5-6 SYNTHESIS AND RECOMMENDATIONS

5-6.1 WILDLAND FIRE AND FUELS, VEGETATION: PLANT COMMUNITIES (ISSUES 1 AND 2)

The effects of wildland fire and vegetation management have altered the structure, composition, and functioning of vegetation within the watershed; therefore, Issue 1 (Wildland Fire and Fuels) and Issue 2 (Vegetation) will be grouped in the S*ynthesis* section of this chapter.

Issues 1 and 2, Key Question 1: What are the landscape level patterns and trends of plant communities and their associated fuel loads within the watershed, and how have these patterns changed through time?

Issues 1 and 2, Key Question 2: What have been the causes of landscape-level changes in the watershed, and how have these changes affected plant species composition, structure, fuel loads and continuity in the watershed?

Issue 1, Key Question 3: How have historic management practices altered the frequency, severity, magnitude, and ignition sources of wildland fires (the fire regime) within the watershed?

Issue 2, Key Question 4: How have historic management practices altered other natural disturbance regimes within the watershed?

5-6.1.1 Synthesis

5-6.1.1.1 Disturbances Defining Vegetation in the Watershed

In the Canyon Creek watershed and elsewhere in the intermountain west, vegetation structure, composition, and functioning have been shaped by a multitude of disturbance factors, all acting as a complex disturbance regime that has changed through time. Before Euro-American settlement, the majority of the Canyon Creek watershed was dependent upon fire and climate as “keystone” disturbance processes, or those processes that drive ecosystem dynamics. Since that time, anthropogenic disturbances, including mining, livestock grazing, and timber harvest, have added to the complexity of disturbances that shape vegetation within the watershed. Within the last 100 years, and more pronounced in the latter half of the century, another form of disturbance has emerged on the landscape that has defined and constrained decision-making by land managers. This “socioeconomic” or “political” disturbance, for ecological benefit and for detriment, has promoted or discouraged natural disturbance processes across the landscape, depending on changing political priorities through time. One key relationship where this disturbance has had the most pronounced effect has been on the exclusion of fire and intensities and methods of timber harvest.

Constraints that have defined timber harvest in the 20th century, through practice and through regulation, have promoted an ecological condition that is more often outside the historic range of variability in terms of structure and composition for the forests of the Canyon Creek watershed. The absence of fire within fire-dependent plant communities, in combination with timber harvest practices, has shifted the species composition and structure in two important ways. Timber harvest has generally led to the removal of fire-resistant overstory species and overstocking in the understory strata; the absence of fire has promoted late-seral, fire-intolerant species that out-compete early-seral, fire-tolerant species. The conditions created with these shifts in species composition and structure have encouraged other natural disturbance processes to manifest with greater severity from what would have been expected prior to the 20th century. Insects and diseases, chiefly spruce budworm and dwarf mistletoe, have increased to epidemic proportions in areas within the Canyon Creek watershed and in the Malheur National Forest as a whole. While important and certainly defining of forest dynamics, insects and disease outbreaks in the majority of the watershed (i.e., ponderosa pine forest potential, fire regime I) are a symptom of the loss of a keystone disturbance process – fire in a fire-dependant community.

5-6.1.1.2 Fire as a Keystone Disturbance Process

Fire is a keystone disturbance process that maintains several critical functions in ecosystems in the Blue Mountains. Fire maintains structural and species diversity, regulates plant succession and regeneration, reduces biomass, controls insects and disease populations, triggers animal-plant interactions, and maintains biological and biogeochemical processes (Crutzen and Goldammer 1993, Keane et al. 2002) (Table 5-6.1). Since Euro-American settlement (beginning in the 1850s), fire exclusion has been a leading cause of alteration in many of these key functions for the Canyon Creek watershed. This chapter presents a synthesis of the degrees by which fire exclusion has affected ecosystem functioning, provides recommendations for addressing important data gaps, and offers passive- and active-management options.

Table 5-6.1. Summary of landscape and stand-level effects of fire exclusion.

Scale	Ecosystem attribute	Fire exclusion effect
Landscape	Composition	Decrease in early seral communities, increased landscape homogeneity, increase in dominance of one patch type, and decreased patch diversity.
	Structure	Increase in patch evenness, patch size, patch dominance, and contagion.
	Disturbance	Larger and more severe fires, increase in crown fires, increased insect and disease epidemics, and increased contagion resulting in more severe insect and disease epidemics.
	Water Cycles	Increased water use, increase in drought, lower stream flows, increased water quality, and decreased stream sediment.
	Resources	Decreased visitation, visual quality, and viewing distance.
Stand	Composition	Increased number of shade-tolerant species, decreased number of fire-tolerant species, decreased forage quality, decreased plant vigor, and decreased biodiversity in plants and animals.
	Structure	Increased vertical stand structure, multistoried canopies, increased canopy closure, increased vertical continuity (fuel ladders), greater biomass, higher surface fuel loads, and greater duff and litter depths.
	Ecosystem processes	Slowed nutrient cycling, greater fire intensities and severities, increased chance of crown fires, increased insect and disease epidemics, short-term increase in stand productivity, decrease in individual plant vigor, and decreased decomposition. Increased leaf area, increased evapotranspiration, rainfall interception, autotrophic and heterotrophic respiration; increased snow losses (ablation).
	Soil dynamics	Decreased nutrient (N, P, S) availability, increased pore space and water-holding capacity, lower soil temperatures, increased hydrophobic soils, and increased seasonal drought.
	Wildlife	Increased hiding and thermal cover, increased coarse woody debris, lower forage quality and quantity, increased insects and disease, and decreased biodiversity.
	Resources	Decrease in aesthetics, increased timber production, decreased visitation, increased risk to human life and property, increased fire fighting efforts, and improved air quality.

Some of these attributes and effects were addressed in this watershed analysis (adapted from Keane et al. 2002)

5-6.1.1.3 Landscape-Level Effects of Fire Exclusion

To understand the extent to which fire severity has diverged from historic levels, the current live fuels condition (live fuels condition classes) of all forested upland and riparian stands was evaluated. In general, live fuels conditions were evaluated as having fires of non-lethal severity, mixed severity, or lethal severity (Table 5-6.2). For example, a stand having ponderosa pine potential (fire regime I) with old forest single-stratum structure (OFSS, condition class 1) would likely be subject to a ground-based fire and

would burn with non-lethal severity. In contrast, the same stand having stem-exclusion, closed-canopy structure with a very dense understory of Douglas-fir and grand fir (condition class 3) would likely burn as a crown fire and have lethal severity. As a generalization, "non-lethal severity" fires would be associated with ground-based fires, "mixed severity" fires would have moderate degrees of crown entry, and "lethal severity" fires would be crown fires. Historical fire severity was assumed to be a live fuels condition class 1 for each fire regime (Table 5-6.2).

Table 5-6.2. Severity of fires expected for forested stands within the analysis area.

	Live fuels condition class		
Fire regime	***1***	***2***	***3***
I	Non-Lethal	Mixed	Lethal
III(a)*	Non-Lethal	Mixed	Lethal
III	Mixed	Lethal	Lethal
IV	Lethal	Lethal	
V	Lethal		

Stands were classified as having non-lethal, mixed severity, or lethal fires on the basis of their current live fuels condition classes and their historic fire regimes.

** A Fire Regime III(a) refers to a low intensity, long return interval fire (e,g,, ponderosa pine and low sagebrush).*

It is important to note that this evaluation of fire severity does not take into account downed and dead fuels because these data do not exist for the Canyon Creek watershed. The composition and structure of dead fuels is critical in predicting fire behavior and intensity because these fuels have the lowest moisture content of available fuels and hence directly influence the ignition, spread, and heat (intensity) of fire. An expected outcome of decades of timber harvest, overstocking, increased pathogen damage, and absence of fire is the accumulation of fine fuels, or those fuels less than three inches in diameter. The degree by which fine fuels, litter, and duff has accumulated will have a direct effect on the consequences of prescribed and wildland fire for two reasons: (1) fine fuels directly influence fire behavior and intensity (along with topography and weather) and (2) prolonged smoldering from litter and duff surrounding tree boles can lead to scorching of the cambium (increased tree mortality).

In addition to downed dead fuels data, it is important to consider the horizontal continuity of fuels when addressing fire behavior and severity at landscape scales. This analysis has used a stand-based approach of the expected divergence of historic fire behavior based upon live fuels and species composition only. The condition of neighboring stands has a considerable effect on landscape-level behavior of fire because fuels and topography influence how fire travels from one stand to another under certain weather conditions. This analysis does not address horizontal continuity of fuels because sufficient data were not available to ascertain fire behavior at the stand level. For these important reasons, it

must be stressed that the effects of fire exclusion and the changes in predicted fire severity presented in this analysis are conservative estimates.

5-6.1.2 Forested Stands

5-6.1.2.1 Watershed Scale

The forests on NFS lands within the Canyon Creek watershed have moved away from their historic fire regimes (Figure 5-6.1). Current conditions are such that fires would likely burn with non-lethal severity in approximately 7% of the watershed, which is a dramatic decrease from the 37% expected prior to the 20th century. In contrast, current live fuels conditions indicate that about 44% of the watershed could burn with lethal severity crown fires, which is an increase from the historic range of approximately 21% (Map 5-6.1). These results suggest that the exclusion of fire has altered the composition, structure, and functioning of vegetation at the local and watershed scales, and the current conditions would likely support uncharacteristically severe wildland fires.

