additionally, during future stream surveys one option would be to increase the frequency and intensity of Wolman Pebble counts.

Quantitative modeling of the effects of vegetation manipulation, road drainage, wetland loss, and other management-related activities on peak and base flows. No quantitative information is currently available on the extent to which peak flow magnitudes and/or base flows have been affected by past or potential future changes in vegetation patterns (due to fuels reduction activities, timber harvest, catastrophic fire, etc.), road construction and road drainage networks, wetland loss or restoration, or other management-related activities. A robust, spatially-distributed, modeling tool such as the Distributed Hydrology-Soil-Vegetation Model (DHSVM) (Wigmosta et al. 2002) or the Precipitation-Runoff Modeling System (PRMS) (Risley 1994) should be considered for evaluating proposed future activities and/or current legacy effects.

Mapping of current and historical wetland extent within the watershed. The role of wetlands in the watershed in augmenting base flows is unknown and should be included in any modeling effort (as described elsewhere). However, both the current and historic extent and function of wetlands within the watershed is unknown. A thorough compilation of all sources of wetland information (e.g., NWI data, hydric soils data, in-house wetland mapping, etc.) should be completed.

Retain wetland functions of Canyon Meadows area. The Canyon Meadows dam is currently being considered for removal. However, the wetland area behind the dam provides many functions, among them storage of flood flows. Dam removal, if conducted, should be carried out in such a way as to avoid impairment to current wetland functions.

Create long riparian exclosures on as many fish bearing streams as possible to allow riparian areas time to restore themselves. Prioritize streams that currently support west slope cutthroat trout and redband steelhead. Long, continuous exclosures have proven successful as a passive restoration tool along the Middle Fork of the John Day River (Kauffman et al., 2002).

When possible, plant native hardwoods and shrubs along the newly created exclosures. Protect plantings with fences to prevent browsing. If reintroducing fire into a riparian zone, coordinate planting with Fire Management Officer and riparian ecologist to ensure the success of these operations.

Protect beaver and encourage their recovery through public education. Work together with ODFW, the Watershed Council, and other parties to educate residents about the benefits of beaver activity. Consider enhancing beaver populations along lower gradient well-vegetated reaches.

Monitor above ground biomass within riparian corridors. Grazing reduces above ground biomass (stubble height), below ground biomass (root integrity), and ultimately lowers water quantity and quality. Monitoring of above and below ground biomass will allow managers to make decisions about grazing intensities along streams.

Eradicate brook trout in Canyon Creek. In reaches where brook trout presence is confirmed, consider:

- trapping brook trout by using multiple fish-shockers moving in a downstream direction and herding the fish into trap nets
- have anglers trained at identifying brook trout fish reaches where brook trout are known to be present
- use a passive and inexpensive method involving pheromone traps. Place hoop nets seeded with reproductively mature brook trout in reaches of concern during spawning season to lure other brook trout into nets

(Re)install continuous stream flow gages. Efforts to characterize stream flow within the Canyon Creek watershed were hampered by the lack of continuous stream flow data from within the subwatersheds. Continuous stream flow data would improve understanding of peak flow history, allow for better estimation of natural stream flows, provide calibration data for any future modeling activity, and allow for better understanding of the effects of water use within the subwatersheds. Reinstalling gages at the locations of the two former USGS stream gages (gages #14038550, East Fork Canyon Creek near Canyon City, and #14038600, Vance Creek near Canyon City), and at the locations of the three former OWRD gages (gages #14038560, Canyon Creek at Thissel's Ranch near Canyon City, #14038602, Canyon Creek near Canyon City, and #14038630, Canyon Creek at John

Day) would build upon the existing data sets. Of these five locations, the Canyon Creek near Canyon City gage (#14038602) should be the highest priority for reinstallation, as it has the longest continuous record in the watershed and is located at a point that captures most of the flow originating from National Forest lands within the watershed

5-6.2.2.5.2 Data gaps pertaining to fish and stream habitats

The USFS supplied several data sets to the contractor to conduct this analysis. Some of the data was submitted in electronic format while other data sets were submitted in hard copy. Electronic data sets are easily queried for analysis; hard copy data sets are not.

One data set in hard copy provided to the contractor was a series of riparian surveys conducted between 1993 and 1998. If these surveys were electronic in format, they would have been easily queried and more useful in determining how riparian areas are currently functioning within the watershed. Additionally, if this data were linked to maps via geographic information systems it would have added valuable data for this analysis. Further still, a current validation of riparian ecotypes would be useful to understanding how riparian areas function today. A riparian survey like the one conducted for the Emigrant Creek Ranger District of the Malheur National Forest in 2002 would serve as an excellent template for future studies.

The SMART survey data provided to the contractor was incomplete. This was discovered while reviewing hard copy reports of the same stream data contained in the database. Attributes reviewed in the hard copy report were missing from the SMART database. These reports and the original data used to compile the reports should be reviewed and compared to the data in the SMART database. The SMART database, if not obsolete, should be updated from the raw data if that raw data is still available.

The data contained in the SMART database is nine or ten years old. In order to better understand the condition of the streams within the watershed, Level II stream surveys should be conducted soon. The LRMP for the Malheur National Forest calls for surveying of these streams every decade.

Range information pertaining to allotments, grazing intensity, fences, etc., would be useful to determining the grazing pressures put on the aquatic resources. This type of data was not available for our analysis. In the future, be sure to measure and monitor above ground biomass in riparian zones to determine suitability for grazing and habitat protection.

The road inventory for Canyon Creek watershed offers general information about road conditions. A complete analysis of the roads in Canyon Creek will provide more detail as to the hazards posed by roads especially in terms of erosion that may lead to embedded substrate.

5-6.3 TERRESTRIAL WILDLIFE SPECIES AND HABITAT (ISSUE 4)

Past management activities and natural disturbance processes have altered the diversity and distribution of wildlife populations and the condition of wildlife habitat.

- Key question 1: How has the diversity and distribution of Proposed Endangered, Threatened, and Sensitive Species (PETS) and their habitat changed from historical conditions?
- Key question 2: How has the diversity and distribution of non-PETS terrestrial wildlife and their habitat changed from historical conditions?

The species that appear to be most impacted by the changes from historical conditions are those associated with the old forest single-stratum stand structure, riparian areas, and aspen and large-diameter snag habitats. The viability of these species is a concern from the perspective of both the ESA and the standards and guidelines set forth in the Malheur National Forest LRMP and Regional Forester's Amendment 2. These standards and guidelines were designed to maintain suitable habitats for certain species during project design and implementation. The changes in diversity, abundance, and distribution of these species and their habitat from historical conditions as well as the causes of those changes are discussed below.

5-6.3.1 Proposed, Endangered, Threatened, and Sensitive Species

5-6.3.1.1 Synthesis

5-6.3.1.1.1 Shrubland and Herbland Associated Species

Pygmy Rabbit and Western Sage Grouse. Sagebrush is a crucial and critical component for both these species. These species have declined primarily because of loss of habitat due to the conversion of sagebrush habitat to grassland and agricultural uses (Howard and Bushey 1996, 1986). Heavily grazed areas can also limit the amount of habitat.

Fire can create a mosaic of sagebrush of different ages and structures that benefits sage grouse (Klebenow 1969). However, in the short term, fire always removes a certain amount of sage grouse food and cover, and sagebrush can be slow to recover from fire in the long term (Griner 1939). If historically the watershed had a higher percentage of suitable sagebrush habitat than it does currently, fire may have helped to maintain that habitat. If historically the watershed had limited sagebrush habitat, fire occurring in areas with limited nesting grounds in any season may have had an adverse effect on sage grouse populations and habitats (Autenrieth et al. 1982).

Sage grouse have one of the lowest recruitment rates of any upland game bird in North America. Loss of habitat, predation, drought and poor weather conditions during hatching and brooding periods have been cited as factors leading to poor recruitment throughout their range (Mattise 1995). Some of these factors may be responsible for the lack of documented occurrences in the watershed.

Upland Sandpiper, Gray Flycatcher, and Bobolink. Habitat is currently limited in the watershed and has been limited historically. These species are not documented to occur in the watershed. This may be due to the lack of surveys for the other species as well as a general lack of preferred habitat.

5-6.3.1.2 Recommendations for Shrubland and Herbland Associated Species

- Manage for the reduction/elimination of livestock grazing impacts from areas of potential suitable nesting habitat for grassland associated species. The amount of late-season grazing should also be limited to encourage and maintain vegetation for forage and cover throughout the year.
- Restore hardwood habitats in the riparian areas prior to the introduction of beaver to facilitate successful establishment and population maintenance. Introduce beaver to reflect the historical distribution of this species in the watershed. The introduction of beaver into the riparian areas may assist in the restoration of wet meadows. See Aquatic Species and Habitat recommendations.

5-6.3.2 Wide Ranging Carnivores

5-6.3.2.1.1 Synthesis

Gray Wolf. As stated previously, wolves in the Blue Mountains are most likely strays that traveled from reintroduced experimental populations in Idaho. This is likely to continue as the Idaho populations grow. Oregon is not part of the federal recovery program for the gray wolf. ODFW will mostly likely be the lead agency for management of this species.

Canada Lynx. Historically, the warm dry PAGs did not provide suitable habitat for the Canada lynx. Due to past timber management and fire suppression, this PAG may contain habitat suitable for this species and its prey. The wilderness area provides suitable denning habitat and suitable foraging and travel habitat occurs throughout the watershed in the SECC, SEOC, and YFMS stands.

Wolverine. Wolverine habitat occurs within the Strawberry Mountains wilderness where human impacts and human disturbance are low in the analysis area. Elsewhere on the District, the Vinegar Hill-Indian Rock Scenic Area and Dixie Butte Wildlife Emphasis Area exhibit characteristics of wolverine habitat as do the Dry Cabin Wildlife Emphasis Area and the Shaketable, McClellan Mountain, and Aldrich Mountain Roadless Areas, which share the same characteristics.

The Moist Upland Forests PVG with a Cool/Moist PAG represent the highest quality habitat, particularly where they remain relatively undeveloped and undisturbed. Quality habitat includes both the OFMS and YFMS structural stages. Approximately 10,270 acres of these forest types exist. Structural stage percentages are within the estimated HRV for OFSS and in excess of the estimated HRV for YFMS.

Elsewhere, lesser quality habitat provides sufficient cover and security to meet landscape connectivity between potential home range areas.

5-6.3.2.2 Recommendations for Wide Ranging Carnivores

- Continue to work with ODFW on wolf management in the Blue Mountains.
- Continue to follow the direction outlined in the Lynx Conservation Assessment Strategy (Ruediger et al. 2000).
- The Lynx Conservation Assessment Strategy states that land managers establish Key Linkage Areas (KLA) for lynx habitat connectivity between LAU's. The establishment of these corridors would best be established Forest-wide using GIS and then field verified at the project level to assess connectivity at the stand level.

5-6.3.3 Multiple Habitat Associated Species

5-6.3.3.1 Synthesis

Tricolored Blackbird and Bufflehead. As stated previously, NFS lands within the analysis area appear to not have suitable habitat for these species.

Peregrine Falcon and Columbia Spotted Frog. Both species have specialized habitats that occur in the watershed. For peregrine falcons, known suitable or suspected suitable cliff sites should continue to be monitored for nesting activity. Surveys should be conducted in suitable habitats for the Columbia spotted frog. These surveys should at least be conducted prior to projects and elsewhere as opportunities and budgets allow. Access to existing habitats and the enhancement of that habitat should be considered in projects design especially is there are proposed activities in riparian areas. Riparian restoration activities including road removal and plantings will most likely benefit these species.

Elk. Past timber harvest and fire suppression changed the forest stand structure from a single stratum to a multi-strata condition. This change in structure changed the thermal cover conditions in the watershed. The impact of this change to big game utilization of the watershed is unknown. Ungulate-vegetation interactions in the Blue Mountains are both complex and different from those of pre-settlement conditions. Vegetation composition, productivity, and diversity have been influenced by ungulates, fire suppression, the effects of insects and disease, and past timber management. Despite such complexity, evidence is clear that long-term herbivory by both wild and domestic ungulates has changed vegetation productivity (Irwin et al. 1994). Forage quality is below what is necessary for optimum growth for young deer, elk, and cattle. In the analysis area, hiding cover usually provided by a tall shrub layer have been reduced or replaced by a dense understory of trees created by overstocking and a low fire frequency. Therefore, hiding cover in the analysis area is provided by high densities of understory trees rather than a vigorous shrub layer. It is assumed that this high density of understory trees is most likely still providing some level of security refuge for elk.

Another factor that impacts big game use of the watershed is road density. The tendency for elk to avoid open areas near roads has been the most studied and well-documented aspect of elk behavior. Elk will consistently and dramatically avoid areas near open roads across a variety of seasons and landscape conditions (Wisdom and Cook 2000). Road densities exceed the LRMP standards throughout the watershed.

