1 CHARACTERIZATION OF THE WATERSHED

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).

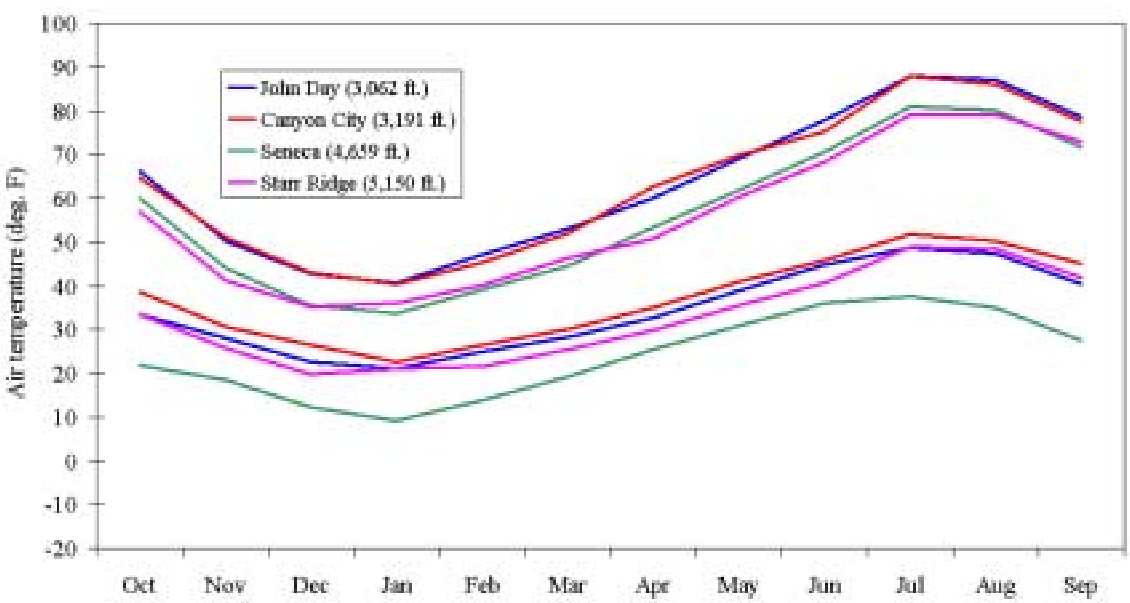
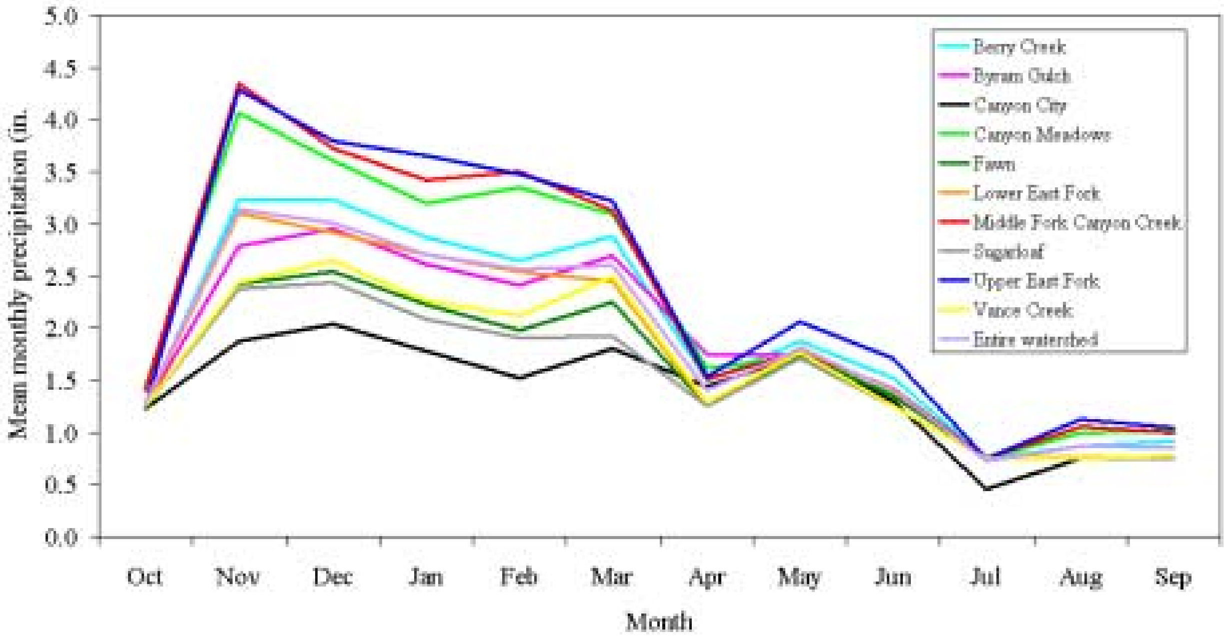


Figure 1.1. Mean minimum and maximum air temperatures for climate stations in the vicinity of the Canyon Creek watershed. Refer to Table 1.4 and Map 1.8 for station location and data availability.