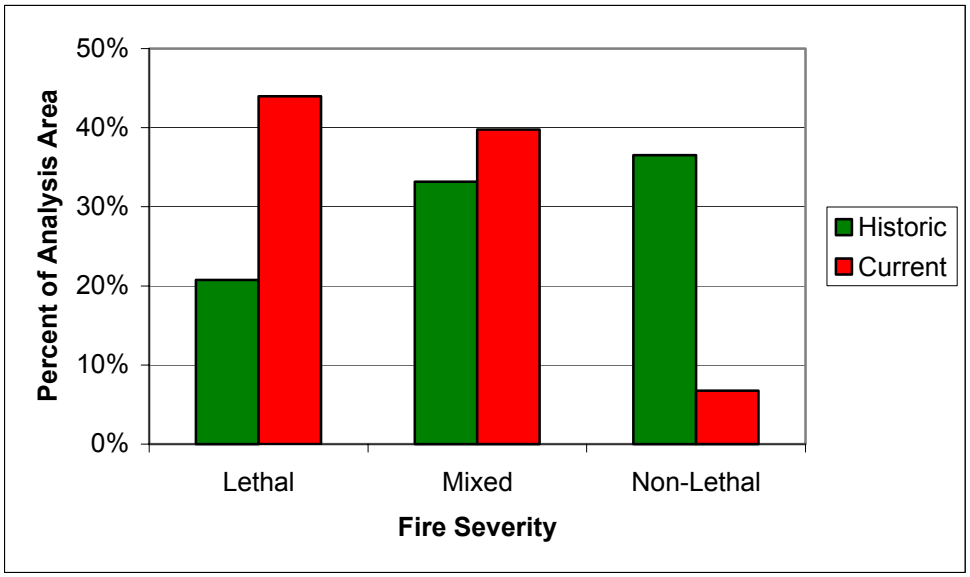

Figure 5-6.1. Expected fire severity for historic (pre 1850s) and current (2001) conditions for 53,906 (90%) acres of the analysis area.

The cumulative effects of management (especially fire exclusion and timber harvest) have resulted a shift in expected fire severity for 46% of the study area (27,108 acres) (Table 5-6.3). This shift has occurred in one of three ways: 1) from historically non-lethal to a mixed severity, 2) from historically mixed severity to a lethal severity, or 3) from historically non-lethal severity to a lethal severity. The majority of the affected stands have changed from potentially non-lethal to a mixed severity fire (13,284 acres, or 22% of the analysis area). In general, these are ponderosa pine stands that have shifted in structure from single-stratum to multi-strata stands, with moderate densities of Douglas-

fir and grand fir in the understory strata. The live fuels condition of these stands would suggest moderate crown fire risk. Steep topography, high loads of dead fuels, insect damage, and disease are attributes that would increase the risk of crown fires in these stands.

Approximately 16% of the analysis area (9,374 acres) contains stands that have historically experienced mixed severity fires (fire regime III) but currently contain live fuels conditions that would promote lethal, crown fires (Table 5-6.3). These stands are predominantly Douglas-fir and warm grand fir forest types that are in young forest (YFMS) or stem exclusion structural stages (SECC). Generally, these stands have dense tree covers in the middle and lower strata and have high probabilities of sustained crown fires. Several of these stands also contain minor components of large-diameter ponderosa pine trees, which suggests that timber harvest may have dramatically changed the composition and structure of these stands away from historic ponderosa pine potential stands (fire regime I). Pathogen loads and mortality and fuel loading in these stands are expected to be high. Ground-truth analysis of aerial photograph interpretation as well as stand-specific fuels data and pathogen levels is recommended to clarify the condition of these stands.

Table 5-6.3. Changes in expected fire severity between historic (pre 1850s) and current (2001) conditions for forested stands within the analysis area.

Historic fire severity	Current fire severity	Acres	Percent of analysis area
Non-Lethal	Mixed	13,284	22%
Mixed	Lethal	9,374	16%
Non-Lethal	Lethal	4,450	7%
Total Acres		27,108	46%

Values are for 53,906 acres (90%) of the analysis area.

The most severe changes in live fuels conditions occurred in 4,450 acres (7% of the analysis area) with alterations from historically non-lethal ground fires to a high probability of lethal crown fires (Table 5-6.3). These were primarily ponderosa pine stands that have undergone dramatic changes in structure and species composition. One such change involved the dominance of a very dense understory of Douglas-fir and grand fir in a stem exclusion structural stage (SECC). Another stand type involved ponderosa pine stands that were in fringe environments (i.e., mountain big sagebrush) that have been densely colonized with young ponderosa pine and western juniper in the mid-story stratum. Both of these stand types have undergone changes due to fire exclusion and both have a live fuels condition that would likely support continuous crown fires. It also follows that stands with dense understories of shade-tolerant trees would promote higher degrees of insect and disease infestation and would therefore be at even higher risks for

fires of lethal severity. Further site-specific review of fuels composition and structure is recommended to ascertain catastrophic fire risk in these stands.

5-6.1.2.2 Wildland/Urban Interface (WUI)

A total of 30,197 acres of NFS lands were evaluated for changes in fire severity within the Wildland/Urban Interface (WUI, see *Chapters 1 and 3* for more discussion). Similar to the watershed as a whole, the forest environments in the WUI have dramatically changed from the historic species composition and structure that are representative of their historic fire regimes (Figure 5-6.2). The current live fuels conditions suggest a marked decrease in potential for non-lethal fires, from 52% to 8% of the WUI. The potential for lethal crown fires crossing subwatershed boundaries in the WUI has increased from historic conditions. Approximately one-third of the WUI (31%) have live-fuels conditions that would likely promote crown fires, which is a large increase from the 5% of the WUI expected prior to the 20th century. The live fuels conditions within the WUI have been considerably altered from historic conditions, and currently pose a serious risk for catastrophic wildland fires. Considering the extreme divergence from historic conditions, other effects of fire exclusion are likely in the WUI (Table 5-6.3), particularly increased fuels loading and increases in insects and disease.

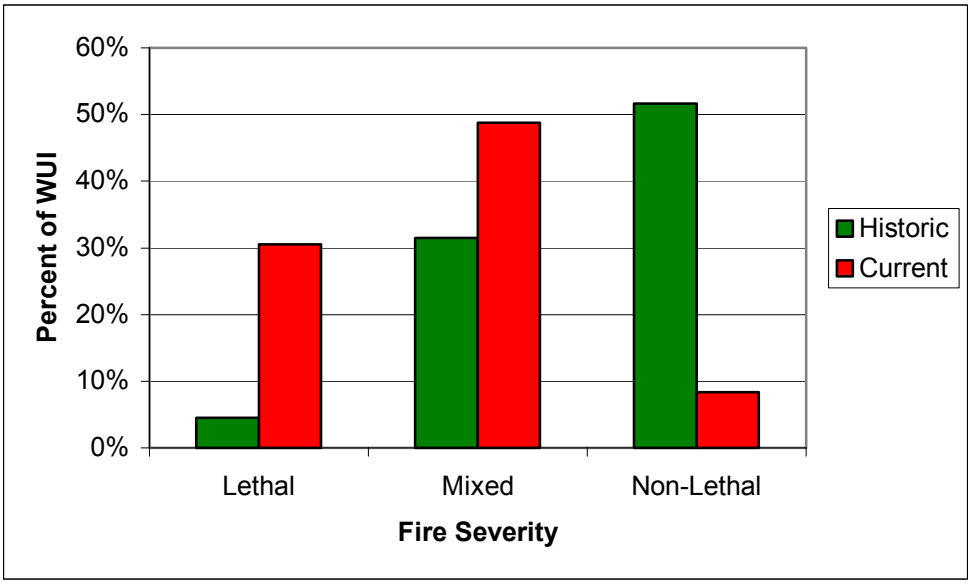

Figure 5-6.2. Expected fire severity for historic (pre 1850s) and current (2001) conditions for 30,197 acres within the 34,460-acre wildland/urban interface (WUI) on NFS lands.

The majority of the WUI has undergone a dramatic alteration of structure and live-fuels conditions to the extent that now 58% of the area (20,419 acres) will no longer support the historic fire regimes without becoming an uncharacteristically severe wildfire (Table 5-6.4). Most of this land area contains ponderosa pine stands with multi-strata or stem exclusion stage structure and contains high proportions of shade-tolerant species (i.e., Douglas-fir and grand fir) in the understory strata. Approximately one-third of the WUI

(11,189 acres, or 32%) are stands with elevated levels of live-fuels that would promote mixed severity fires from historically non-lethal (ground fire) conditions. Expected fuels loading and insects and disease damage associated with dense understory canopies would increase the likelihood of crown fires in these stands. Further site-specific analysis of fuels structure and degree of insect and disease damage is needed to model the fire behavior of these stands to ascertain the risk of catastrophic wildland fires.

Table 5-6.4. Changes in expected fire severity between historic (pre 1850s) and current (2001) conditions for forested stands on NFS lands within the WUI.

Historic severity	Current severity	Acres	% of NFS land within the WUI
Non-Lethal	Mixed	11,189	32%
Mixed	Lethal	5,320	15%
Non-Lethal	Lethal	3,729	11%
Total Acres		20,149	58%

Figures are for 20,149 acres of the 30,197-acre NFS land within the wildland/urban interface (WUI).

Approximately 15% of the WUI (5,320 acres) that has historically experienced mixed severity fires (i.e., Douglas-fir stands on north-facing slopes) currently have live fuels conditions that would support lethal crown fires (Table 5-6.4). In general, these stands have elevated levels of understory biomass in shade-tolerant species that would be typical of a mixed severity fire regime (fire regime III). The cumulative effects of management (fire exclusion and timber harvest) have modified the species composition to contain more grand fir in the understory and an elevated level of dead fuels. Fire exclusion and timber management activities have promoted multi-strata forest structure with high socking levels in the understory. Insects and disease, particularly spruce budworm, bark beetles, and dwarf mistletoe, have contributed to increased fuels loading in these Douglas-fir stands, particularly in the Vance Creek subwatershed (Spiegel and Schmitt 2002). The combined effects of increased live and dead fuels have promoted conditions that would support uncharacteristically severe wildland fires.

Approximately 11% of the WUI has undergone appreciable changes in vegetation structure and composition because of timber harvest and fire exclusion (Table 5-6.4). These 3,729 acres have historically supported non-lethal ground fires and now contain dense live ladder fuels structure that would promote crown fires. Similar to watershed-level patterns, these ponderosa pine stands exhibit one of two major effects of fire exclusion. The first involves a dense understory growth of shade-tolerant species, which contains live fuels structures that are very dense in the understory and have likely encountered moderate degrees of other fire exclusion effects, including disease and insect outbreaks, increased fuels loading, etc. Another stand type involves encroachment of conifers in marginal ponderosa pine stands or fringe shrublands, which is the result of decades of successful regeneration of ponderosa pine and western juniper in the

understory, and these stands have undergone conversion from open, "park-like" conditions to dense conifer understory conditions. The abnormally high levels of live and presumably dead fuels in the understory would promote crown fires and a high likelihood of secondary mortality from girdling from smoldering duff.