Hunting regulations have increased the number of elk above documented historical levels in the watershed. Mule deer populations are currently lower than in the 1960s. This decline may be associated with changes in vegetation such as overbrowsing in some areas, some of which was caused by the deer themselves, competition with elk and cattle, and/or increased predator populations. Dense elk populations could preclude increases in mule deer herds, too, by reducing shrubs on mule deer summer and winter ranges (Irwin et al. 1994).

5-6.3.3.2 Recommendations for Multiple Habitat Associated Species

- Seek to reduce road densities in subwatersheds that do not meet the LRMP road density standard for summer range. Roads proposed for closure should be prioritized to areas that would provide the most benefit to elk (i.e., roads adjacent to riparian areas that provide calving and fawning habitat). Where feasible, roads should be decommissioned to discourage motor vehicle use and provide an effective closure for wildlife.
- Monitor livestock and big game use of forage in the watershed. Determine whether the available forage can support current ungulate population levels and still restore/ maintain riparian hardwood and shrubland habitats. Develop management recommendations if necessary to reduce livestock, and/or big game population levels in the watershed.
- Hiding cover should be retained in multi-strata stands that are being managed towards old forest single-stratum in at least 10% or more of the stand depending on current presence of cover and site capability.
- As stated above, conduct surveys at the project level in slow moving permanent water of the watershed for potential of suitable breeding areas for the Columbia spotted frog. During project design include, where appropriate, site enhancement and restoration opportunities.
- For peregrine falcons, known suitable or suspected suitable cliff sites should continue to be monitored for nesting activity.

5-6.3.4 Late and Old Forest Multi-Stratum Structure Associated Species

5-6.3.4.1.1 Synthesis

Bald Eagle. Suitable bald eagle nesting and winter roosting habitat currently is limited along Canyon Creek due to the removal of large ponderosa pines during past timber management, conversion to agriculture, and water withdrawals. Historically, more nesting and winter roosting habitat may have been available. This species has been documented in the watershed during the winter.

Pacific Fisher. Systematic habitat alteration and overexploitation have reduced historical distribution of fishers in suitable habitat in the interior Columbia Basin to isolated and fragmented populations (Witmer et al. 1998). Current populations may be extremely vulnerable to local and regional extirpation because of their lack of connectivity and small numbers (Witmer et al. 1998). Fishers are thought to occur primarily in the Cascade Range and Rocky Mountains in the interior Columbia Basin (Witmer et al. 1998). No museum-documented occurrences are known in the Oregon Blue Mountains (Verts and Carraway 1998).

Past timber management and fire suppression have provided mature multi-strata mixed conifer stands in portions of the warm-dry PAGs. However, stand conditions in these PAGs typically do not provide the dense canopy closures preferred by this species. These areas may be too high in elevation to provide preferred habitat conditions due to deep snow accumulations. There are no historical documented occurrences, and current populations in the interior Columbia Basin are not thought to occur in the Blue Mountains.

Pileated Woodpecker. The moist upland forest types provides the more favorable habitat conditions for the pileated woodpecker, i.e. mixed conifer stands with high canopy cover. Past timber management and fire suppression have changed the forest composition from a ponderosa pine-dominated forest to a Douglas-fir, grand fir, and ponderosa pine forest. Past timber management has also reduced the number of large-diameter trees that would have provided potential future recruitment for large-diameter snags and downed wood, which are important habitat components for this species. Old forest multi-strata stand structure should be maintained in the warm-moist PAGs that provide habitat conditions for this species.

Northern Goshawk. Past timber management and fire suppression in the watershed have changed the forest structure in the warm-dry PAGs. These changes have provided more multi-strata structural stands in larger patch sizes than occurred historically. Currently, there is probably less suitable habitat due to the loss of the large-diameter trees used for nesting habitat and the increase in small-diameter trees, which may reduce the quality of the foraging habitat.

Three-Toed Woodpecker. Lodgepole pine occurs as a minor component in the grand fir vegetation type in the warm-dry PAGs both historically and currently. This habitat is limited in the watershed and occurs primarily in the Lower East Fork and Canyon Meadows subwatersheds. There is only 771 acres of dominant lodgepole pine stands identified in the watershed most of which is wilderness area. The removal of mature lodgepole pine that is infested with mountain pine beetle may reduce or eliminate habitat for this species (Van Dam et al. 1993). Lodgepole pine should be maintained as a component of the grand fir vegetation type where appropriate to provide habitat for this species in the watershed.

Black-Backed Woodpecker. Black-backed woodpeckers are dependent on forests containing wood-boring larvae. Past timber management and fire suppression have reduced the historical abundance of suitable habitat for this species. Past timber management activities have reduced the amount of late and old forest stand structures in the watershed, which provide habitat for this species. Because this species is associated with early post-fire conditions, fire suppression has limited its habitat. This species population probably fluctuates over time in response to disturbances such as fire and windthrow.

5-6.3.4.2 Recommendations for Late and Old Forest Multi-Strata Structure Associated Species

- Retain patches of old forest multi-strata stand structure in the stands identified as young multi-strata that provide suitable nesting habitat for goshawks. Continue to monitor goshawk nesting territories and establish a PFA around Table Mountain if goshawks are documented.
- Maintain lodgepole pine as a component of the grand fir vegetation type where appropriate to provide habitat for the three-toed woodpecker. Lodgepole dominated stands greater than 75 acres in the Canyon Meadows subwatershed should be field verified to determine if a DOG unit could be established.
- Seek opportunities to manage (enhance or maintain the components depending on the field verification of existing condition) the DOG and ROG areas in Fawn and Sugarloaf subwatersheds that are outside the wilderness area. Review of the PI data indicates the presence SECC and SEOC stand structures within the units and therefore there may be opportunities for silvicultural treatments in these stands to facilitate the stands in moving towards a OMFS condition. Manage the replacement areas for future old-growth conditions to provide habitat for the pileated woodpecker and other old forest-associated species.
- To provide snag habitat for deadwood-associated species in the watershed, continue to retain existing large-diameter snags, to meet forest standards in DOG areas, which is the retention of 2.39 snags, 21 inch and over dbh, per acre.
- During project design consider managing the young forest multi-strata stands in the warm/dry PAGs (grand fir vegetation type) to move toward old forest multi-strata stand structure with associated snag and downed wood components to provide more suitable habitat for the pileated woodpeckers in the future.
- Prevent further fragmentation of the old forest multi-strata stand structure in the warm/dry PAG's that provide suitable stand structures and snags and downed wood for pileated woodpecker.

- Late and old forest stand structure is more fragmented currently than historically. Reconnect the DOG, ROG and old forest multi-strata structural stands with travel corridors by managing the young forest multi strata and stem exclusion open canopy structural stands towards old forest single-stratum to reflect two-thirds of site potential canopy closure.

5-6.3.5 Late and Old Forest Single-Stratum Structure Associated Species

5-6.3.5.1 Synthesis

White-Headed Woodpecker. Historically, the white-headed woodpecker was probably more abundant and well-distributed in the watershed. The old forest single-stratum was the most prevalent stand structure in warm dry and hot dry PAGs, covering 15% to 55% and 20% to 70% respectively. This preferred habitat type currently does not exist in the watershed. The removal of the large ponderosa pines and subsequent suppression of fire resulted in the loss of suitable habitat for this species in the watershed.

Lewis' Woodpecker. As discussed above, open ponderosa pine habitat was historically more abundant and well distributed in the watershed. Hardwood communities, including cottonwood, were also more abundant historically in the riparian areas. Currently, a majority of the lower elevation riparian areas and hardwood communities has been eliminated due to domestic livestock, deer and elk, timber harvest and associated road construction, and fire suppression. Lewis' woodpecker has not been documented in the watershed, which may be due to the lack of habitat.

Williamson's Sapsucker. Historically, the open ponderosa pine forests were more abundant and well distributed in the watershed. Open ponderosa pine is absent and aspen habitats are currently lacking, but conifer-dominated stands occur throughout the watershed. Past timber management removed trees of large diameter (i.e., above 20 inches in diameter), which limit nesting habitat for this species.

5-6.3.5.2 Recommendations for Late and Old Forest Single-stratum Structure-Associated Species

- Where appropriate, seek opportunities to move the young multi-strata stands toward single-stratum stand structure that reflects the historical range of 15% to 55% in the warm/dry PAGs and 20% to 70% in the hot/dry PAGs to provide habitat for the white-headed woodpecker and other species associated with this stand structure. This could include, where appropriate, managing the old forest multi-strata stand structures to provide habitat in the short term and the young forest multi-strata and stem exclusion with open canopy stand structures to provide habitat in the long term. See *Vegetation* recommendations.

5-6.3.6 Deadwood-Associated Species

5-6.3.6.1 Synthesis

Downy Woodpecker and Red-Naped Sapsucker. Historically the riparian areas consisted of a mixture of grasses, shrubs, and hardwoods. Currently, a majority of these riparian areas and hardwood communities have been reduced due to the effects of domestic livestock, deer and elk, timber harvest and associated road construction, and fire suppression. Aspen is preferred habitat for both these species. Scattered clumps or small groves of aspen currently occur in the watershed. The condition of aspen throughout the watershed is generally believed to be poor, and regeneration is very limited, with the dominant age classes being decadent. It is generally accepted that aspen occupies a much smaller portion in both riparian areas and among forested PAGs than was found historically. Preferred habitat conditions were more evenly distributed in the watershed historically.

Hairy Woodpecker and Northern Flicker. These species use a variety of habitats but prefer open habitat, which was more abundant historically. Although habitat conditions have changed, because these species use a variety of habitat types, suitable habitat may occur throughout the watershed. Past timber management has limited the large-diameter soft snags used by the northern flicker for nesting habitat. The distribution of nesting habitat for the northern flicker is thought to be patchy in the watershed. For nesting, the hairy woodpecker uses smaller diameter snags, which are not lacking in the watershed.

5-6.3.6.2 Recommendations for Deadwood-Associated Species

- Aspen provides habitat for a variety of wildlife species. Aspen is less abundant than it was historically in the watershed, is in poor condition, and has a low rate of regeneration. Measures such as fencing and conifer removal should be taken to protect the remaining aspen groves and enhance regeneration of this species.
- Hardwoods are lacking in the watershed. Restoring hardwoods through plantings where project design indicates, especially aspen, to the riparian area would improve habitat conditions for those species dependent on this habitat.
- As mentioned above, retain existing large-diameter snags, to meet forest standards, which is the retention of 2.39 snags, 21 inch and over dbh, per acre. Retain large-diameter soft snags to provide habitat for the northern flicker.
- Continue to meet to down wood requirements specified in the Amendment 2 at the project level.

5-6.3.6.3 LRMP Featured Species

5-6.3.6.3.1 Osprey and other raptors

Osprey are successfully nesting and reproducing along lakes and large lakes throughout the state as the persistence of DDT levels continue to lessen in intensity in the environment. Canyon Creek in the Fawn subwatershed continue to provide potential habitat but the watershed does not have a high density of large, fish-bearing water bodies. Other raptors discussed in *Chapter 3* continue to use the watershed for nesting and foraging.

5-6.3.6.3.2 California bighorn sheep

As stated previously, bighorn sheep were extirpated from Oregon by the mid-1940s and last seen in the John Day area around 1915. The size of the reintroduced population throughout the Blue Mountains managed by ODFW is not known.

5-6.3.6.3.3 Blue Grouse

Grouse, which prefer large mistletoe-infected Douglas-fir trees for winter roosts currently have an abundance of available habitat. This mistletoe however is currently posing a fire danger due to the absence of the frequent fires that historically kept the infection present in the watershed but at lower level.

5-6.3.6.3.4 Pronghorn

As stated before, this species is associated with open grasslands, precludes it's presence in the analysis area.

5-6.3.6.3.5 Neotropical migratory land birds

As stated previously, neotropical migratory land birds, probably had access to a greater quantity available habitats than the current day situation. Studies have shown a slow but steady decline of habitats through the range of these species especially in riparian areas. The restoration of these habitats is an issue, not only in watershed or the Malheur National Forest, but range-wide throughout North and South America.

5-6.3.6.4 Recommendations for LRMP Featured Species

- For osprey, continue to retain large old growth along Canyon Creek for suitable nesting trees.
- For bighorn sheep, no recommendations for this particular watershed as ODFW continues to work with the re-introduced population.
- For blue grouse, the LRMP directs to maintain mistletoe infected trees however some of these trees will need to be thinned to reduce the fire danger in the WUI and elsewhere in the watershed.
- For pronghorns, no recommendations.
- For neotropical migratory land birds, the Partners in Flight, Northern Rocky Mountain Bird Conservation Plan calls for a number of restoration objectives to occur with species and their habitats over the next 25 years. *The Large Scale Conservation Assessment for Neotropical Migratory Birds in the Interior Columbia River Basin* (Saab and Rich 1997) conducted for ICBEMP also calls for basin –wide

coordination of inventory and monitoring results and site specific management plans. Implementation of such recommendations in the watershed may be of benefit to many of the neotropical bird species that occur in the watershed. At a project design level within the watershed, opportunity should be taken improve riparian and grassland habitats and retain and improve hardwood habitats.

- For raptors, continue to protect known nest trees, monitor nesting success and avoid disturbance in the nesting season through seasonally restricting the implementation of projects until after the nesting season.