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;* $r^2 = 0.52$

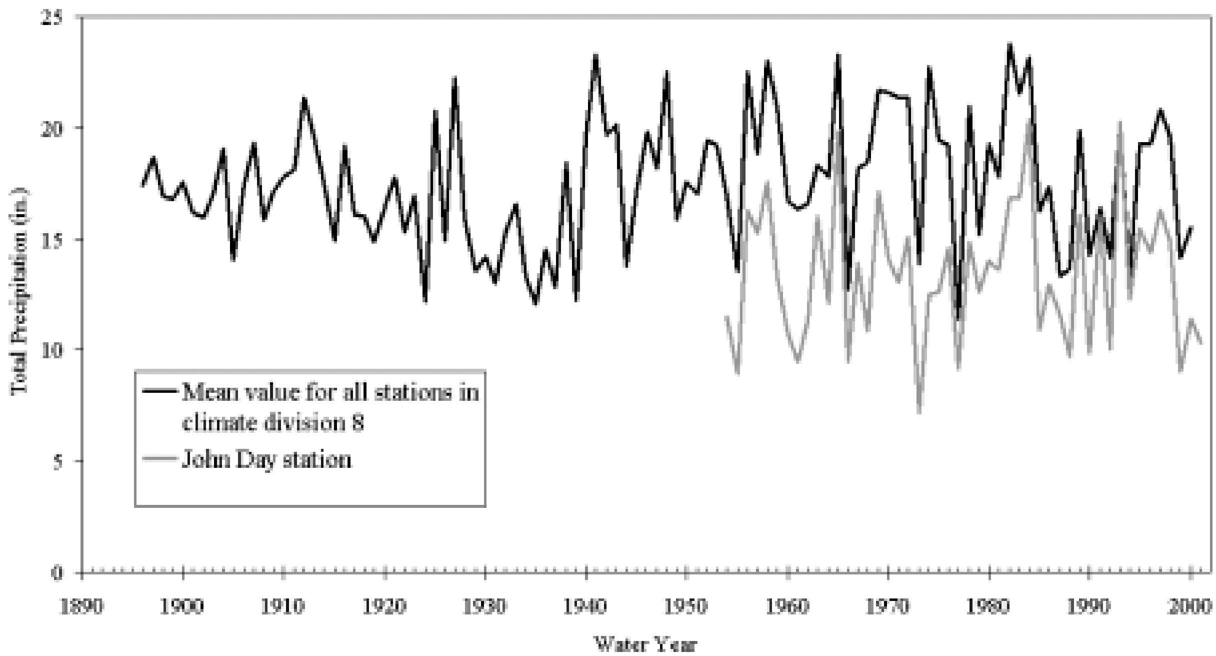


Figure 1.3. Composite annual precipitation record for Oregon climate division #8 (OCS 2002), and annual precipitation from the John Day climate station.

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.