5-6.1.2.3 Non-Federal Ownership Areas

Although not within the scope of this analysis, the private landholdings within the Canyon Creek watershed have likely undergone similar changes in stand dynamics to what has been described in earlier sections. Management activities on non-industrial forestlands have historically involved large-diameter timber harvest and often have not followed with treatments to avoid overstocking conditions (such as thinning and/or prescribed fire). These types of harvest practices promote high fuels loading, through insect and disease outbreaks (dead fuels) and through the overabundance of regenerating trees with low live crown heights (live fuels). Although private land managers have recently made considerable efforts to minimize fuels loading on privately-held timberlands, the combined effects of historic land management on private and public lands has altered the historic fire regimes to promote more severe fire conditions. Because of their proximity and connectivity to federal lands, the condition of lands under non-federal ownership will have a considerable impact on fire behavior in the WUI.

5-6.1.3 Other Areas of Concern

5-6.1.3.1 Riparian Zones

Although riparian forests were considered in the analysis of landscape-level effects of fire exclusion (previous section), riparian zones are unique in how they respond to fire and in their importance for aquatic resources. Low-intensity ground fires that carry through riparian zones often damage or kill the low-lying aboveground vegetation (i.e., shrubs, deciduous trees, grasses and sedges). These fires act as a stimulus to plant growth, as post-fire conditions result in an increase of available nutrients (particularly nitrogen, phosphorous, and sulfur) and available light resources. In riparian meadow environments, frequent fires moderate the degrees of conifer encroachment from adjacent uplands and retain the connectivity of the riparian floodplain environment. Currently, no data as to the species composition of riparian floodplains exist for the Canyon Creek watershed.

In the process of reintroduction of fire as a disturbance process, it is important to consider that there is an increased risk of stand-replacement wildfires in the watershed. Under these uncharacteristically severe conditions, fires in riparian zones will not likely function as natural firebreaks and hence will experience hot, stand-replacing wildfires. The loss of canopy and riparian shading increases stream temperatures (Beschta and Taylor 1988); both stream temperature and shading have been identified as factors affecting fish populations in the watershed. For the short term, it is recommended that restoration efforts in upland environments do not further degrade the quality of stream shading found

in the watershed. Restoration of riparian vegetation is an important long-term goal for the stability and health of aquatic ecosystems.

5-6.1.3.2 Shrublands and Grasslands

No data exist for the historic structure or composition of shrublands or grasslands within the Canyon Creek watershed. Grazing history information was also not available, so history and intensity of livestock grazing and the associated effects on aboveground structure, species composition, or exotic species introduction could not be evaluated.

Forested stands in the Canyon Creek watershed have shown clear evidence of aforestation of late-seral species as a result of management (fire exclusion and timber harvest). Like riparian meadows, conifer encroachment is also a probable outcome in grasslands and shrublands of the Canyon Creek watershed. In the analysis of potential vegetation groups (PVGs), further review of aerial photographs suggested 455 acres of shrublands and 277 acres of grasslands had at least 10% canopy closure of western juniper (see *Juniper Encroachment* section of *Chapter 3*, Table 3-45). Similarly, the forested ponderosa pine stands with marginal cover (~15% canopy closure) in the watershed may have had shrubland or grassland potential vegetation. The degrees of conifer encroachment by western juniper, ponderosa pine, and other conifers is recommended to assess rangeland ecosystem health within the Canyon Creek watershed.

5-6.1.3.3 Quaking Aspen

In general, quaking aspen stands are becoming more isolated and fewer in number, and their distribution has been on the decline in the past century. Because fire is a stimulus for their growth, the absence of fire has limited the production of emerging sprouts. In addition, fire exclusion has allowed for the successful competition of conifers to reach the overstory, limiting light resources for aspen. Grazing of emerging shoots by livestock is another major limiting factor affecting aspen. Exclosures, removal of conifer shade, and the reintroduction of fire in these fire-dependant ecosystems are all pathways to restore quaking aspen in the watershed.

5-6.1.3.4 Federally Listed Plant Species

Although only one plant species was documented in the Canyon Creek watershed, it is likely the topographically diverse landscape and expansive wilderness area could harbor other plant species of interest or concern. A plant survey, required before a substantive ground-disturbing activity takes place, would reveal populations of sensitive species if they are present. Increases in biodiversity is one expected outcome with the reintroduction of natural, keystone disturbance processes in the ecosystem.

5-6.1.4 Summary of Recommendations

5-6.1.4.1 Minimize Risks of Catastrophic Wildfire and Restore Fire as a Disturbance Process

This watershed analysis has presented the combined effects of management at the landscape level, especially how fire exclusion and timber harvest have changed the composition, structure and functioning of forest stands. Management activities have resulted in overstocked understory conditions, with increased dominance of late-seral species, increases in mortality due to insects and disease, and a decline in forest health. Ultimately, these conditions translate to elevated risks for uncharacteristically severe wildland fires (catastrophic wildfire) compared with historic conditions, especially within the WUI. Reintroduction of fire as a keystone disturbance process in the Canyon Creek watershed would have a pronounced beneficial effect on forest health for the long term. However, before historic fire regimes can be properly restored, the current condition of stands must be verified. After which time, answering the question of how fire will behave can be better understood. This understanding can then be applied as prescriptions for healthy forest stands.

The proportion and magnitude of effects of fire exclusion presented in this watershed analysis has been conservative, as many key factors that influence fire behavior – primarily the horizontal and vertical continuity of fuels – have not been addressed because data are not available. The following are data gaps that would increase our understanding of fire behavior in the Canyon Creek watershed.

5-6.1.4.1.1 Data Gaps

- ***Downed and Dead Fuels.*** Quantify the structure and composition of downed and dead fuels, including litter and duff. Sampled stands should be prioritized based on areas of highest concern for catastrophic wildfires identified in this watershed analysis. Horizontal and vertical continuity of fuels is a critical data gap in understanding fire behavior. An analysis of fuels and topography under different weather scenarios is recommended using models to predict fire behavior. Modeling fire behavior on landscape scales (using tools such as BEHAVE and FARSITE) will provide managers with target areas in need of treatments to minimize catastrophic fire risk. It is suggested data collection can be streamlined to select areas needing fuels reduction treatments (particularly in the WUI). However, the efficacy of models predicting fire behavior is dependent upon the intensity of site-specific data collected.
- ***Live fuels structure.*** Although data collected from aerial photographs has provided the information necessary to make coarse structural classifications, it is recommended stand-level inventories be completed for target areas. In addition to downed and dead fuels, live fuels influence the behavior and severity of fires. Variables including base to crown height ("ladder fuels") and validation of plant associations, in addition to stand structure and species composition, are important for predicting the risk of crown fires and the dynamics of stand development. These data

are useful in implementing stand-specific treatments for minimizing fire risk and assuring long-term ecosystem health.

5-6.1.4.2 Restore Stand Structure to Resemble Historical Range of Variability (HRV)

In the process of restoring fire as a disturbance process in the watershed, it is recommended that management focus on reversing the long-term effects of timber management and fire exclusion. Particularly for areas within the WUI, overstocking of shade-tolerant, fire-intolerant species in the understory and subsequent increases in pathogen loading have created conditions that are outside the historical range of variability within the watershed (*Chapter 4*). Although the data gaps mentioned in the previous section are important for quantifying stand-specific treatment alternatives, one of two general recommendations can be made to reduce stands to their historic structural and compositional ranges of variability:

- Prescribed burning to reduce elevated loads of fine fuels that have accumulated over time
- Mechanical reduction of fuels (via thinning, mowing or pruning) to minimize vertical fuel ladders, followed by prescribed burns to reduce ground fuels

The overall goal for these treatments should be to shift the current structural and compositional trends from aforestation of shade-tolerant species (overstocked conditions) to species compositions and structures that are within the HRV for each vegetation type (see *Chapter 4*). One common example that illustrates this condition is to promote old forest single-stratum structure within ponderosa pine stands and reduce the high levels of Douglas-fir and grand fir found in the mid-story strata. In some instances, the use of prescribed fire may be sufficient in limiting understory biomass and fuels; in other instances, mechanical thinning will need to be used before the introduction of fire. Because of the structural, compositional, and topographic diversity of the Canyon Creek watershed, more in-depth analysis and planning are recommended to reduce the risks of catastrophic wildland fire and restore historical conditions.

It is very likely that decades of fire exclusion and multiple management practices have led to an understory structure that has economic value. It is recommended that NFS specialists be engaged with community leaders and the local timber industry to evaluate the economic viability for small-diameter wood products. In addition, any future timber harvest planning should consider the ecological requirements inherent with the historic fire regime for targeted stands. While timber harvests clearly alter the structure of stands, the removal of fire from fire-dependant communities has long-lasting and costly effects that affect forest health and the human environment. In essence, timber harvest acts as a tool and not a surrogate for the restoration of forest stands.

Because of the proximity and continuity of non-federal lands to federal lands within the WUI, it is important to involve these landholders in the greater treatment design. It is

recommended that homeowners follow recommendations under the FIREWISE program (www.firewise.org). These include creating a "survivable space" around buildings and structures, where fuels are limited to minimize ignition and risk of fire spread. Non-industrial forest landholders should incorporate the general recommendations presented here in minimizing overstocked conditions and vertical fuel ladders.

5-6.1.4.3 Minimize Conditions that Promote Uncharacteristically Severe Insect and Disease Outbreaks

One of the compounding effects of removing fire from fire-dependant ecosystems is an increase in insect and disease activity (Keane et al. 2002, Powell 1994). An overstocked condition in the understory strata, especially in harvested units, has led to increases in a suite of pathogens, including spruce budworm, bark beetles, and dwarf mistletoe (see *Chapter 3*). Disturbance by insects and diseases are a natural occurrence and help to moderate fire behavior at local scales. However, the severely altered conditions in forest structure and composition have promoted conditions that support landscape-scale outbreaks of pathogens. Treatment options that promote the historic ranges of composition and structure are recommended. However, treatment options are highly site-specific, as pathogens respond differently to like treatments.