Plate 5-6.1. Vance Creek along 3920 road. Note dense riparian vegetation along creek to left of road; however, the road encroaches too closely to the stream (photo taken November 19, 2002).

Plate 5-6.2. Canyon Creek mainstem, upstream of the Middle Fork Canyon Creek confluence. Riparian area shows effects of cattle grazing. Note shallow stream, trampled banks, high width/depth ratio (photo taken November 19, 2002).

Plate 5-6.3. Beaver dam in mainstem Canyon Creek, immediately upstream of confluence with East Fork Canyon Creek (photograph taken November 19, 2002).

Plate 5-6.4. Head cut in small stream on private land. Photograph taken from 6510 road (photograph taken November 19, 2002).

Plate 5-6.5. Small stream along 1500651 road. Area may have been wet meadow with undefined channel prior to burn in contributing area (photograph taken November 19, 2002).

Plate 5-6.6. Canyon Meadows Reservoir, looking downstream at the dam (photograph taken November 19, 2002).

Plate 5-6.7. Canyon Meadows Reservoir, looking upstream from same location as Plate 5-6.6 (photograph taken November 19, 2002).

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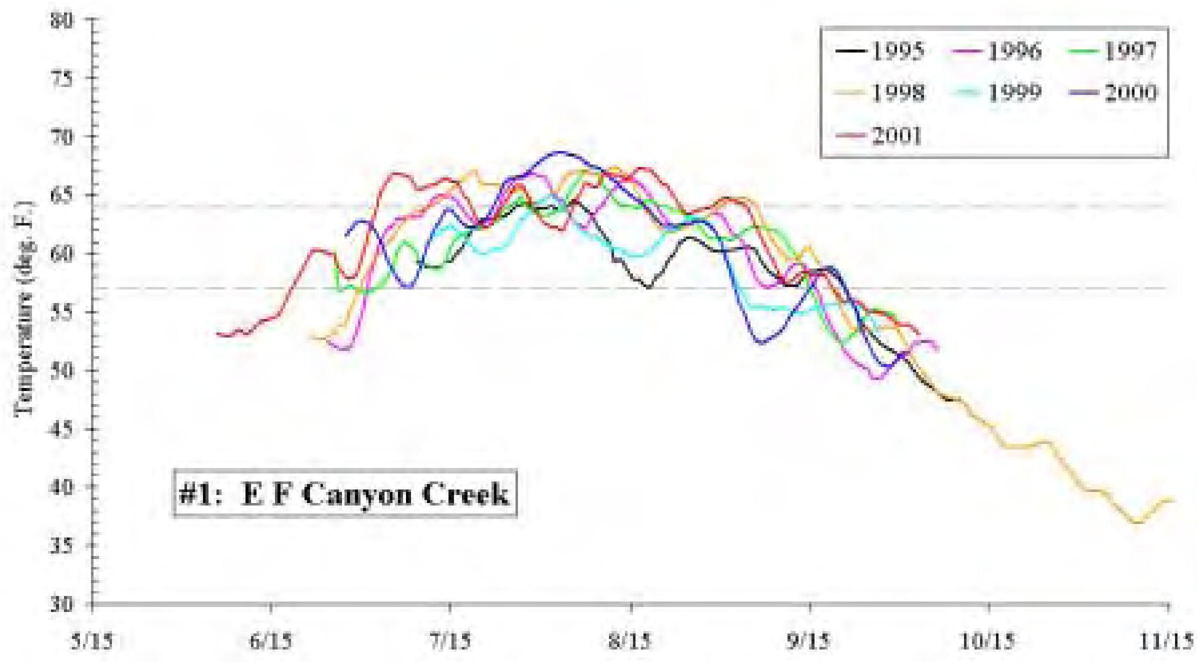
APPENDIX 1 – STREAM TEMPERATURE GRAPHS

Summary Table of USFS water temperature monitoring within the Canyon Creek watershed.

Map #	Site description	Year	Max 7-day temp. (° F)	Number of days 7/15 – 9/15: < 57 ° F	57 to 64 ° F	> 64 ° F
1	E F Canyon Creek	1995	64.6	0	57	6
		1996	66.9	0	39	24
		1997	67.1	0	44	19
		1998	67.5	0	22	41
		1999	65.0	12	46	5
		2000	68.7	13	24	26
		2001	67.3	0	28	35
2	M F Canyon Creek @ Mouth	1996	71.2	0	17	46
		1997	68.9	0	24	39
		1998	71.9	0	15	48
		2000	71.8	10	16	37
		2001	72.6	0	10	53
3	M F Canyon Creek near Wilderness	1999	61.2	28	35	0
		2000	64.5	15	43	5
4	M F Canyon Creek, Sec. 30 (#1)	1999	66.2	12	38	13
		2000	70.9	9	7	47
		2001	70.8	0	10	53
5	M F Canyon Creek, Sec. 30 (#2)	2000	64.8	16	41	6
6	M F Canyon Creek, Sec. 36	2000	72.4	7	9	47
7	M F Canyon Creek Above Wetlands	2001	73.0	0	9	54
8	M F Canyon Creek Below Wetlands	2001	72.8	0	10	53
9	M F Canyon Creek Below Narrow Canyon	2001	72.1	0	9	54
10	Canyon Creek above M F Canyon	1999	64.5	14	42	7
		2000	67.5	15	25	23
		2001	67.9	9	37	17
11	Canyon Creek above M F Canyon @ Draw	2002	70.0	18	26	19
12	Canyon Creek 1,000' below M F Canyon	2002	73.8	4	26	33
13	Canyon Creek above Big Canyon	2001	71.0	8	22	33
		2002	73.0	9	33	21
14	Canyon Creek below Crazy Creek	2001	72.7	0	7	56

Summary Table (continued) of USFS water temperature monitoring within the Canyon Creek watershed.

Map #	Site description	Year	Max 7-day temp. (° F)	Number of days 7/15 – 9/15:		
				< 57 ° F	57 to 64 ° F	> 64 ° F
15	Canyon Creek above Crazy Creek	1995	68.3	0	35	28
		1996	70.4	0	14	49
		1997	69.9	0	16	47
		1998	73.3	0	6	57
		1999	70.4	0	22	41
		2000	73.5	7	8	48
		2001	73.1	0	7	56
16	Crazy Creek Sec. 4	1999	50.7	63	0	0
		2000	51.3	63	0	0
17	Crazy Creek @ mouth	2000	61.2	35	28	0
18	Canyon Creek Sec. 31	2000	64.7	16	40	7
19	Canyon Creek Sec. 29	2000	59.4	28	35	0
20	Canyon Creek above Reservoir	1999	60.4	38	25	0
		2000	63.9	16	47	0
21	Canyon Creek @ Boundary	1999	69.1	0	27	36
		2000	73.7	7	8	48
		2001	75.1	0	0	63
		2002	76.9	0	6	57
22	Canyon Creek @ Wickiup Campground	2002	74.2	0	23	40
23	Canyon Creek below Wickiup Campground (at aspen exclosure)	1994	83.0	0	3	60
		1995	63.6	0	63	0
		1996	66.2	10	42	11
		1997	68.6	0	25	38
		1998	70.1	0	6	57
24	Canyon Creek below Road Gulch	1997	72.6	0	2	61
		1998	74.2	0	0	63
25	Vance Creek @ Boundary	1994	55.0	63	0	0
		1995	54.0	63	0	0
		1996	55.0	63	0	0
		1997	54.4	63	0	0
		1998	55.9	63	0	0
		1999	53.5	63	0	0
		2000	55.1	63	0	0



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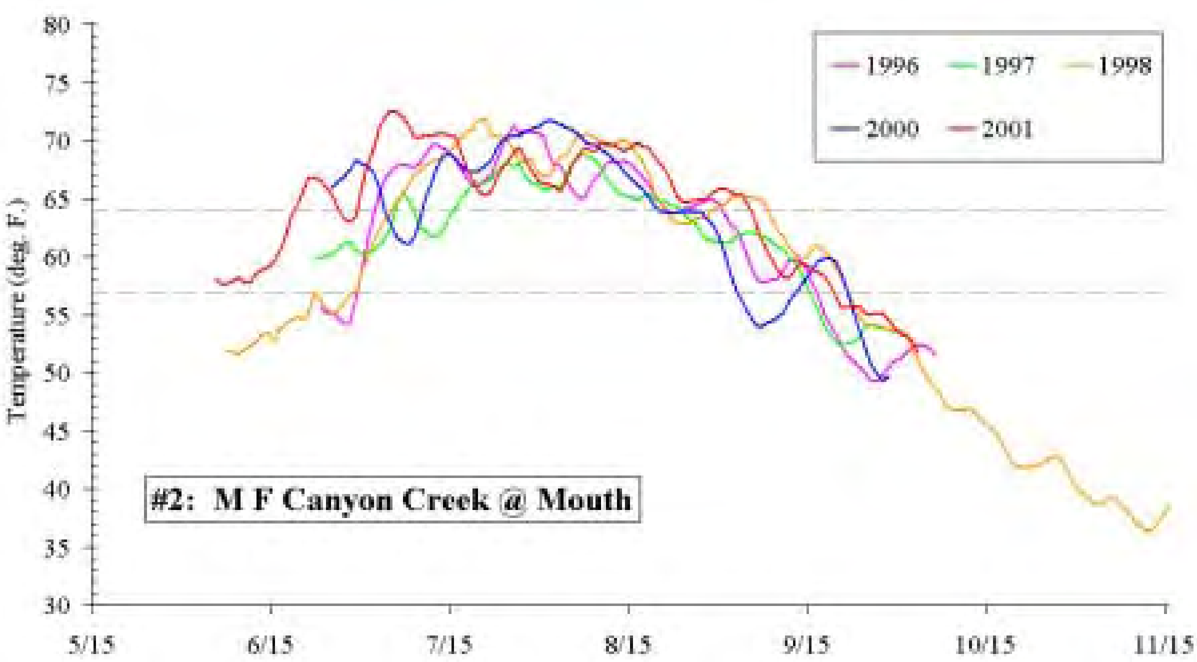
30
Temperature (deg. F.)
1995
1996
1997
1998
1999
2000
2001
#1: E F Canyon Creek
5/15
6/15
7/15
8/15
9/15
10/15
11/15



80
75
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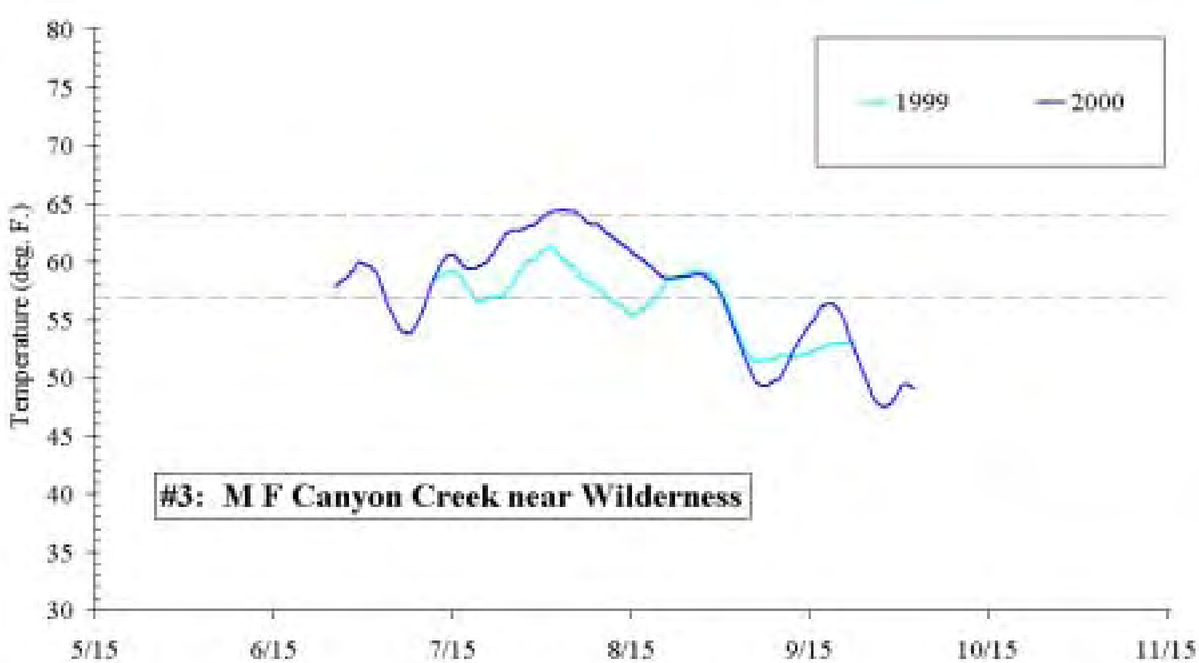
40
35
30
Temperature (deg. F.)
1996
1997
1998
2000
2001
#2: M F Canyon Creek @ Mouth
5/15
6/15
7/15
8/15
9/15
10/15
11/15