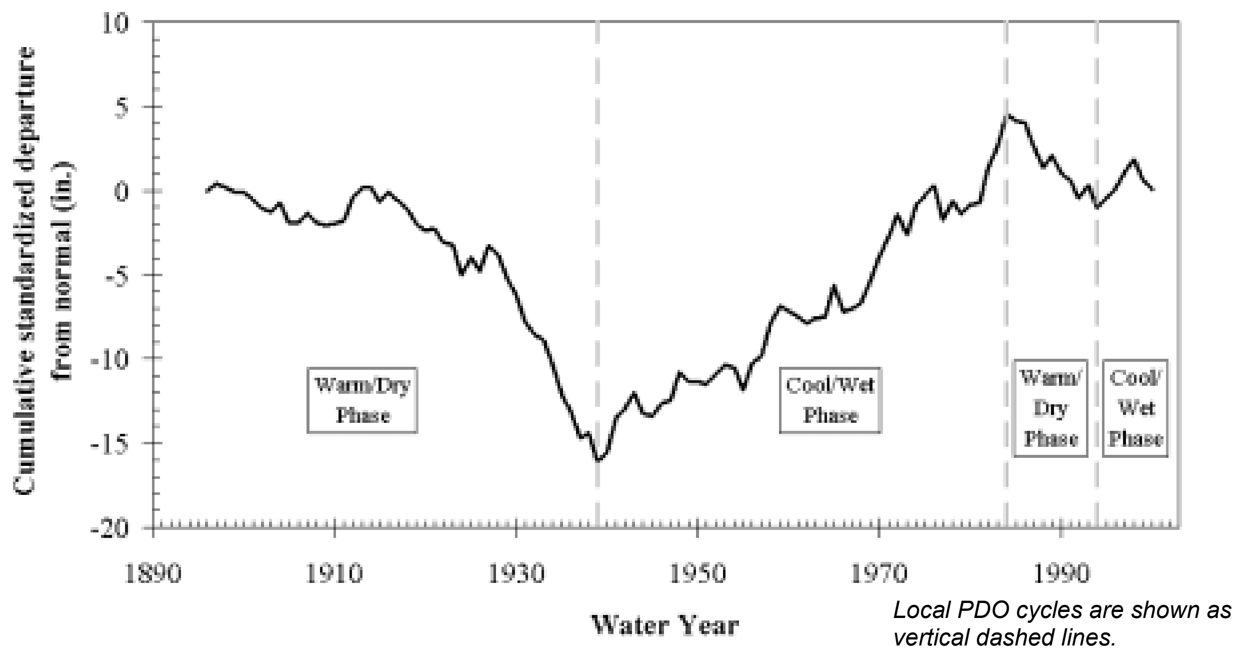
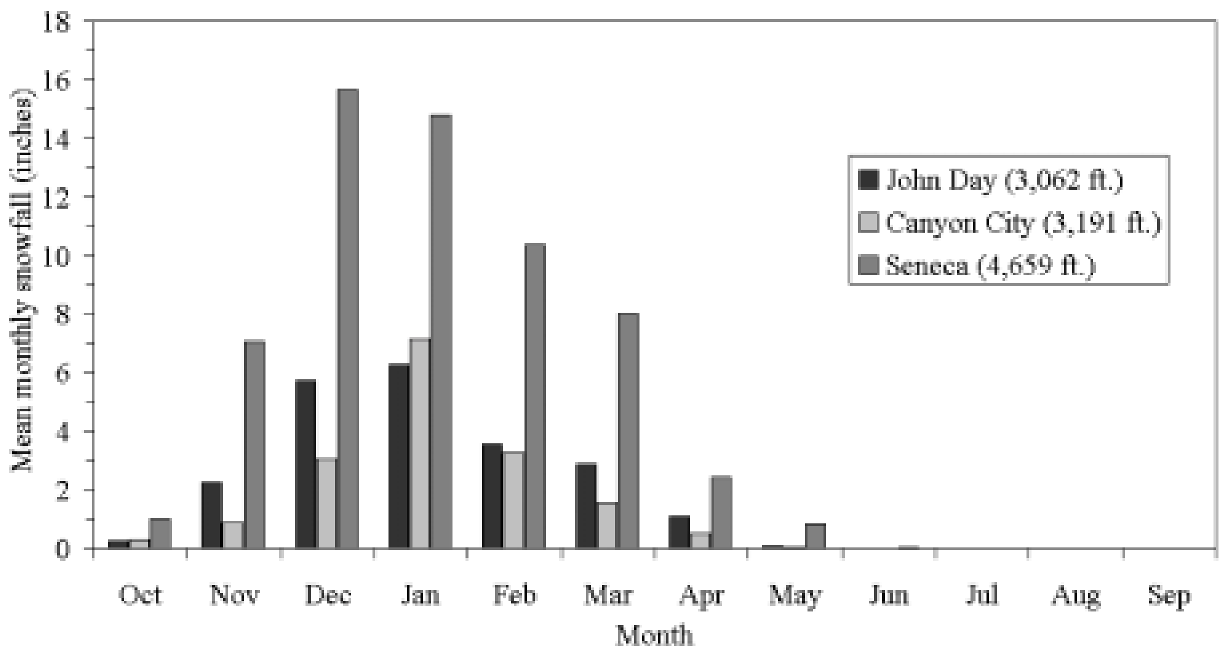


Figure 1.4. Cumulative standardized departure from normal for the composite annual precipitation record for Oregon climate division #8.