- Prioritize stands at risk of elevated insect damage and disease for restoration treatments with the goal of restoring the stand structure and composition described by the HRV for each vegetation type (e.g., favor old forest single-stratum for ponderosa pine stands). Collect data on stand structure, fuels, and pathogen species in these stands and evaluate mechanical treatment options.
- Incorporate the processes that help to maintain HRV structure and composition (use of prescribed fire in addition to mechanical treatments may be necessary to revert pathogen populations to historic levels and distributions)

5-6.1.4.4 Noxious and Exotic Plant Species

Other than potential conifer encroachment, the conditions of grasslands and shrublands are not known, especially for shifts in species dominance away from native species toward complexes of invasive species (especially annual cheatgrass). It is therefore recommended that any and all rangeland condition data be consolidated and evaluated for several factors:

- ***Range condition.*** Address the condition of the shrublands and grasslands within the Canyon Creek watershed for their proportion of exotic species. Evaluate the grazing history and current allotments.
- ***Reduce conifer encroachment into rangelands.*** The reintroduction of fire as an important disturbance process will undoubtedly reduce the levels of conifer encroachment into rangelands, especially young western juniper. It is important, however, to understand the degree of invasion by exotic species (particularly cheatgrass) in the process.

- ***Create a watershed-level inventory*** and map the distribution and abundance of non-native plant species of concern.

5-6.1.4.5 Aspen Stands

- No ground-truth information is known to exist for quaking aspen stands. Thirteen stands were identified from aerial photographs where quaking aspen was present. It is recommended that aspen groves and individual clones be mapped throughout the watershed. Restoration of fire as an historic disturbance process and control of livestock grazing will have a positive effect on quaking aspen. Short-term solutions involve large exclosures and removal of coniferous shade.

5.2 AQUATIC SPECIES AND HABITAT (ISSUE 3)

This section provides a synthesis that answers key questions first listed in *Chapter 2* and repeated below. This section identifies how aquatic habitats differ from reference conditions or from habitat standards determined by the Malheur National Forest. In addition, the synthesis reveals how and where habitat problems exist. Recommendations as to how habitat improvement may occur are listed near the end of the chapter. Finally, data gaps that were identified during this analysis are discussed.

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

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

5-6.2.1 Synthesis

5-6.2.1.1 In-stream Habitat Characteristics

Federal land managers decide, within the constraints of current laws and under direction of the Aquatic Conservation Strategy, how to manage federal lands to ensure the long-term viability and health of aquatic ecosystems. To that end, the Malheur National Forest Land and Resource Management Plan, Amendment 29 is used as a guide to the range of desired future conditions (DFC) within aquatic ecosystems (Table 5-6.5). Aquatic habitat surveys are conducted to understand the current conditions of aquatic resources and the results of those surveys are summarized to determine if the current conditions meet the DFCs on a pass or fail basis.

For this watershed analysis, aquatic habitat survey data was summarized in SMART and the results were evaluated according to Amendment 29 DFC standards. Attributes that had missing data for a particular reach were reported as unknown. Some inconsistencies occurred when evaluating survey data against the Amendment 29 standard. For example, substrate must be embedded by less than 21% to pass Amendment 29. Yet surveyors

rated substrate at a threshold of 35%. Any reach that had less than 35% embedded substrate to pass the standard was considered.

Table 5-6.5. Malheur National Forest Amendment 29 standards used to rate data collected for attributes during early 1990s stream surveys in Canyon Creek watershed.

Attribute	Amendment 29 standard
Bank Stability	> 89%
Cobble Embeddedness	< 21%
Large Wood Debris/mile[1]	80 – 120/mile
Wetted Width/Depth	< 10
Ground Cover	> 89%
% Stream Bank Vegetated	90% of site potential
Shade Canopy Closure	50% - 65% Closure
Instantaneous Temperature	≤ 68° F

Pool frequency (based on bankfull width)	
Bankfull width	**Pools / mile (to pass)**
5	151 – 264
10	75 – 132
20	38 – 66
25	15 – 26
50	10 - 23
75	10 – 23
100	8 - 18
125	6 - 14
150	5 – 12
200	4 - 9

[1] *Based upon mixed conifer forest standards.*

Canyon Creek Watershed. Six reaches were evaluated using Amendment 29 standards in the main stem of Canyon Creek (Table 5-6.6). Seventy-five percent of the attributes rated along wilderness reaches passed Amendment 29 standards. The reaches outside of the wilderness illustrated generally poorer conditions than the wilderness reaches. Three reaches failed the standard for embedded substrate. These reaches were investigated to determine whether a dense network of native material roads built on highly erosive soils bordered these reaches (Map 3.6). The only reach that failed for embedded substrate and was adjacent to the road condition described above was SMART Reach 3. However, within the rest of the reaches, there is no apparent relation between road density, soil erosive properties, and embedded substrate.

Table 5-6.6. Attributes from the early 1990s stream surveys for Canyon Creek.

	SMART reach number					
Canyon Creek attribute	***1***	***2***	***3***	***5***	***Canyon Wilderness R1***	***Canyon Wilderness R2***
Cobble Embeddedness	Passed	Passed	Failed	Failed	Failed	Passed
Bank Stability	Unknown	Unknown	Unknown	Unknown	Passed	Passed
% Stream Bank Vegetated	Failed	Passed	Passed	Passed	Failed	Passed
Ground Cover	Unknown	Unknown	Unknown	Unknown	Passed	Passed
Pool Frequency	Passed	Passed	Failed	Failed	Passed	Failed
Large Wood Debris	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Passed	Mixed Conifer/ Passed	Mixed Conifer/ Failed
Potential LWD Determined from PI	Failed	Failed	Failed	Failed	Passed	Failed
Shade Canopy Closure	Failed	Failed	Failed	Failed	Passed	Passed
Shade Canopy Determined by PI	Failed	Failed	Failed	Failed	Passed	Passed
Instantaneous Temperature	Failed	Passed	Failed	Passed	Passed	Passed
Width/Depth	Passed	Passed	Passed	Passed	Passed	Passed
% of Attributes Failing Standard	63%	38%	63%	50%	25%	25%
Rosgen Stream Type	G/C	G/C	B	B	A	Aa+
Fish Species Present	ONCL/ONMY	ONCL/ONMY	ONCL/ONMY	ONCL/ONMY/ SAFO	ONCL/ONMY/ SAFO	ONCL/ONMY/ SAFO

Attributes in each surveyed reach were rated according to the Malheur National Forest LRMP Amendment 29 standards to determine if the attribute passed or failed the standard.

Three of six reaches passed the standards for pool frequency. These reaches should provide adequate in-stream diversity for rearing fish. In summer, pools may provide a cool resting area; during winter, fish move into the interstitial spaces within the pools' gravels. The pool frequency agreed in 50% of the reaches with the number of pieces of LWD/mile. Since there is no data to describe pool creators, it is not known how important wood is to forming pools in this system.

Comparisons were made of the field survey of LWD and the remotely sensed LWD survey. There was 83% agreement between these two independent surveys. Also compared were field survey results for shading against the remote survey; 100% agreement was found. Shade canopy closure decreased as the creek flowed downstream away from the wilderness.

A review was made of tree size in terms of LWD recruitment in the two wilderness reaches. Although there was little detectable difference in tree size along either reach, the furthest upstream reach had a lower density of large diameter trees growing along it. The second wilderness reach is near timberline and probably has thinner soils and a reduced growing season, which results in fewer large diameter trees.

Since steelhead/redband, and cuttroat trout pass through all or part of their life cycle in these reaches, further monitoring is needed to determine if these reaches are capable of functioning at the DFC. The habitat within this system illustrates a high degree of fragmentation. One goal of the Aquatic Conservation Strategy is to maintain and restore connectivity to aquatic systems. The reaches outside the wilderness in this subwatershed are not meeting this goal.

Middle Fork Canyon Creek Subwatershed. Six reaches were surveyed along the mainstem of Middle Fork Canyon Creek (Table 5-6.7). The wilderness reach had the least amount of attributes fail Amendment 29 standards (40%) while 57% of the attributes rated in the non-wilderness reaches failed the standard. An investigation was made of the relation between native material roads built on highly erosive soils and embedded substrate; no strong relation between the two was found (Map 3.6). For example, SMART Reach 5 failed for embedded substrate. This reach overlies soil types where the potential erosion factor is considered Low – Moderate and road density is very low.

In pool frequency, all reaches considered in Table 5-6.7 failed the Amendment 29 standards. The number of pieces of LWD/mile also failed for all six reaches. Only the wilderness reach passed the standard for remotely sensed LWD recruitment. An explanation cannot be made concerning the interaction of pools and LWD in these reaches because pool creator data is not available. There was a 67% agreement between the number of pieces of LWD counted in the stream and near-term LWD potential. There was 100% agreement between the field shade survey and the remote shade survey, and only the wilderness reach passed for shading.

The data presented in Table 5-6.7 indicate that the six reaches along the mainstem Middle Fork of Canyon Creek were not functioning well as fish habitat. Few pools, a lack of in-stream LWD, and insufficient shade imply stressful conditions for fish and potential impairment of the long-term survival of the aquatic species within these reaches.

Tributaries to Middle Fork of Canyon Creek. Three of the four reaches evaluated in Table 5-6.8 are tributaries to the Middle Fork of Canyon Creek and are located within the wilderness boundaries. SMART Reach 1 is the exception. Each tributary was surveyed as a single reach.

Thirty percent of the attributes in Tributary 6 failed the Amendment 29 standards. Tributary 7 had the highest percentage of attributes fail (60%). All tributaries passed the standard for embedded substrate.