80
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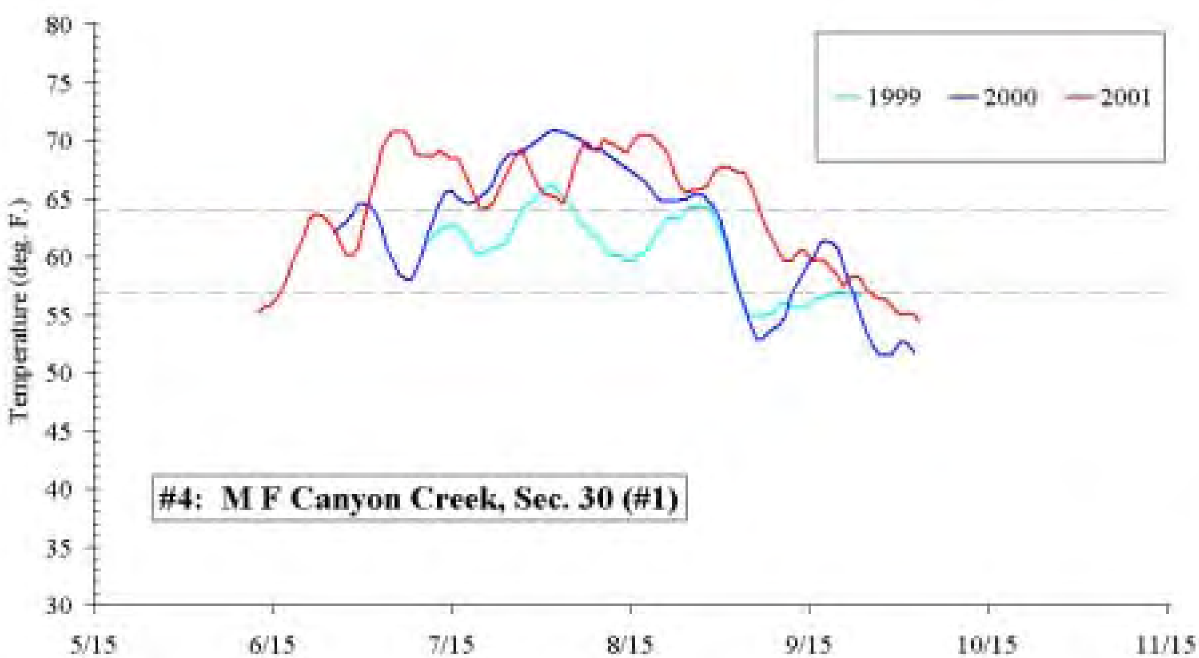
35
30
Temperature (deg. F.)
5/15
6/15
7/15
8/15
9/15
10/15
11/15
1999
2000
#3: M F Canyon Creek near Wilderness



80
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65
60
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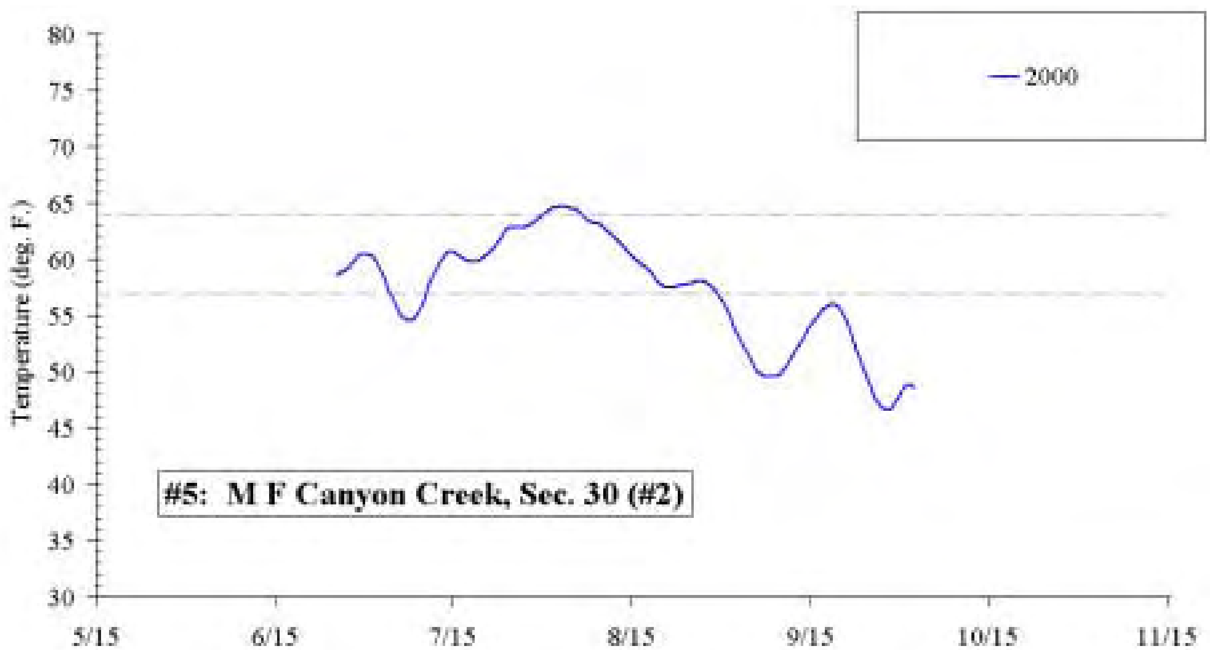
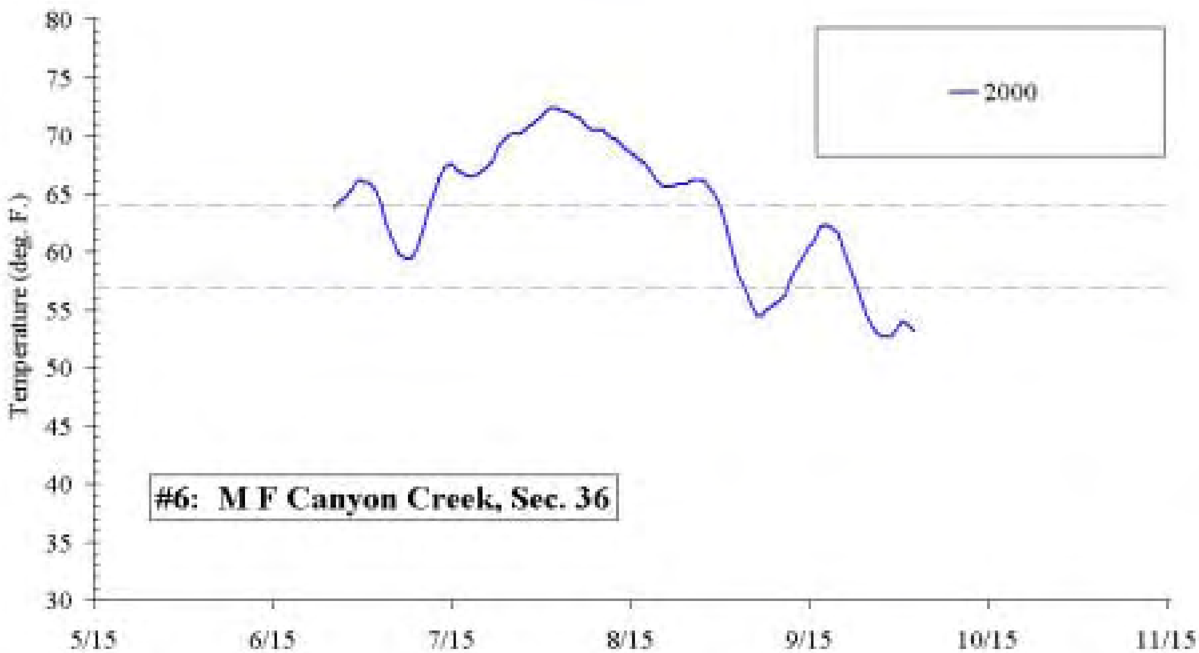
35
30
Temperature (deg. F.)
5/15
6/15
7/15
8/15
9/15
10/15
11/15
1999
2000
2001
#4: M F Canyon Creek, Sec. 30 (#1)


2000
Temperature (deg. F.)
80
75
70
65
60
55
50
45
40
35
30
#5: M F Canyon Creek, Sec. 30 (#2)
5/15
6/15
7/15
8/15
9/15
10/15
11/15


2000
Temperature (deg. F.)
80
75
70
65
60
55
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45
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35
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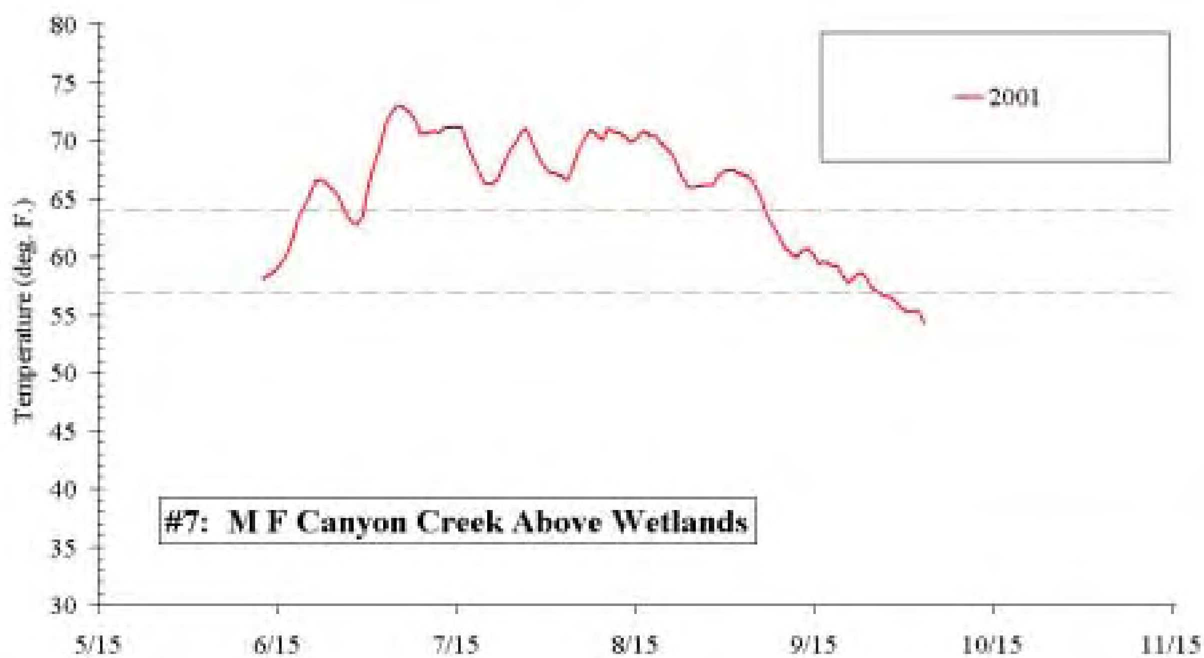
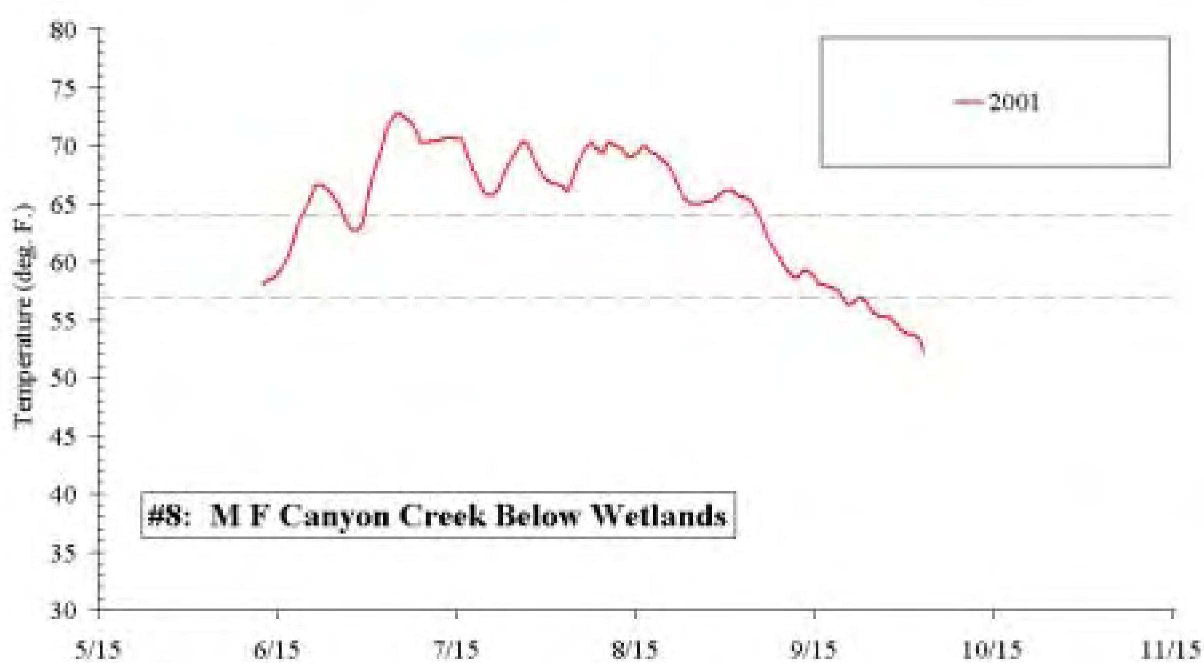
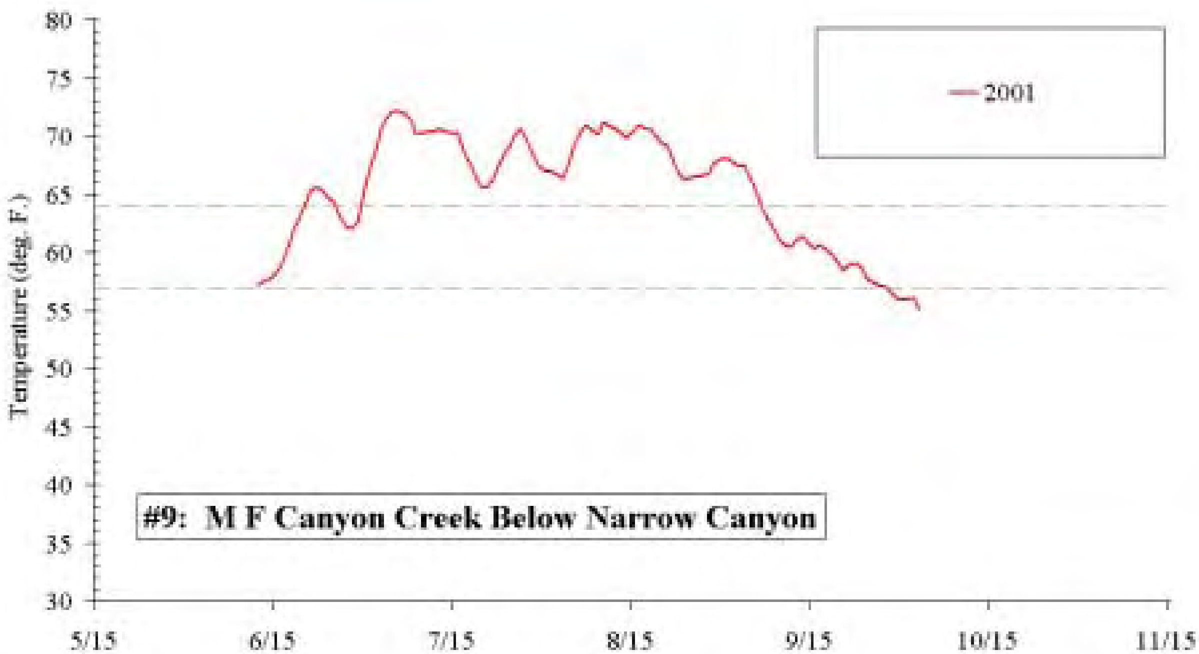
#6: M F Canyon Creek, Sec. 36
5/15
6/15
7/15
8/15
9/15
10/15
11/15