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.

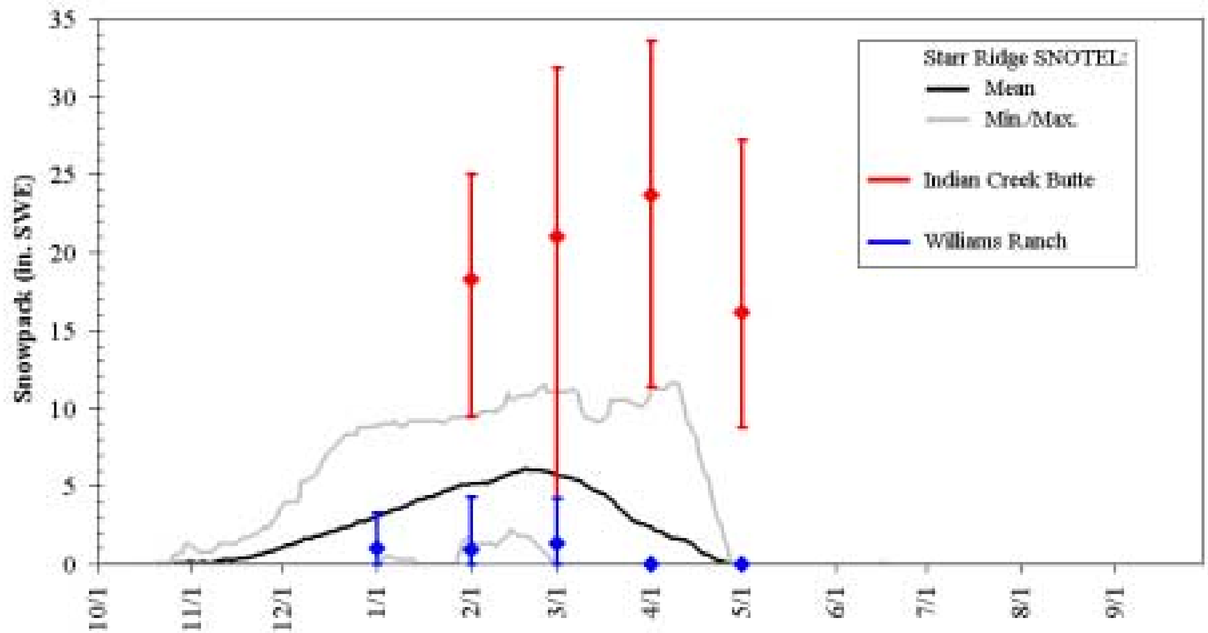
1.4.4 Snowfall and Snowpack

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.

		Elevation (ft):			Slope (%):		
Subwatershed	**Area (mi^2)**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**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).