Each tributary failed for pool frequency, the number of pieces of LWD/mile, and near-term LWD recruitment, while two reaches failed for shade canopy closure. The remote data for LWD recruitment revealed a high quantity of small diameter trees in the riparian zone. These are high elevation streams where stressful conditions, in terms of soils depth and climatic factors, inhibit the growth of large diameter trees. In the absence of pool creator data, no determination can be made of the interaction between LWD and pools in these reaches. There was 100% agreement between the near term remote LWD survey and the LWD field survey, whereas 50% agreement occurred between the remote shade survey and the field shade survey.

Redband/steelhead and cutthroat trout inhabit all these tributaries except for Tributary 1. Tributary 4 and 6 are approaching the DFCs explained in Amendment 29. Tributary 7 is furthest from the DFCs. Pools and the absence of large wood appears to be the limiting factors for fish in these streams. Since these are high gradient streams with step-pool morphology, pool creator mechanisms are probably boulders and rock. Young fish may select these reaches for rearing, and higher gradient reaches like these with clean substrate may be essential spawning habitat. Further monitoring of habitat and fish presence/absence would provide critical data on when and how fish use these reaches.

Table 5-6.7. Attributes from early 1990s stream surveys for Reaches 1 – 5 and the wilderness reach of the Middle Fork of Canyon Creek.

Middle Fork Canyon Creek	***Reach number***					
Attribute	***1***	***2***	***3***	***4***	***5***	***Wilderness reach 1***
Cobble Embeddedness	Passed	Passed	Passed	Passed	Failed	Passed
Bank Stability	Unknown	Unknown	Unknown	Unknown	Unknown	Passed
% Stream Bank Vegetated	Passed	Passed	Passed	Passed	Passed	Failed
Ground Cover	Unknown	Unknown	Unknown	Unknown	Unknown	Passed
Pool Frequency	Failed	Failed	Failed	Failed	Failed	Failed
Large Wood Debris	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed
Potential LWD Determined from PI	Failed	Passed	Failed	Failed	Failed	Passed
Shade Canopy Closure	Failed	Failed	Failed	Failed	Failed	Passed
Shade Canopy Determined by PI	Failed	Failed	Failed	Failed	Failed	Passed
Width/Depth	Failed	Failed	Failed	Passed	Passed	Failed
Instantaneous Temperature	Passed	Passed	Unknown	Unknown	Unknown	Passed
% of Attributes Failing Standard	63%	50%	71%	57%	57%	40%
Rosgen Stream Type	B	B	A	A	A	A
Fish Species Present	ONCL/OMNY	ONCL/OMNY	ONCL/OMNY	ONCL/OMNY	ONCL/OMNY	ONCL/OMNY

Attributes in each surveyed reach were rated according to Malheur National Forest Amendment 29 standards to determine if attribute passed or failed standard.

Table 5-6.8. Attributes from early 1990s stream surveys on Middle Fork of Canyon Creek Tributaries 1, 4, 6, and 7.

Middle Fork Canyon Creek	***Reach number***			
Attribute	***T1***	***T4***	***T6***	***T7***
Cobble Embeddedness	Passed	Passed	Passed	Passed
Bank Stability	Passed	Passed	Passed	Passed
% Stream Bank Vegetated	Passed	Passed	Failed	Failed
Ground Cover	Passed	Passed	Passed	Failed
Pool Frequency	Failed	Failed	Failed	Failed
Large Wood Debris	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/Failed
Potential LWD Determined from PI	Failed	Failed	Failed	Failed
Shade Canopy Closure	Failed	Passed	Passed	Passed
Shade Canopy Determined by PI	Failed	Failed	Passed	Failed
Width/Depth	Passed	Failed	Passed	Failed
Instantaneous Temperature	Passed	Passed	Passed	Passed
% of Attributes Failing Standard	40%	40%	30%	60%
Rosgen Stream Type	A	Aa+	Aa+	A
Fish Species Present	NONE	ONCL	ONCL/OMNY	ONCL/OMNY

Attributes in each surveyed reach were rated according to the Malheur National Forest Amendment 29 standards to determine if the attribute passed or failed the standard.

Vance Creek Subwatershed. Seventy-one percent of the attributes rated in each of the three reaches in the Vance Creek subwatershed failed the DFC standards explained in Amendment 29 (Table 5-6.9)

Two reaches failed the standard for embedded substrate, possibly caused by the dense network of native material along roads that surround these reaches. All reaches met the standard for percent of stream bank vegetated. Anecdotal information describes the streambanks along these reaches as being choked with shrubs.

All streams failed the standard for the number of pools/mile, LWD pieces/mile, and near term LWD recruitment potential. There was 100% agreement between the surveyed LWD data and the remotely sensed LWD data as both failed in each reach. According to the stream survey data for shade canopy closure, all streams failed, while Reach 1 passed for shade canopy closure using the remotely sensed data.

Vance Creek subwatershed has been disturbed by management activities including grazing, diversion boards, road building, and clearcut logging. The cumulative effects of these land use activities has resulted in degraded aquatic habitat. Yet the cool

temperatures found in Vance Creek, possibly the result of springs and sub-surface flow, coupled with the closeness in proximity to the mainstem John Day River may create a foundation for restoring these reaches. Simple approaches that increase the number of pools could create better summer rearing habitat. The heavy sediment loading will be difficult to control and may impede efforts to restore these reaches as viable spawning streams.

Table 5-6.9. Attributes from early 1990s stream surveys on Vance Creek tributaries 1, 2, and 3.

Vance Creek	***Reach number***		
Attribute	***1***	***2***	***3***
Cobble Embeddedness	Failed	Passed	Failed
Bank Stability	Unknown	Unknown	Unknown
% Stream Bank Vegetated	Passed	Passed	Passed
Ground Cover	Unknown	Unknown	Unknown
Pool Frequency	Failed	Failed	Failed
Large Wood Debris	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed
Potential LWD Determined from PI	Failed	Failed	Failed
Shade Canopy Closure	Failed	Failed	Failed
Shade Canopy Determined by PI	Passed	Failed	Failed
Width/Depth	Passed	Failed	Passed
Instantaneous Temperature	Unknown	Unknown	Unknown
% of Attributes Failing Standard	71%	71%	71%
Rosgen Stream Type	G/B	G/B	A
Fish Species Present	OMNY	OMNY	OMNY

Attributes in each surveyed reach were rated according to the Malheur National Forest Amendment 29 standards to determine if the attribute passed or failed the standards.

Crazy, Fawn, and South Fork of Vance Creeks. The attributes evaluated in Crazy Creek, Fawn Creek, and the South Fork of Vance Creek failed Amendment 29 standards by 40%, 62%, and 100%, respectively. Each reach considered here failed for embedded substrate. Dense road networks bordered each reach on a variety of soil types.

Pool frequency, LWD pieces/mile, and near-term recruitment potential failed the standard on all reaches in Table 5-6.10. There was 100% agreement between the remote LWD survey and the field LWD survey data in all three reaches. In-stream habitat diversity appears low with too few pools present, while LWD is generally in short supply with little future near-term recruitment potential. Small hardwoods and shrubs provide adequate shade to Crazy and Fawn Creeks, but the South Fork of Vance Creek has little shade.

Fish are not considered to be present in the South Fork of Vance Creek and Fawn Creek. It is assumed that at one time several fish species inhabited these creeks. Yet the current condition of the South Fork of Vance Creek makes it a low priority for restoration. Fawn Creek is a bit closer to the DFCs explained in Amendment 29; however, intense management (timber, livestock) in the subwatershed suggest it also is a low priority for restoration. Further monitoring of these two creeks could help determine if the conditions in these creeks have changed to warrant restoration efforts.

Since Crazy Creek currently supports cutthroat and redband/steelhead trout and 60% of its attributes meet the DFCs of Amendment 29, it may be a candidate for restoration efforts. It is a high gradient stream with a step-pool morphology and the absence of LWD may not be a problem; boulders and bedrock may be the primary pool creators. Step-pools do not often span the channel, so the survey data may not reflect the actual conditions in the creek because survey criteria require that pools are only counted if they span the entire channel. Further survey and monitoring needs to occur to understand the types of restoration projects that would improve the aquatic habitat within these streams.

Table 5-6.10. Attributes from early 1990s stream surveys on Crazy Creek, Fawn Creek, and South Fork Vance Creek.

Creek attribute	Crazy Creek	Fawn Creek	South Fork Vance Creek
Cobble Embeddedness	Failed	Failed	Failed
Bank Stability	Passed	Unknown	Unknown
% Stream Bank Vegetated	Passed	Failed	Failed
Ground Cover	Passed	Unknown	Unknown
Pool Frequency	Failed	Failed	Failed
Large Wood Debris	Mixed Conifer/ Failed	Mixed Conifer/ Failed	Mixed Conifer/ Failed
Potential LWD Determined from PI	Failed	Failed	Failed
Shade Canopy Closure	Passed	Passed	Failed
Shade Canopy Determined by PI	Passed	Passed	Unknown
Width/Depth	Passed	Passed	Failed
Instantaneous Temperature	Passed	Passed	Unknown
% of Attributes Failing Standard	40%	62%	100%
Rosgen Stream Type	A	A	A
Fish Species Present	ONCL/ONMY	NONE	NONE

Attributes in each surveyed reach were rated according to the Malheur National Forest Amendment 29 standards to determine if the attribute passed or failed the standard.

5-6.2.1.2 Deep Pools

During the stream surveys in the early 1990s, pools were measured for their depth. Deep, large pools are important loci for thermal regulation and buffering. Deep pools buffer

temperature extremes and provide areas of low stream energy to reduce physiological stress on fish. Deep pools signal a stable river system. In contrast, a lack of deep pools may signal stream aggradation. Aggradation occurs when streams lose the ability to transport sediment out of the system and sediments fill pools and cover substrate. Of the 1,301 pools identified in the Canyon Creek watershed stream surveys, only nine pools were at least three feet deep. All pools listed in Table 5-6.11 were located outside the wilderness boundary. With only one exception, these pools were found in larger C, G, and B stream types. Large pools are essential winter rearing habitat for adult salmonids. Habitat restoration must include the creation of deep pools.

Table 5-6.11. Quantity of pools exceeding three feet in depth.