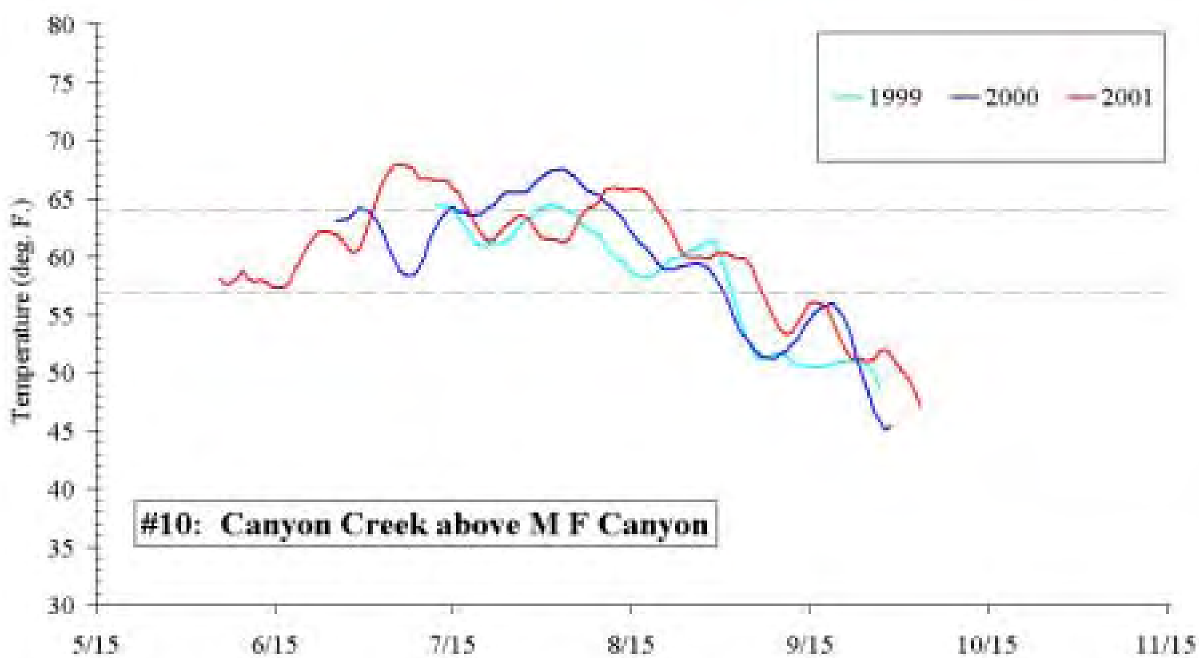
2001
#7: M F Canyon Creek Above Wetlands
Temperature (deg. F.)
80
75
70
65
60
55
50
45
40
35
30
5/15
6/15
7/15
8/15
9/15
10/15
11/15



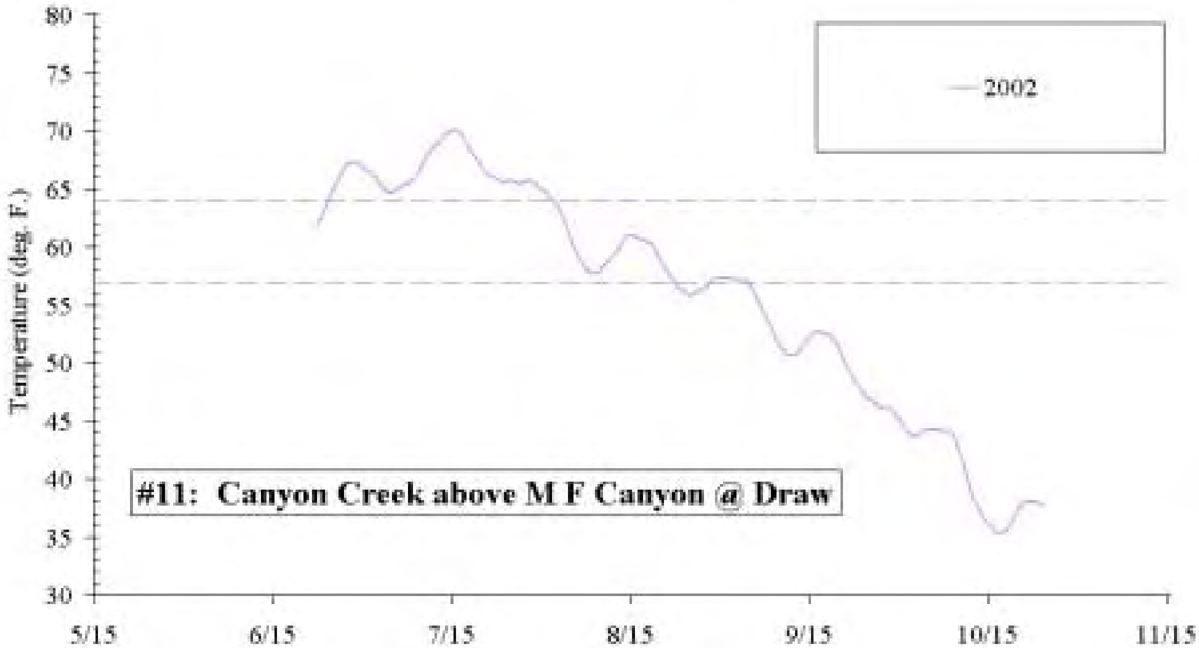
2001
#8: M F Canyon Creek Below Wetlands
Temperature (deg. F.)
80
75
70
65
60
55
50
45
40
35
30
5/15
6/15
7/15
8/15
9/15
10/15
11/15



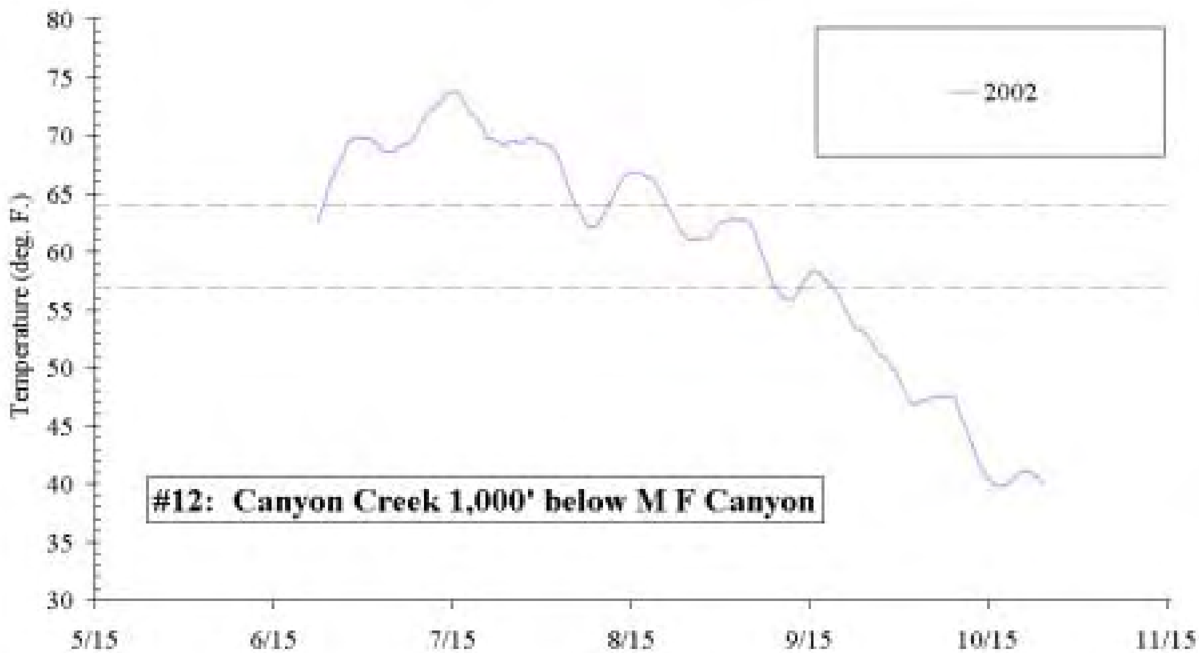
2001
#9: M F Canyon Creek Below Narrow Canyon
Temperature (deg. F.)
80
75
70
65
60
55
50
45
40
35
30
5/15
6/15
7/15
8/15
9/15
10/15
11/15



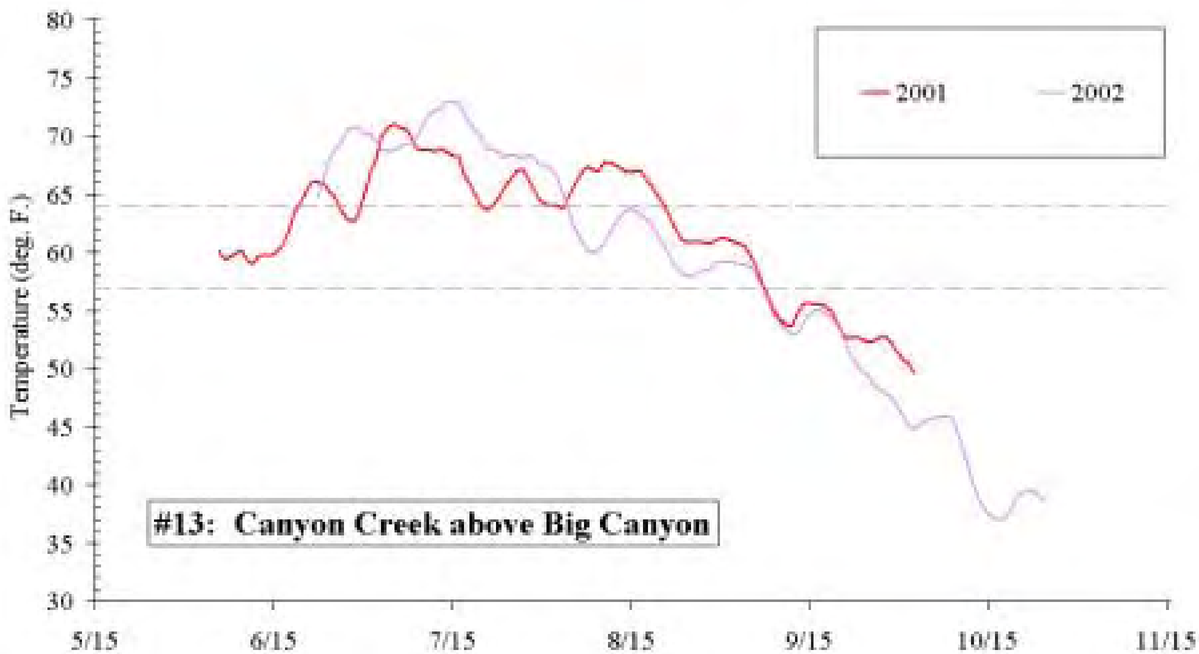
1999
2000
2001
#10: Canyon Creek above M F Canyon
Temperature (deg. F.)
80
75
70
65
60
55
50
45
40
35
30
5/15
6/15
7/15
8/15
9/15
10/15
11/15