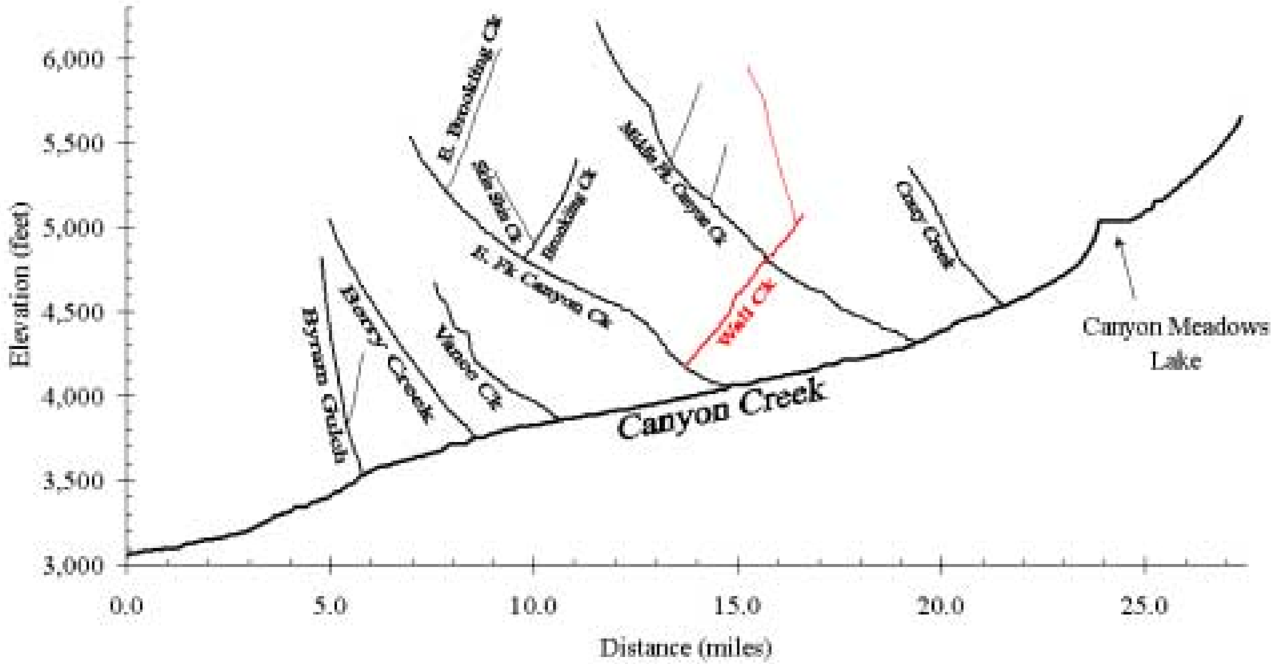


Figure shows relative channel gradients of the principal streams in the watershed.

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*

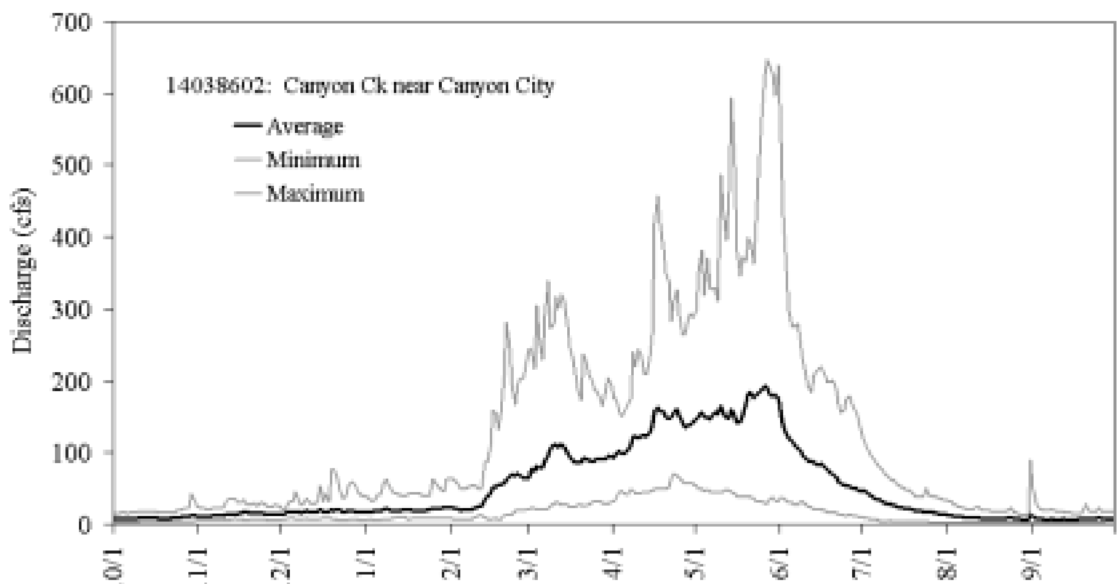
Refer to Map 1.11 for gage locations. Data source: OWRD (2002a), USGS (2002).

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.