Stream name	SMART survey reach number	Pool depth (feet)
Canyon Creek	1	3.7
Canyon Creek	1	3.1
Canyon Creek	1	3
Middle Fork Canyon Creek	1	4
Middle Fork Canyon Creek	1	3
Middle Fork Canyon Creek	2	3.3
Middle Fork Canyon Creek	3	3.6
Middle Fork Canyon Creek	3	3
Vance Creek	1	3

Pool measured during stream surveys conducted in early 1990s for selected reaches within Canyon Creek watershed.

5-6.2.1.3 Fish Blocks

Low water flows block fish from accessing critical rearing and spawning habitat. With the exception of waterfalls located in the headwaters of streams identified in the stream surveys, little data exist to determine where fish blockages may exist. The dam at Canyon Meadows acts as a block during low flows. An additional mechanism that may be considered a blockage to fish passage is dewatering of stream channels associated with the use of water rights. As discussed in *Chapter 3*, OWRD estimates that consumptive water use associated with the full use of water rights would not be expected to result in dewatered channels in the East Fork Canyon Creek, Middle Fork Canyon Creek, or Canyon Creek upstream of the East Fork. However, OWRD estimates for the mouth of Canyon Creek indicate that consumptive water use associated with the full use of water rights could result in a dewatered channel during the months of August and September during dry years.

Existing data pertaining to potential fish blocks in the Canyon Creek watershed were not available for this watershed analysis. In the future, however, the existing data should be

made available and reviewed to determine where fish blocks occur and what might be done to remove them. One partial barrier has been identified along Vance Creek near the J-L Ranch where boards and rocks have been placed in the stream.

5-6.2.1.4 Non-Native Fishes

Non-native fish are a widespread problem for bull trout and cutthroat trout populations across the inland west. Brook trout are established above the dam on Canyon Creek and have likely moved below the dam since the floodgates were opened. Habitat conditions influence the interactions of cutthroat and brook trout (Shepard et. al. 2002). Brook trout emerge several months earlier than west slope cutthroat trout. Brook trout obtain a competitive size advantage over cutthroat in the same age cohort during the first year of life (Shepard et. al. 2002). When habitat becomes degraded and food supplies limited, brook trout will outcompete cutthroat trout for scant resources. Under stressed conditions, brook trout may actually feed on cutthroat eggs and/or fry. The brook trout population in Canyon Creek poses a clear and present threat to the cutthroat trout population.

5-6.2.1.5 Aquatic Macro-invertebrates

The diversity and quantity of aquatic insects present in streams indicate water quality and substrate condition. The insects also reveal if the stream suits trout. From 1988 to 1991, an aquatic macro-invertebrate study was conducted along portions of Canyon Creek and the Middle Fork of Canyon Creek. The results of the survey reported whether the stream was in poor, fair, good, or excellent condition. The biological surveyors reported that their survey of macro-invertebrates indicated these streams were in good condition overall. The surveyors found good numbers of clean water invertebrate species in Canyon Creek and the Middle Fork of Canyon Creek and this trend continued for the duration of the study. The reports did not include specific geographic information about where the study occurred. The reports failed to describe to what extent of the stream the results applied.

5-6.2.1.6 Canyon Creek Mainstem Outside National Forest System Lands

The lower reaches of Canyon Creek are steep gradient reaches that run through a relatively narrow canyon (*Chapter 3*, Level I Analysis). The wider valley bottoms and historic meandering reaches are found upstream of Berry Creek outside of NFL lands. Historically these mid-creek reaches probably meandered around a dense hardwood and shrub complex. Alder, willow, and to some extent aspen covered the riparian areas, creating a relatively cool valley bottom comprised of a complex vegetation structure. Side channels, oxbows, and wetlands stabilized water flows, and native aquatic species were diverse and abundant. Beaver activity helped to raise water tables and form deep pools.

Today, little remains of this historic ecosystem because of various land-use activities: wetlands were drained, creeks were dredged, and side channels filled. Agricultural

practices including plowing and grazing have resulted in overgrazed fields filled with invasive grasses, herbs, and shrubs. Irrigation rights have priority over in-stream fish rights, limiting fish access to rearing and spawning habitat. Species richness and channel diversity has been replaced by a trend toward fewer species and channelization. However, even with the loss of habitat, important aquatic species still use this waterway.

The mainstem of Canyon Creek outside federally managed lands may be the limiting factor to successful aquatic habitat restoration in the upper reaches. Efforts to restore the upper reaches while ignoring the mid to lower reaches may do little to repair the restore the aquatic ecosystem.

5-6.2.1.7 Aquatic Habitat Review

The SMART stream data indicated a mixed report for habitat conditions. The streams appeared fragmented, with little consistency between the reaches. Generally, habitat improved in the upper reaches, while creeks downstream, like the South Fork of Vance Creek and Vance Creek, offered aquatic species little refuge. Based on 1993 and 1994 data

- 64% of the reaches surveyed failed the Amendment 29 standard for stream shading
- 95% of the reaches failed the standard for functional in-stream LWD
- 68% failed for near-term LWD recruitment potential
- 86% of the surveyed reaches failed the standard for number of pools/mile
- 41% failed for embedded substrate using a threshold of 35% instead of 20% as called for in Amendment 29
-

Poor shading meant warmer water temperatures and less cover for all species utilizing the streams. The small number of pools scattered throughout the system and the low potential for LWD revealed the low quality of in-stream habitat for fish. The native fish present in Canyon Creek watershed are threatened by declining habitat conditions and habitat fragmentation. The goals of the Aquatic Conservation Strategy are not being met.

The strategy states that managers must “Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.”

The fragmented habitat within the analysis area disrupts life history requirements of important fish species. For example, aggraded and silted channels provide low quality spawning habitat. Fish that rear in the streams that have high temperatures and low are

physiologically stressed. Stressed fish populations will ultimately result in lower individual fish presence in the streams.

An evaluation of the *overall* agreement between the SMART survey data and the remote survey data for LWD recruitment potential and shade canopy indicated an agreement greater than 85% as to whether the Amendment 29 standards were passing or failing for all the reaches surveyed. The strong explanation of variance between the remote shade canopy data and temperature (see *Hydrology* section this chapter), coupled with the agreement between field and remote surveys for LWD recruitment and shading, provide confidence that the remote surveys, while not perfect, did a good job of evaluating conditions within the watershed.

5-6.2.2 Hydrology Synthesis

5-6.2.2.1 Climatic Conditions

Climatic conditions and cyclical changes in climatic conditions are among the primary factors that determine aquatic productivity within a watershed. Precipitation volumes and timing are one of the primary determinates of the carrying capacity for many aquatic and terrestrial species.

Monthly precipitation is highest in November and December (ranging from an average of 2.0 to 4.3 inches per month) and lowest in July (ranging from an average of 0.5 to 0.8 inches per month). Annual precipitation ranges from 16.8 inches per year in the Canyon City subwatershed to 27.7 inches per year in the Upper East Fork subwatershed and is 22.4 inches per year for the entire watershed. In general, Berry Creek, Canyon Meadows, Middle Fork Canyon Creek, and Upper East Fork subwatersheds are below the watershed average for monthly and annual precipitation volumes, and the remaining subwatersheds are above the average.

Air temperatures generally vary with elevation throughout the area, with mean minimum temperatures occurring in December and January (ranging from approximately 10° F to 40° F) and mean maximum air temperatures occurring in July (ranging from approximately 80° F to 90° F).

Snowpack is one of the principal locations where water is stored in watersheds such as Canyon Creek that have very few lakes and ponds and limited wetland areas. Snowfall generally occurs in October through April at all elevations, and snowpack is generally gone by the beginning of May at all but the highest elevations. Maximum snowfall occurs in December and January, and snowpack appears to reach the greatest depths in late February at the lower elevations, and in early April at the higher elevations. No information is available from within the watershed on snowpack trends over time or on land-use effects to snowpack; however, it is possible that snowpack may be reduced under the denser forested canopies that have resulted from fire exclusion. Snow accumulation may be greater within small forested openings than in adjacent forested

areas (Toews and Gluns 1986), although there may be a maximum opening size, above which accumulation is the same or even less than the surrounding forest (Golding and Swanson 1986; Troendle 1983).

Climatic cycles, such as the El Niño/Southern Oscillation and the Pacific Decadal Oscillation (discussed further in *Chapter 1*), have been correlated with ecosystem performance, with warm/dry periods being correlated with enhanced coastal ocean productivity in Alaska and decreased productivity off the west coast of the lower 48 states, and cold/wet periods being correlated with the reverse. Consequently, local actions within the watershed that may impair or improve anadromous fish production must be considered relative to these larger-scale climatic cycles. For example, the relatively cool/wet period that occurred from the 1940s to the 1980s may have had a positive influence on anadromous fish populations, while the relatively warm/dry period during the late 1980s and early 1990s may have had the opposite effect, regardless of changes in local habitat conditions during the same period. It is also important to consider that human-caused stresses to the system (e.g., decreased stream flows due to water withdrawals) become an even greater concern to fish survival during these dry cycles.

5-6.2.2.2 Stream Channel Characteristics

Stream channel types within the Canyon Creek watershed reflect the geologic and geomorphic processes active in the region. Stream gradient and valley bottom development is primarily a function of position within the watershed, with the upstream reaches tending to be the steepest and most confined; however, some anomalous situations exist. The lowest-gradient streams flowing through the widest valley bottoms occur along the mainstem of Canyon Creek from the confluence with Berry Creek upstream to the confluence with the Middle Fork of Canyon Creek. The portion of Canyon Creek downstream of Berry Creek to the mouth is relatively steep and confined, due to the greater resistance of the underlying geology.

The principal streams within the watershed were classified using the Rosgen level I classification methodology. Rosgen type “Aa+” streams (greater than 10% channel gradient, confined) are located in headwater areas and make up approximately one-quarter of the principal stream length in the Canyon Creek watershed. Transport processes dominate in these reaches, as they are often source areas for downstream deposition. Rosgen type “A” channels have a slightly lower gradient than the “Aa+” classification (4% to 10%, confined). Type “A” channels make up the largest proportion (40%) of the principal stream length within the Canyon Creek watershed. Type “B” channels, which have a more moderate gradient and may include areas of floodplain development, may be both transport and depositional reaches. Within Canyon Creek, type “B” channels are typically found at the lower end of the larger tributaries and along the mainstem of Canyon Creek downstream of Byram Gulch. Type “B” channels make up 13% of the principal stream length in the watershed.