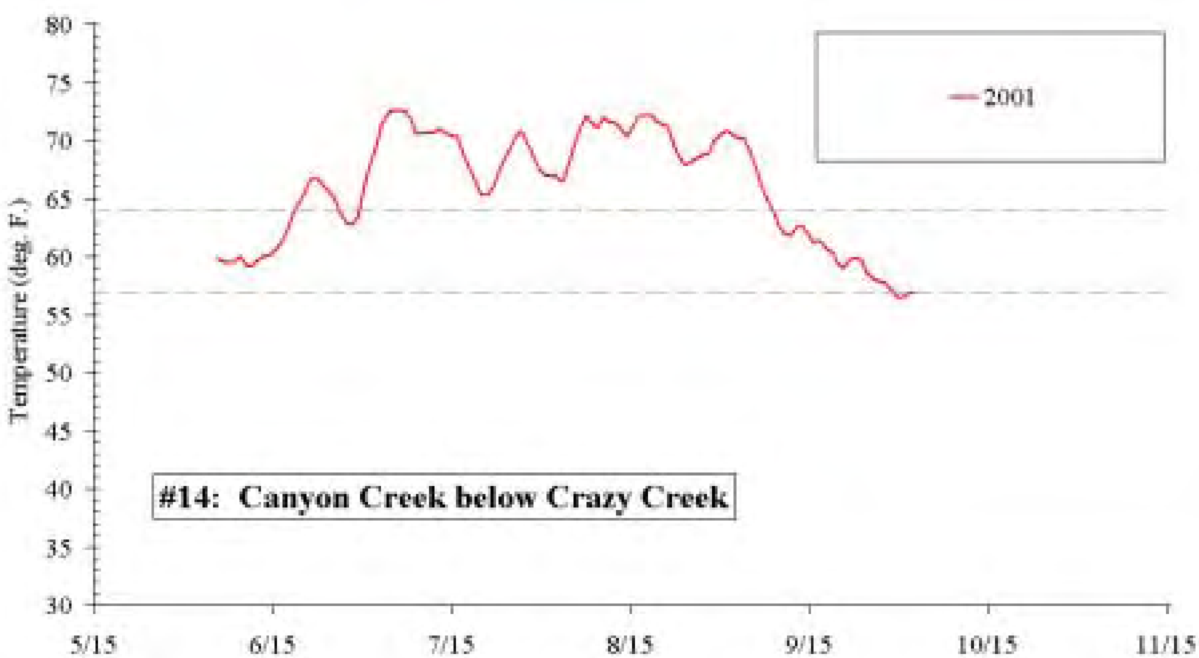
2002
#11: Canyon Creek above M F Canyon @ Draw
Temperature (deg. F.)
80
75
70
65
60
55
50
45
40
35
30
5/15
6/15
7/15
8/15
9/15
10/15
11/15



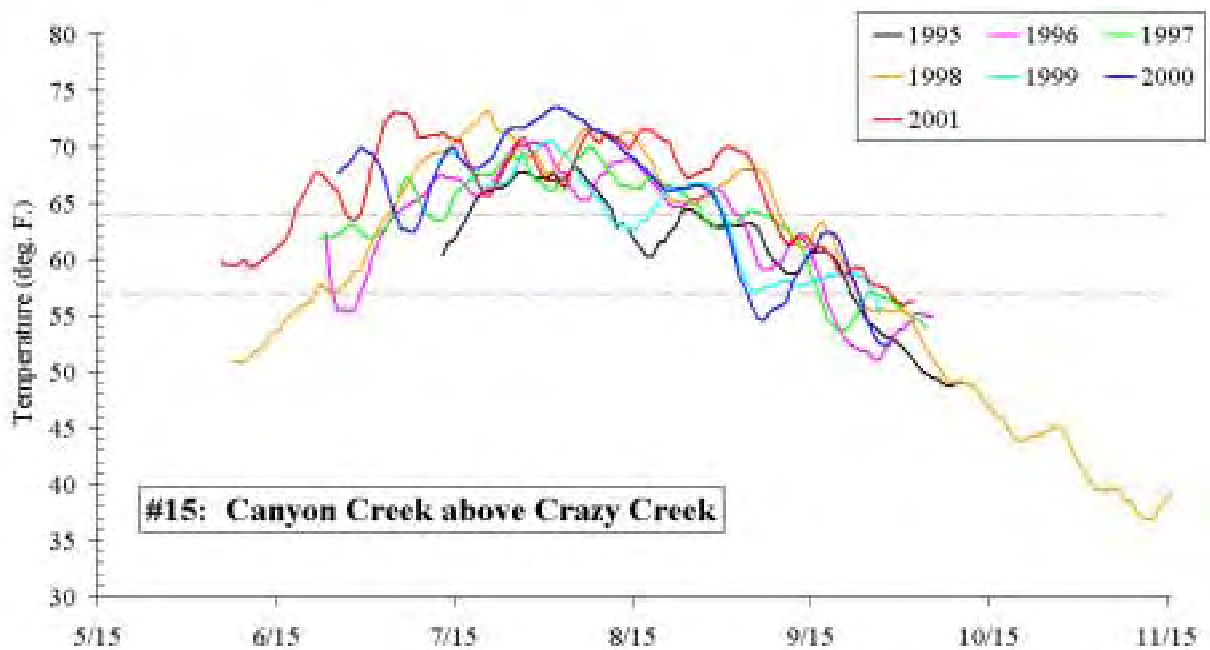
2002
#12: Canyon Creek 1,000' below M F Canyon
Temperature (deg. F.)
80
75
70
65
60
55
50
45
40
35
30
5/15
6/15
7/15
8/15
9/15
10/15
11/15



80
75
70
65
60
55
50
45
40
35
30
Temperature (deg. F.)
5/15
6/15
7/15
8/15
9/15
10/15
11/15
2001
2002
#13: Canyon Creek above Big Canyon



80
75
70
65
60
55
50
45
40
35
30
Temperature (deg. F.)
5/15
6/15
7/15
8/15
9/15
10/15
11/15
2001
#14: Canyon Creek below Crazy Creek



1995
1996
1997
1998
1999
2000
2001
Temperature (deg. F.)
80
75
70
65
60
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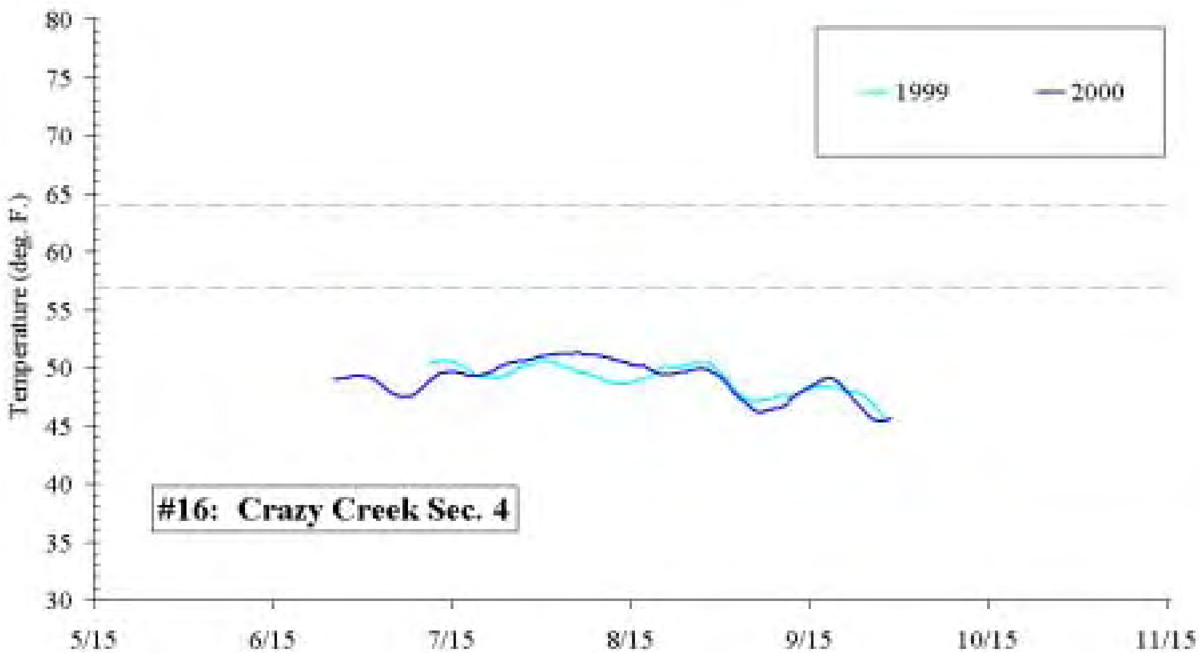
45
40
35
30
#15: Canyon Creek above Crazy Creek
5/15
6/15
7/15
8/15
9/15
10/15
11/15



1999
2000
Temperature (deg. F.)
80
75
70
65
60
55
50
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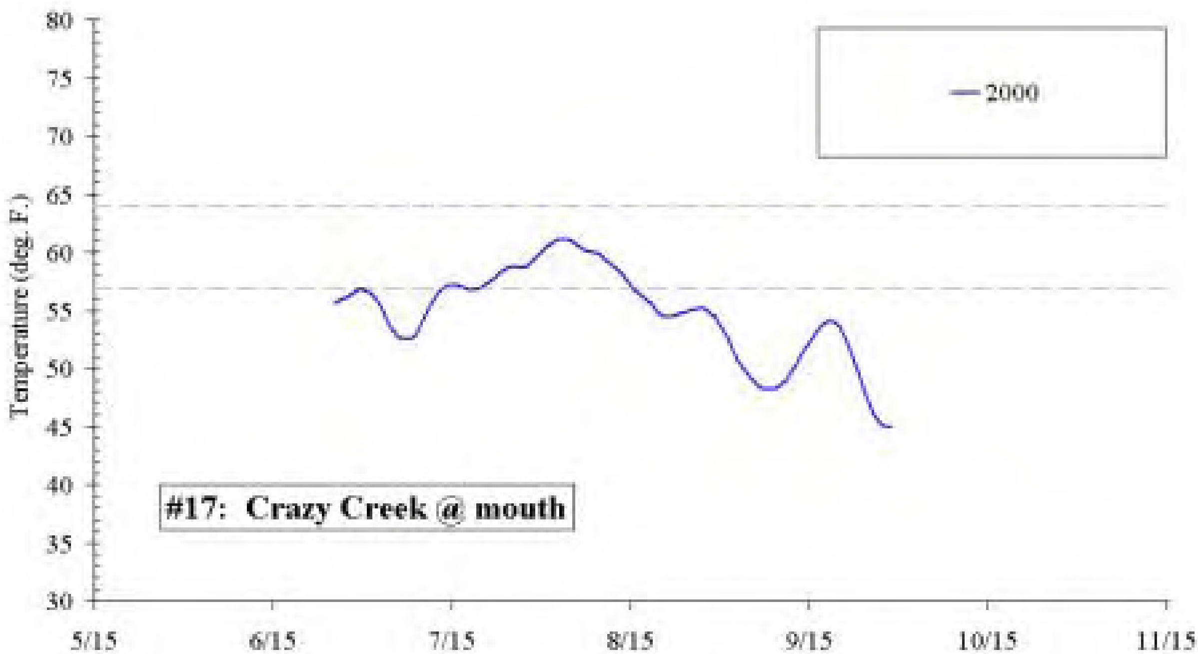
35
30
#16: Crazy Creek Sec. 4
5/15
6/15
7/15
8/15
9/15
10/15
11/15