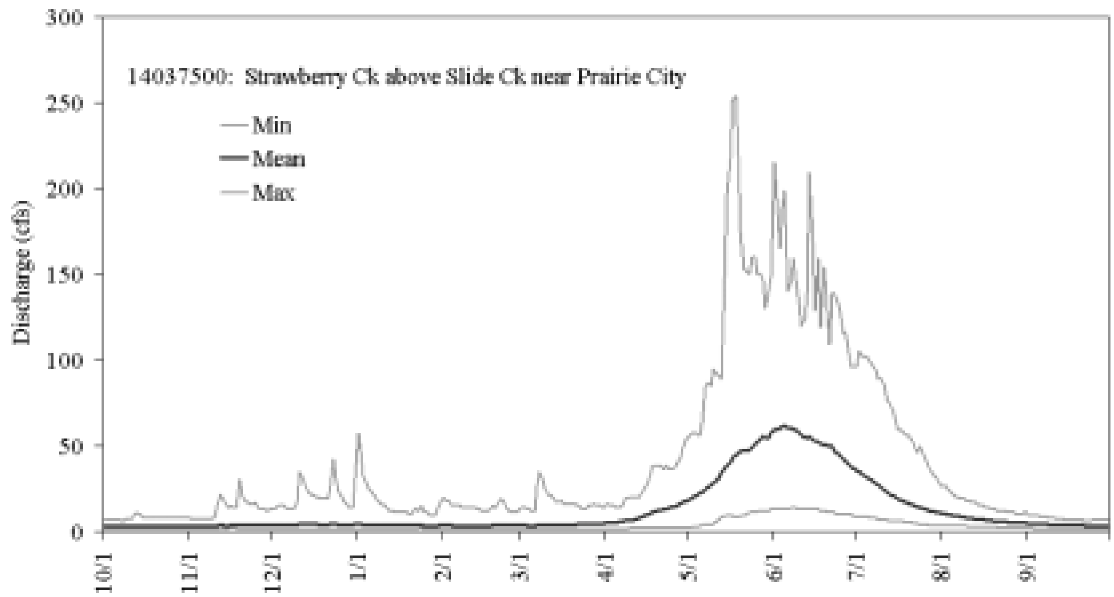
The average, minimum and maximum mean daily discharge at the Canyon Creek near Canyon City stream gage (#14038602) are shown in Figure 1.8. Inspection of the hydrograph for the Canyon Creek gage shows that the highest flows occur during the late spring / early summer snowmelt season; however, high flows 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.



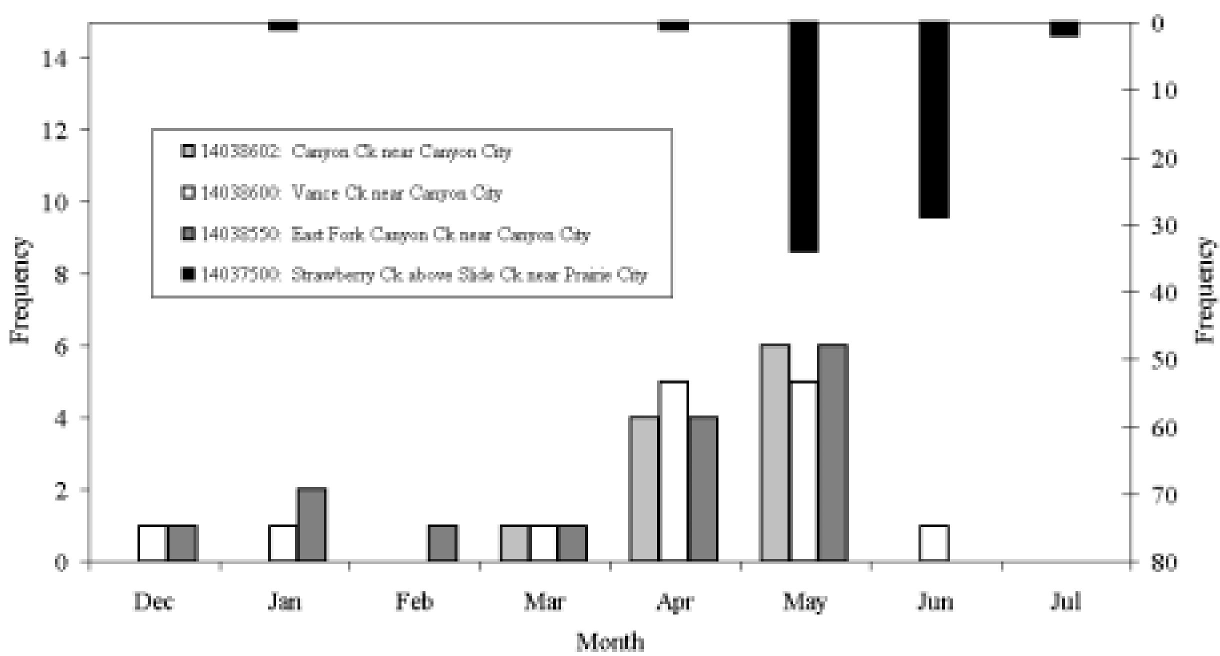
Refer to Map 1.11and Table 1.7 for gage location and characteristics.

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.