The majority of the mainstem of Canyon Creek downstream of Vance Creek has been classified as a “G” type channel. Type “G” or “gullied” channels are narrow, entrenched, non-meandering channels that are often downcut within alluvial deposits. Several other stream segments within the watershed exhibit some “G” channel type characteristics, including the downstream portion of Vance Creek (classified as a “G/B” type); the mainstem of Canyon Creek upstream of Vance Creek to Crazy Creek (“G/C” type). Rosgen type “C” channels consist of relatively low-gradient streams with well-developed floodplains and are typically highly responsive to sediment and wood inputs.

It is unlikely that many of the channels currently classified as “Aa+”, “A”, or “B” were much different historically with respect to Rosgen classification type. The morphological characteristics of these channels are dominated by valley slope and confinement, and consequently they are relatively insensitive to anthropogenic effects. The portion of the mainstem of Canyon Creek that is currently classified as “G/C” (i.e., from the confluence of Crazy Creek downstream to the confluence with Vance Creek) was most likely a Rosgen type “E” or possibly “C” channel type prior to disturbance. The pre-disturbance type “E” or “C” channel type probably continued downstream along the mainstem of Canyon Creek to include the area that is currently classified as type “G” from the confluence with Vance Creek down to the confluence with Byram Gulch. The lowermost portion of Canyon Creek that is currently classified as a Rosgen type “B” channel was most likely a type “B” channel prior to disturbance, as was the lowermost portion of Vance Creek which is currently typed as a “G/B” channel. The changes from historic to current conditions is most likely a result of channel down cutting.

Primary erosion sources within the Canyon Creek watershed include mass wasting, road-related erosion, stream bank erosion, and background soil erosion (or surface creep). No quantitative data on erosion rates are available for the watershed, but the relative importance of the different sources was estimated using available data. Very limited areas of mass wasting were observed within the watershed, and based on available anecdotal information it does not appear that mass wasting is a large source of sedimentation. Road-related erosion is generally not notable throughout the watershed; however, localized areas of road-related erosion exist (see Plate 5-6.1). Road-related erosion is an example of the legacy of past management decisions. Many of the road locations within the watershed are immediately adjacent to streams, a practice that would not occur under today’s management direction.

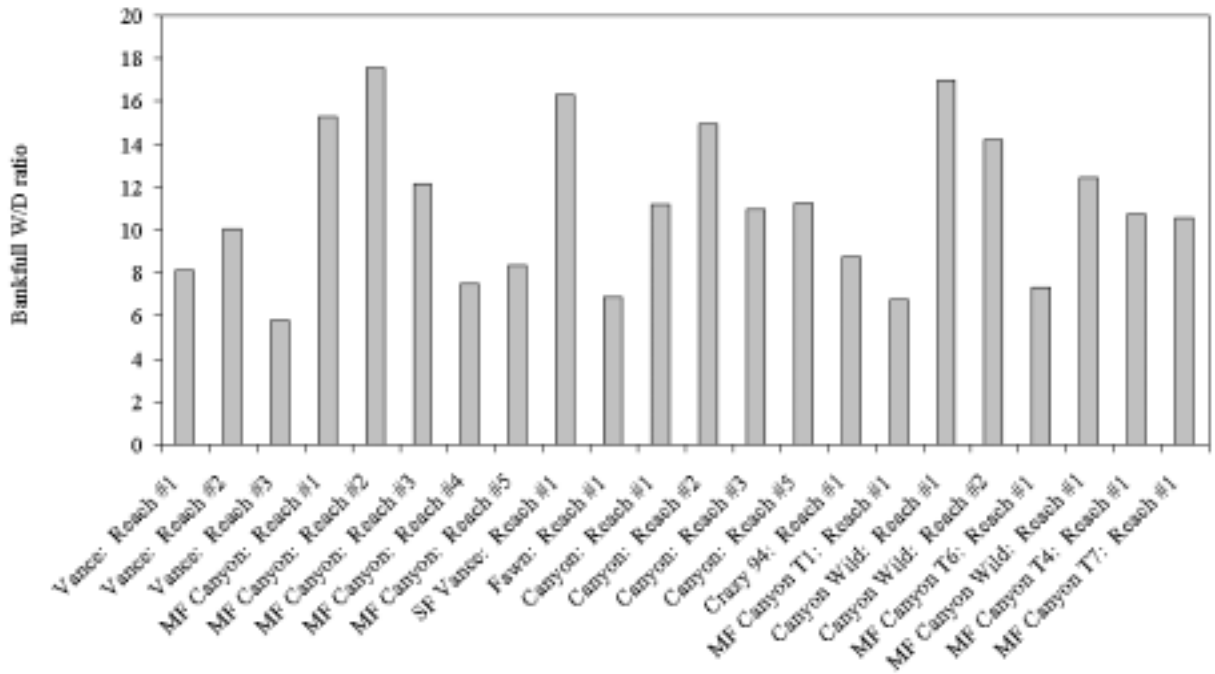

Figure 5-6.3. Bankfull width/depth ratios for streams included in the 1993-94 SMART surveys.

The primary source of erosion (and subsequent sedimentation within stream channels) is most likely the result of streambank erosion, soils within the forested-portions of the watershed being generally permeable, and overland flow being rare. (Although the SMART survey data indicates the reaches meet bank stability requirements, it is important to note that 50% of the reaches measured a decade ago were not measured for bank stability[12]). Much of the bank erosion that is occurring is likely associated with direct disturbance of the stream banks from grazing (see Plate 5-6.2), and channel incision (which is also related to grazing activities).

The only readily available data source for stream characteristics within the Canyon Creek watershed is the SMART database, which consists of several stream surveys conducted within the watershed during the summers of 1993 and 1994. Having data available for only this short time period makes it impossible to discern time-related trends in stream characteristics. Bankfull width/depth ratios for streams included in the SMART surveys are summarized in Figure 5-6.3. Due to the constraints of stream survey protocols, it was

[12] *The Interagency Team established by regional Foresters to monitor PACFISH/ INFISH implementation of effectiveness have found that most methods used to measure bank stability are not easily replicable. New protocols have been established to better detect bank instability during stream surveys. Hence, for the data presented here from past surveys, eroding banks may have been a greater contributor to in-stream sediment than previously recorded (Edwards, pers. comm. 2003).*

not possible to obtain mean wetted width/depth ratios for stream reaches. A wetted width/depth ratio value of less than 10 is required to pass the Malheur National Forest Amendment 29 Standards, and unfortunately, the data do not exist to quantify or evaluate if these streams meet or fail to meet the standards. Grazing pressure (see Plate 5-6.2) and loss of beaver within the watershed (compared to historical population numbers) are also related to changes in channel morphology. Beaver dams were probably responsible for maintaining riparian/floodplain linkages in the low-gradient portion of the watershed (i.e., the mid-portion of the Canyon Creek mainstem; see Plate 5-6.3).

5-6.2.2.3 Water Quality Parameters

The Malheur National Forest has collected summertime stream temperature data at 25 sites within Canyon Creek during the period 1994 to 2002, although not all sites have data for every year. The Oregon Department of Environmental Quality (ODEQ) water temperature standard for salmonid rearing is exceeded when the 7-day average of daily maximum water temperatures exceeds 64˚ F. The annual maximum seven-day moving average of the daily maximum temperature (T_{max}) was calculated for each site and compared to this 64° F temperature standard. The 25 sites within the Canyon Creek watershed can be summarized by four categories given in Table 5-6.12.

Four sites were classified as having two or more years of data and *meeting* the temperature standard in all or most years. All four of the sites were in headwater areas with relatively short upstream stream length. Two of the sites (Site #3, Middle Fork Canyon Creek near Wilderness; Site #20, Canyon Creek above Reservoir) are located downstream of wilderness areas. There were an additional two temperature monitoring sites having only one year of data that *met* the temperature standard; sites #17 (Crazy Creek at mouth) and #19 (Canyon Creek in section 29) were 3° and 5° F below the ODEQ temperature criteria respectively.

Nine sites were classified as having two or more years of data and *failing* the temperature standard in all or most years. All sites with the exception of site #23 (Canyon Creek below Wickiup Campground) exceeded the 64° F T_{max} value by from 1° to 9° F in any given year. Site #23 is an unusual case; T_{max} values at this site range from 0.4° F below the 64° F standard to 19° F above the standard over the five years for which there are data. It is likely that some change in site characteristic (e.g., removal of a beaver dam upstream) is responsible for the dramatic changes in T_{max} values observed at site #23.

Ten temperature monitoring sites having only one year of data *failed* the temperature standard. These sites exceeded the 64° F T_{max} value by from 1° to 10° F. Three of the sites (#11, #12, and #22) had data from the summer of 2002, which was an unusually warm summer (e.g., 2002 had the highest seven-day moving average maximum air temperature on record at the John Day climate station). In a more-typical summer stream temperatures at sites #11, #12, and #22 may be closer to or below the 64° F standard.

Table 5-6.12. Categorization of USFS temperature monitoring sites within Canyon Creek watershed.