80
75
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65
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55
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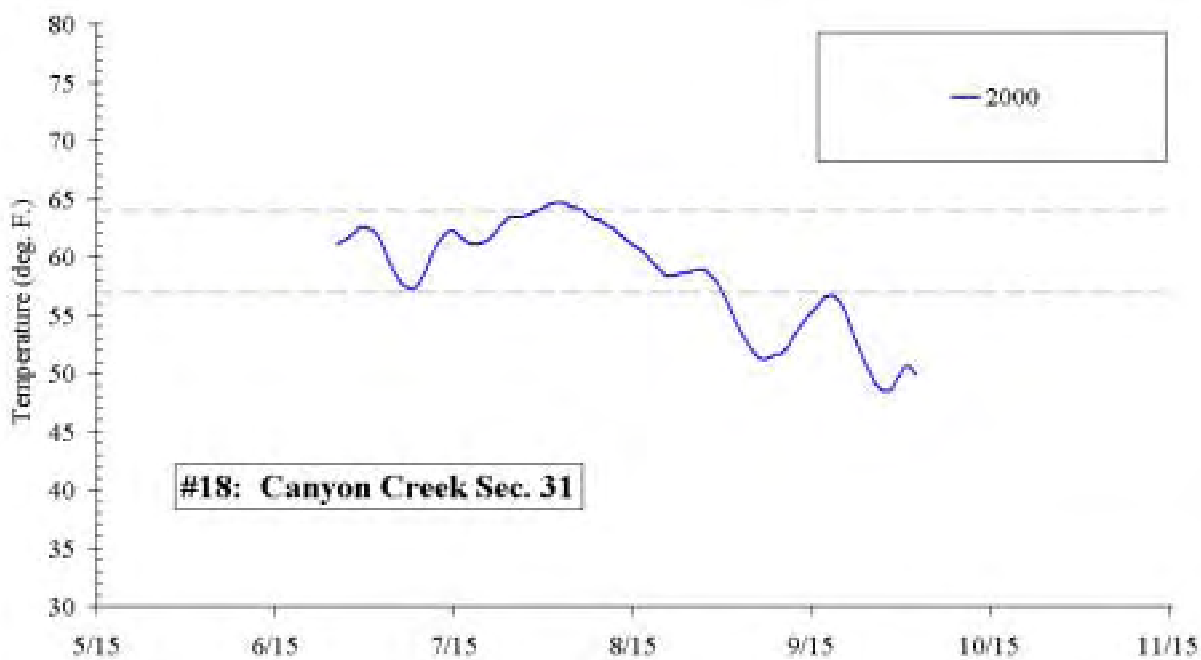
45
40
35
30
Temperature (deg. F.)
5/15
6/15
7/15
8/15
9/15
10/15
11/15
2000
#17: Crazy Creek @ mouth


80
75
70
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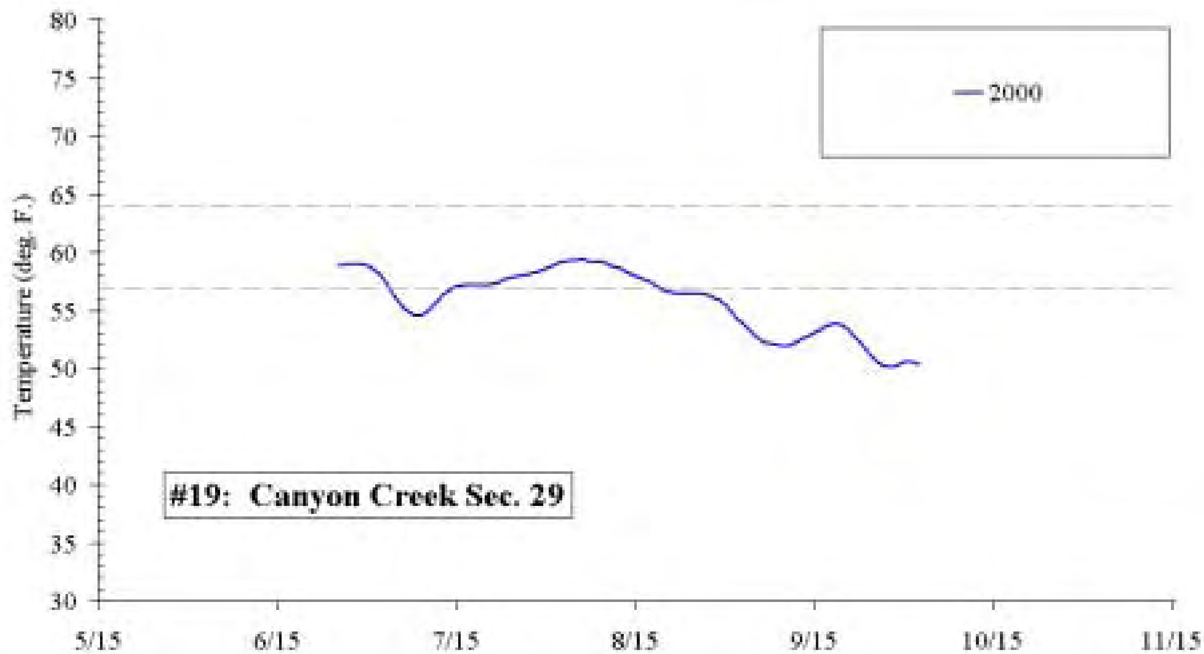
40
35
30
Temperature (deg. F.)
5/15
6/15
7/15
8/15
9/15
10/15
11/15
2000
#18: Canyon Creek Sec. 31



2000
#19: Canyon Creek Sec. 29
Temperature (deg. F.)
80
75
70
65
60
55
50
45
40
35
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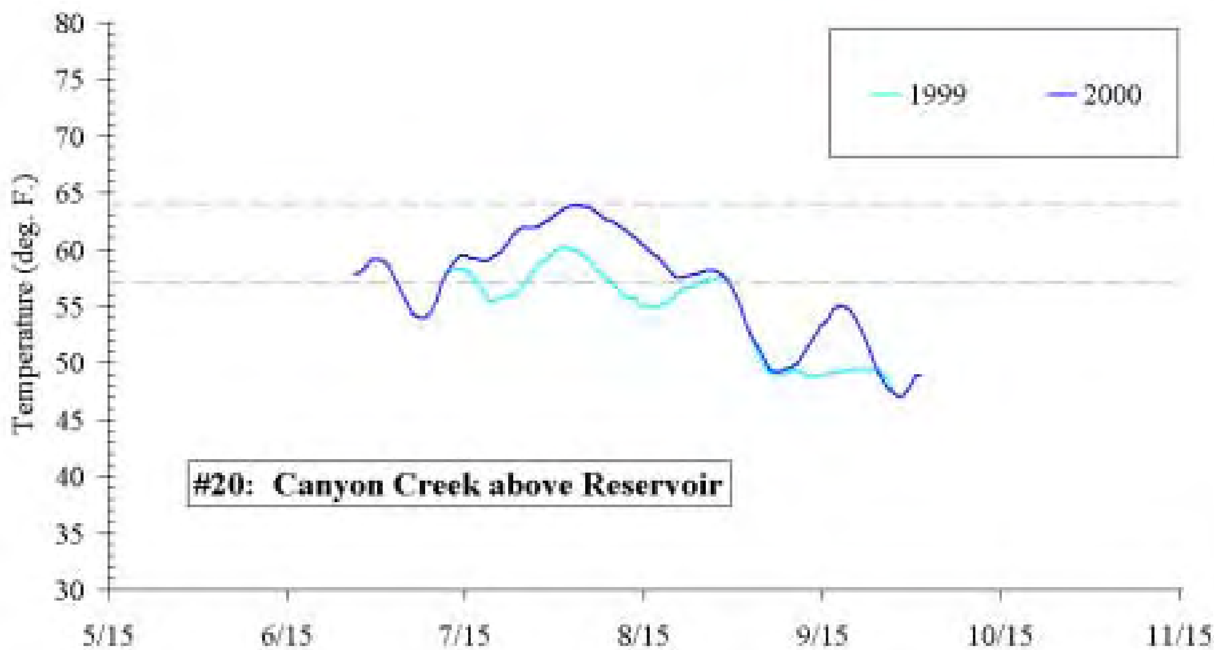
5/15
6/15
7/15
8/15
9/15
10/15
11/15



1999
2000
#20: Canyon Creek above Reservoir
Temperature (deg. F.)
80
75
70
65
60
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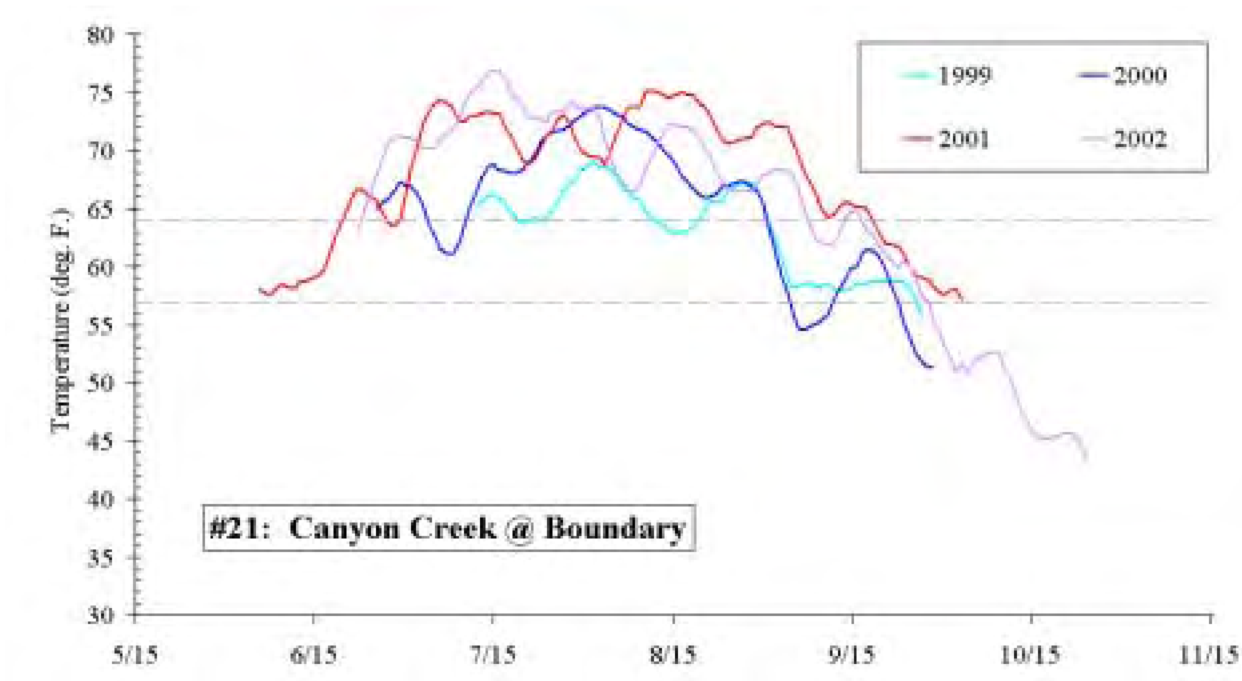
40
35
30
5/15
6/15
7/15
8/15
9/15
10/15
11/15



80
75
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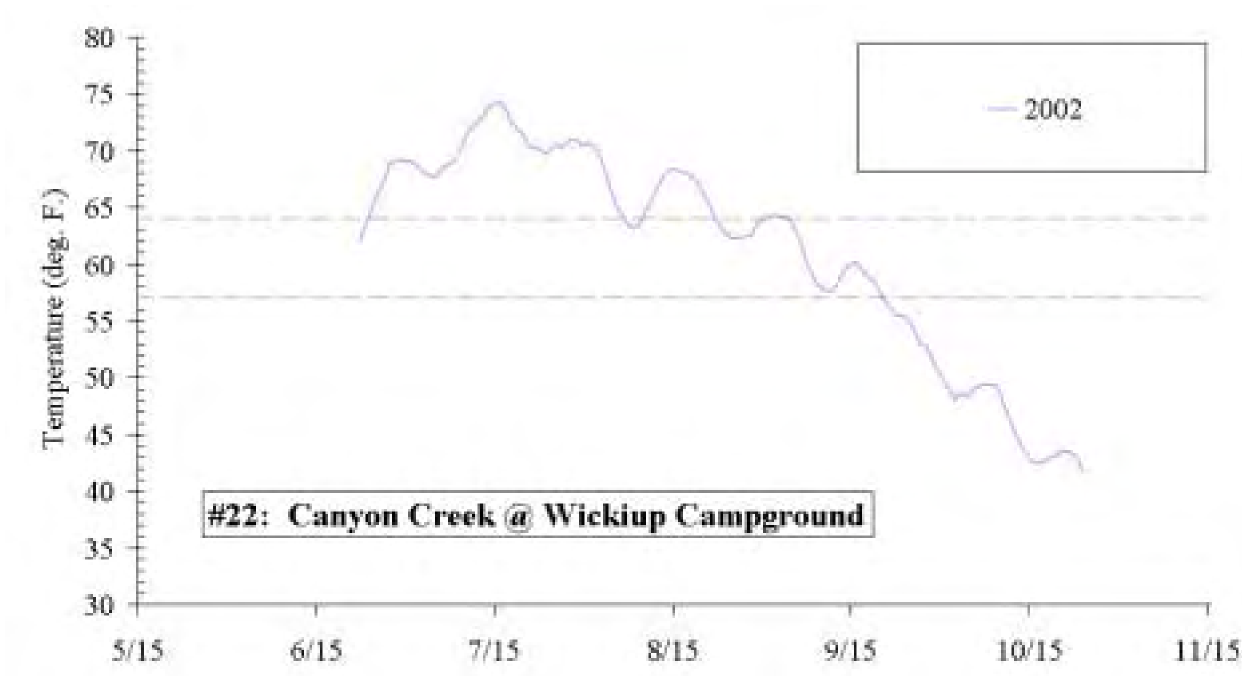
40
35
30
Temperature (deg. F.)
1999
2000
2001
2002
#21: Canyon Creek @ Boundary
5/15
6/15
7/15
8/15
9/15
10/15
11/15