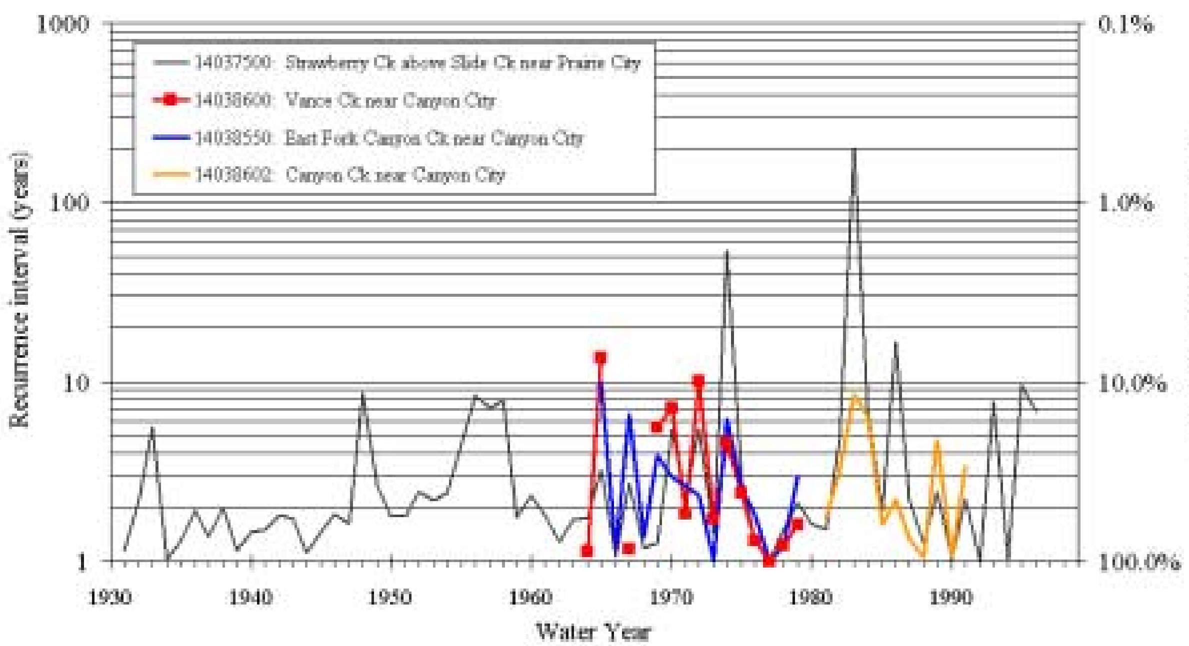


Figure 1.11. Recurrence interval and probability of occurrence associated with annual peak flow events at four stream gages in vicinity of Canyon Creek watershed.

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.*

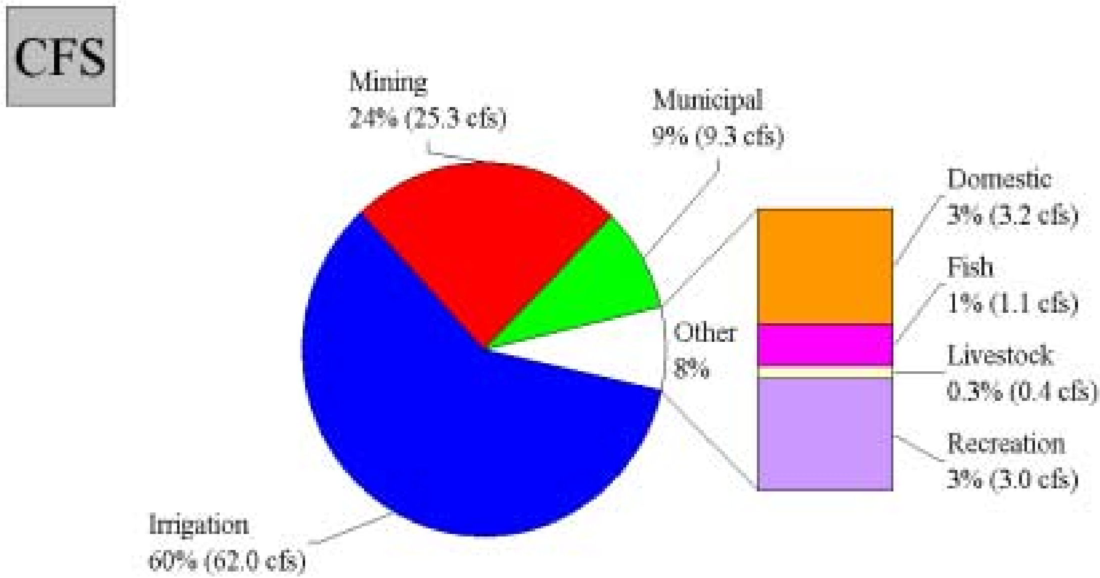
expressed either as an instantaneous rate (i.e., cubic feet per second [cfs]) or as a total yearly volume (i.e., acre-feet). Some (but not all) of the water rights in which the withdrawal rate is expressed in acre-feet have further restrictions that specify an instantaneous rate by which that water can 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).

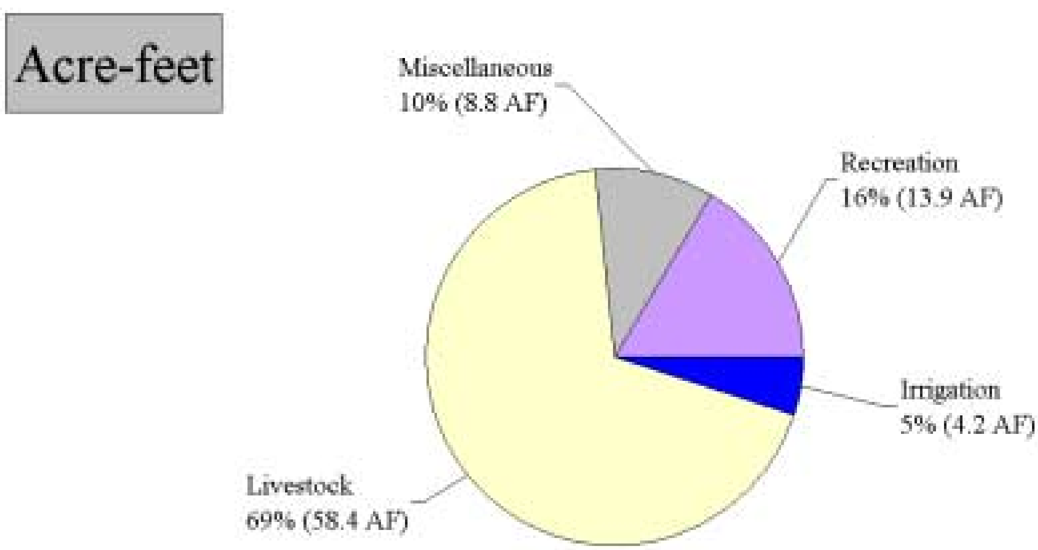


Figure 1.13. Summary of water rights within Canyon Creek watershed reported in acre-feet (AF).

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*

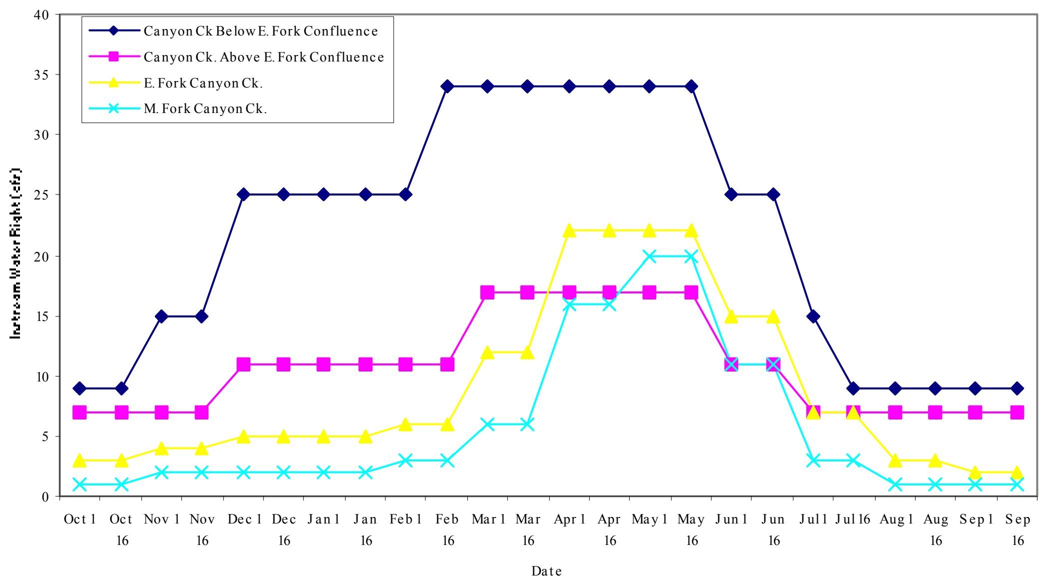
(Bjorn and Reiser 1991).

**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.