80
75
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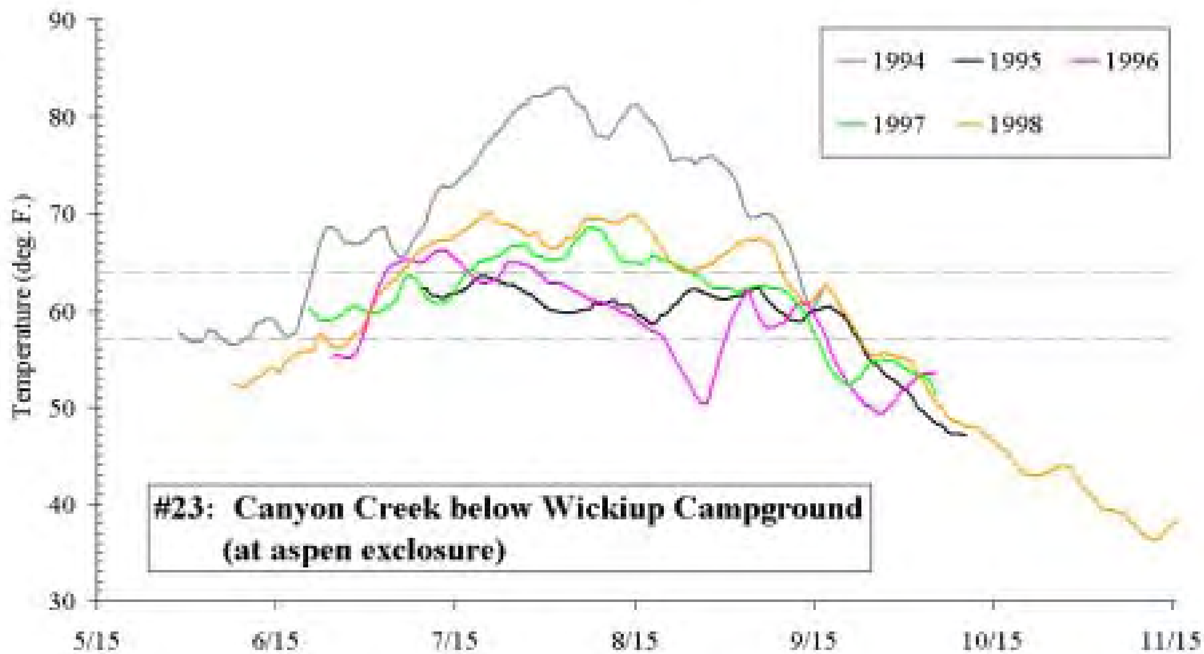
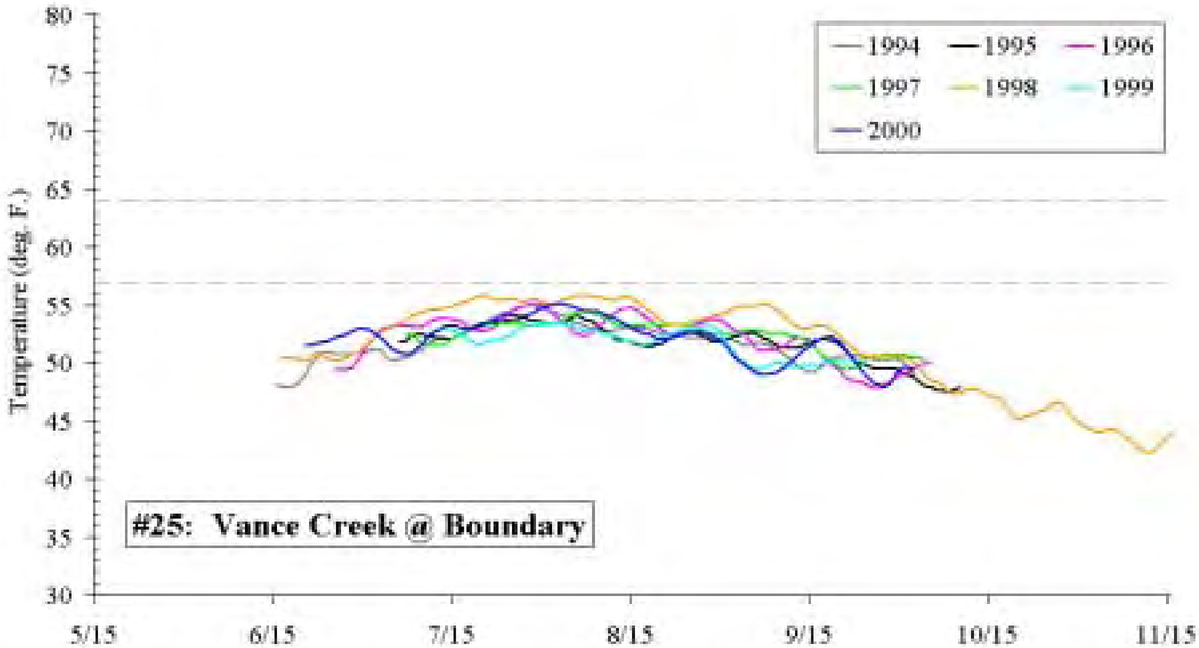
40
35
30
Temperature (deg. F.)
2002
#22: Canyon Creek @ Wickiup Campground
5/15
6/15
7/15
8/15
9/15
10/15
11/15


90
80
70
60
50
40
30
Temperature (deg. F.)
1994
1995
1996
1997
1998
#23: Canyon Creek below Wickiup Campground
(at aspen exclosure)
5/15
6/15
7/15
8/15
9/15
10/15
11/15


80
75
70
65
60
55
50
45
40
35
30
Temperature (deg. F.)
1997
1998
#24: Canyon Creek below Road Gulch
5/15
6/15
7/15
8/15
9/15
10/15
11/15


80
75
70
65
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45
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35
30
Temperature (deg. F.)
1994
1995
1996
1997
1998
1999
2000
#25: Vance Creek @ Boundary
5/15
6/15
7/15
8/15
9/15
10/15
11/15

APPENDIX 2 – CHANNEL REACH SUMMARY

Channel Reach SummaryTable

Subwatershed	Reach	Slope	Sinuosity	Length (ft)	Length (m)	Rosgen type
Berry Creek	Berry Creek: Reach #1	5.7%	1.02	8,889	2,709	A
	Berry Creek: Reach #2	7.3%	1.01	9,160	2,792	A
	Berry Creek: Reach #3	23.6%	1.01	9,773	2,979	Aa+
	Berry Creek_T1: Reach #1	21.3%	1.00	13,612	4,149	Aa+
	Canyon Creek: Reach #3	1.5%	1.03	5,684	1,733	G
	Canyon Creek: Reach #4	1.5%	1.05	9,384	2,860	G
	Deer Creek: Reach #1	9.9%	1.01	4,159	1,268	A
	Deer Creek: Reach #2	14.5%	1.01	8,072	2,460	Aa+
	Sheep Gulch: Reach #1	12.3%	1.02	7,490	2,283	Aa+
	Sheep Gulch: Reach #2	20.8%	1.01	5,315	1,620	Aa+
	Byram Gulch: Reach #1	14.8%	1.01	2,249	685	Aa+
	Byram Gulch: Reach #2	17.1%	1.01	3,300	1,006	Aa+
Canyon City	Canyon Creek: Reach #1	0.8%	1.04	16,086	4,903	G
	Canyon Creek: Reach #2	2.4%	1.02	14,491	4,417	B
Canyon Meadows	Canyon Creek: Reach #10	3.8%	1.05	12,514	3,814	B
	Canyon Creek: Reach #11	0.9%	1.00	4,376	1,334	Res
	Canyon Creek: Reach #12	3.7%	1.06	5,858	1,786	B
	Canyon Creek: Reach #13	4.4%	1.01	4,662	1,421	A
	Canyon Creek: Reach #14	15.1%	1.04	10,969	3,343	Aa+
	Canyon Creek: Reach #9	1.9%	1.06	11,271	3,435	G/C
	Crazy Creek: Reach #1	6.6%	1.03	8,352	2,546	A
	Crazy Creek: Reach #2	9.2%	1.02	4,109	1,253	A
Fawn	Bear Gulch: Reach #1	6.9%	1.02	12,533	3,820	A
	Canyon Creek: Reach #5	1.1%	1.07	11,295	3,443	G
	Canyon Creek: Reach #6	1.0%	1.10	22,020	6,712	G/C
	Canyon Creek: Reach #7a	1.4%	1.09	2,902	884	G/C
	East Gulch: Reach #1	4.1%	1.07	4,115	1,254	A
	East Gulch: Reach #2	9.2%	1.03	7,755	2,364	A
	Fawn: Reach #1	9.0%	1.05	8,110	2,472	A
	W. Fork East Gulch: Reach #1	7.6%	1.02	7,686	2,343	A
Lower East Fork	E. F. Canyon Creek: Reach #1	2.2%	1.07	6,080	1,853	B
	E. F. Canyon Creek: Reach #2	4.9%	1.05	5,202	1,586	A
	E. F. Canyon Creek: Reach #3	2.7%	1.08	13,311	4,057	B
	North Fork Wall Ck: Reach #1	9.3%	1.02	5,734	1,748	A

Subwatershed	Reach	Slope	Sinuosity	Length (ft)	Length (m)	Rosgen type
	North Fork Wall Ck: Reach #2	19.1%	1.02	3,128	953	Aa+
	Wall Creek: Reach #1	6.2%	1.02	14,248	4,343	A
	Wall Creek: Reach #3	6.9%	1.03	1,232	376	A
	Wall Creek: Reach #4	9.8%	1.01	13,633	4,155	A
	Wall Creek_T1: Reach #1	15.1%	1.04	6,494	1,980	Aa+
Middle Fork Canyon Creek	MF Canyon Creek: Reach #1	2.6%	1.05	13,446	4,098	B
	MF Canyon Creek: Reach #2	3.5%	1.05	7,326	2,233	B
	MF Canyon Creek: Reach #3	4.7%	1.04	6,386	1,947	A
	MF Canyon Creek: Reach #4	5.1%	1.05	6,119	1,865	A
	MF Canyon Creek: Reach #5	8.5%	1.06	5,057	1,541	A
	MF Canyon Creek: Reach #6	17.2%	1.01	6,776	2,065	Aa+
	MF Canyon Creek_T1: Reach #1	20.4%	1.02	8,218	2,505	Aa+
	MF Canyon Creek_T2: Reach #1	9.7%	1.01	2,616	797	A
	MF Canyon Creek_T2: Reach #2	17.5%	1.01	7,780	2,371	Aa+
Sugarloaf	Canyon Creek: Reach #7b	1.4%	1.09	15,748	4,800	G/C
	Canyon Creek: Reach #8	1.6%	1.09	5,528	1,685	G/C
	Sugarloaf Gulch: Reach #1	6.2%	1.02	13,270	4,045	A
	WF Wickiup Creek: Reach #1	8.2%	1.03	7,662	2,335	A
	Wickiup Creek: Reach #1	6.9%	1.01	1,836	560	A
	Wickiup Creek: Reach #2	8.4%	1.03	6,520	1,987	A
Upper East Fork	Brooklings Creek: Reach #1	5.8%	1.02	1,450	442	A
	Brooklings Creek: Reach #2	8.9%	1.01	6,512	1,985	A
	Brooklings Creek: Reach #3	24.1%	1.01	6,728	2,051	Aa+
	E. Brooklings Ck: Reach #1	11.6%	1.01	11,809	3,599	Aa+
	E. F. Canyon Creek: Reach #4	4.0%	1.04	12,961	3,950	A
	E. F. Canyon Creek: Reach #5	11.1%	1.01	9,404	2,866	Aa+
	Miner's Creek: Reach #1	14.7%	1.00	11,215	3,418	Aa+
	Skin Shin Creek: Reach #1	9.7%	1.09	7,308	2,227	A
	Skin Shin Creek: Reach #2	32.9%	1.01	4,346	1,325	Aa+
	Tamarack Creek: Reach #1	6.0%	1.01	4,158	1,267	A
	Tamarack Creek: Reach #2	9.8%	1.02	4,263	1,299	A
Vance Creek	Vance Creek: Reach #1	3.0%	1.03	11,468	3,496	G/B
	Vance Creek: Reach #2	3.9%	1.03	2,461	750	G/B
	Vance Creek: Reach #3	8.6%	1.04	9,541	2,908	A
	Vance Creek_T1: Reach #1	15.2%	1.01	6,873	2,095	Aa+
	Vance Creek_T2: Reach #1	6.9%	1.02	4,740	1,445	A