	Summary categories		Site number and description
1	Sites with two or more years of data; meets temperature standard in all or most years	3	M F Canyon Creek near Wilderness
		16	Crazy Creek Sec. 4
		20	Canyon Creek above Reservoir
		25	Vance Creek @ Boundary
2	Sites with two or more years of data; fails temperature standard in all or most years	1	E F Canyon Creek
		2	M F Canyon Creek @ Mouth
		4	M F Canyon Creek, Sec. 30 (#1)
		10	Canyon Creek above M F Canyon
		13	Canyon Creek above Big Canyon
		15	Canyon Creek above Crazy Creek
		21	Canyon Creek @ Boundary
		23	Canyon Creek below Wickiup Campground (at aspen exclosure)
		24	Canyon Creek below Road Gulch
3	Sites with one year of data; meets temperature standard	17	Crazy Creek @ mouth
		19	Canyon Creek Sec. 29
4	Sites with one year of data; fails temperature standard	5	M F Canyon Creek, Sec. 30 (#2)
		6	M F Canyon Creek, Sec. 36
		7	M F Canyon Creek Above Wetlands
		8	M F Canyon Creek Below Wetlands
		9	M F Canyon Creek Below Narrow Canyon
		11	Canyon Creek above M F Canyon @ Draw
		12	Canyon Creek 1,000' below M F Canyon
		14	Canyon Creek below Crazy Creek
		18	Canyon Creek Sec. 31
		22	Canyon Creek @ Wickiup Campground

Regression analysis was used to determine the relationship between T_{max} and the environmental variables most likely to affect water temperatures. The variables considered included: 1) site elevation, 2) riparian shade determined from the remote shade analysis, 3) mean annual air temperature (a surrogate for groundwater temperature), 4) an index value for mean annual stream flow, and 5) distance from the watershed divide (an index of the time that water has been exposed to ambient air temperatures). The regression equation developed using this approach accounted for over 80% of the variability in T_{max} values. This analysis indicates that stream temperature are highly responsive to differences in riparian shade levels, stream temperatures are sensitive to both natural and human-caused variations in summertime stream flow, and

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

5-6.2.2.4 Water Quantity Parameters

The primary peak-flow-generating processes active in the Canyon Creek watershed are spring snowmelt and winter rain-on-snow (high-intensity rainfall produced during thunderstorms probably also contributes to localized peak flow events). Consequently, peak flows within the watershed are sensitive to management practices that have the possibility of affecting snow accumulation and melt rates. Mean daily discharge is highest during the late spring/early summer snowmelt season and lowest during late August and early September.

Management activities have the potential to influence peak flows through several pathways. Vegetation manipulation may influence peak flows by changing snow accumulation and melt rates; wetland loss and channel incision may result in decreased detention time of storm runoff and result in flashier peak flows; soil compaction can reduce infiltration resulting in shorter travel time to stream channels and higher peak flow magnitudes; and road drainage networks may intercept subsurface flows and reduce infiltration, resulting in quicker routing of runoff to the stream system.

Almost no quantitative information on how these processes may be affecting peak flows is available for the Canyon Creek watershed. No modeling of vegetation effects on snow accumulation or melt has been conducted. Anecdotal information suggests the likelihood that most streams in the watershed have experienced some level of stream incision and downcutting associated with grazing and fire (Plates 5-6.4 and 5-6.5), and conditions have been exacerbated by the decrease in the beaver population and subsequent loss of beaver dams. Equivalent roaded area (ERA) analyses for a portion of the watershed indicate that compaction is currently below the threshold of concern. Anecdotal evidence suggests that only a very small portion (less than 5%) of most forested areas within the watershed are detrimentally impacted by compaction and that most compaction in forested areas is a legacy of past ground-based logging activities in the 1950s. No information is available for the Canyon Creek watershed on the level of connectivity between the road drainage and stream channel networks; however, the high density of roads in some watersheds (e.g., over five miles/square mile in the Vance Creek subwatershed) indicate that road drainage effects may be a concern.

In addition to the impact on peak flows, channel incision and wetland loss may also be affecting base flow conditions within the Canyon Creek watershed, although no quantitative information is available. One wetland area within the watershed that may be providing base flow augmentation is the Canyon Meadows reservoir area (Plates 5-6.6 and 5-6.7). Despite the fact that the reservoir is no longer filled, it is likely that seasonal inundation of the area results in wetland storage and water release into the summer months.

5-6.2.2.5 Recommendations and data gaps – Aquatic Habitats

The following recommendations are aimed at addressing the impacts to riparian and aquatic ecosystems within the watershed, the factors limiting to the success of aquatic species, and the primary gaps in our understanding of these processes. In assembling these recommendations an effort has been made to emphasize those actions that are the most obvious and that will give the greatest return for the effort expended. Some of the recommendations (e.g., approaches to mitigate for water loss associated with water rights) apply to areas off National Forest lands. These recommendations are included because they address important processes affecting the health of the entire watershed; consequently, they cannot be ignored. Specific recommendations include the following:

5-6.2.2.5.1 Stream habitats and species

Improve our understanding of current fine sediment impacts to spawning areas within the watershed. Information on substrate embeddedness available from the SMART database was insufficient to characterize the impacts of fine sediments on spawning substrate. A more useful approach may be to collect information on the percentage of fine sediment present using techniques such as those described in Schuett-Hames et al. (1999). Additionally, during future stream surveys one option would be to increase the frequency and intensity of Wolman Pebble counts.

Quantitative modeling of the effects of vegetation manipulation, road drainage, wetland loss, and other management-related activities on peak and base flows. No quantitative information is currently available on the extent to which peak flow magnitudes and/or base flows have been affected by past or potential future changes in vegetation patterns (due to fuels reduction activities, timber harvest, catastrophic fire, etc.), road construction and road drainage networks, wetland loss or restoration, or other management-related activities. A robust, spatially-distributed, modeling tool such as the Distributed Hydrology-Soil-Vegetation Model (DHSVM) (Wigmosta et al. 2002) or the Precipitation-Runoff Modeling System (PRMS) (Risley 1994) should be considered for evaluating proposed future activities and/or current legacy effects.

Mapping of current and historical wetland extent within the watershed. The role of wetlands in the watershed in augmenting base flows is unknown and should be included in any modeling effort (as described elsewhere). However, both the current and historic extent and function of wetlands within the watershed is unknown. A thorough compilation of all sources of wetland information (e.g., NWI data, hydric soils data, in-house wetland mapping, etc.) should be completed.

Retain wetland functions of Canyon Meadows area. The Canyon Meadows dam is currently being considered for removal. However, the wetland area behind the dam provides many functions, among them storage of flood flows. Dam removal, if conducted, should be carried out in such a way as to avoid impairment to current wetland functions.

Create long riparian exclosures on as many fish bearing streams as possible to allow riparian areas time to restore themselves. Prioritize streams that currently support west slope cutthroat trout and redband steelhead. Long, continuous exclosures have proven successful as a passive restoration tool along the Middle Fork of the John Day River (Kauffman et al., 2002).

When possible, plant native hardwoods and shrubs along the newly created exclosures. Protect plantings with fences to prevent browsing. If reintroducing fire into a riparian zone, coordinate planting with Fire Management Officer and riparian ecologist to ensure the success of these operations.

Protect beaver and encourage their recovery through public education. Work together with ODFW, the Watershed Council, and other parties to educate residents about the benefits of beaver activity. Consider enhancing beaver populations along lower gradient well-vegetated reaches.

Monitor above ground biomass within riparian corridors. Grazing reduces above ground biomass (stubble height), below ground biomass (root integrity), and ultimately lowers water quantity and quality. Monitoring of above and below ground biomass will allow managers to make decisions about grazing intensities along streams.

Eradicate brook trout in Canyon Creek. In reaches where brook trout presence is confirmed, consider:

- trapping brook trout by using multiple fish-shockers moving in a downstream direction and herding the fish into trap nets
- have anglers trained at identifying brook trout fish reaches where brook trout are known to be present
- use a passive and inexpensive method involving pheromone traps. Place hoop nets seeded with reproductively mature brook trout in reaches of concern during spawning season to lure other brook trout into nets

(Re)install continuous stream flow gages. Efforts to characterize stream flow within the Canyon Creek watershed were hampered by the lack of continuous stream flow data from within the subwatersheds. Continuous stream flow data would improve understanding of peak flow history, allow for better estimation of natural stream flows, provide calibration data for any future modeling activity, and allow for better understanding of the effects of water use within the subwatersheds. Reinstalling gages at the locations of the two former USGS stream gages (gages #14038550, East Fork Canyon Creek near Canyon City, and #14038600, Vance Creek near Canyon City), and at the locations of the three former OWRD gages (gages #14038560, Canyon Creek at Thissel's Ranch near Canyon City, #14038602, Canyon Creek near Canyon City, and #14038630, Canyon Creek at John

Day) would build upon the existing data sets. Of these five locations, the Canyon Creek near Canyon City gage (#14038602) should be the highest priority for reinstallation, as it has the longest continuous record in the watershed and is located at a point that captures most of the flow originating from National Forest lands within the watershed

5-6.2.2.5.2 Data gaps pertaining to fish and stream habitats

The USFS supplied several data sets to the contractor to conduct this analysis. Some of the data was submitted in electronic format while other data sets were submitted in hard copy. Electronic data sets are easily queried for analysis; hard copy data sets are not.

One data set in hard copy provided to the contractor was a series of riparian surveys conducted between 1993 and 1998. If these surveys were electronic in format, they would have been easily queried and more useful in determining how riparian areas are currently functioning within the watershed. Additionally, if this data were linked to maps via geographic information systems it would have added valuable data for this analysis. Further still, a current validation of riparian ecotypes would be useful to understanding how riparian areas function today. A riparian survey like the one conducted for the Emigrant Creek Ranger District of the Malheur National Forest in 2002 would serve as an excellent template for future studies.

The SMART survey data provided to the contractor was incomplete. This was discovered while reviewing hard copy reports of the same stream data contained in the database. Attributes reviewed in the hard copy report were missing from the SMART database. These reports and the original data used to compile the reports should be reviewed and compared to the data in the SMART database. The SMART database, if not obsolete, should be updated from the raw data if that raw data is still available.

The data contained in the SMART database is nine or ten years old. In order to better understand the condition of the streams within the watershed, Level II stream surveys should be conducted soon. The LRMP for the Malheur National Forest calls for surveying of these streams every decade.

Range information pertaining to allotments, grazing intensity, fences, etc., would be useful to determining the grazing pressures put on the aquatic resources. This type of data was not available for our analysis. In the future, be sure to measure and monitor above ground biomass in riparian zones to determine suitability for grazing and habitat protection.

The road inventory for Canyon Creek watershed offers general information about road conditions. A complete analysis of the roads in Canyon Creek will provide more detail as to the hazards posed by roads especially in terms of erosion that may lead to embedded substrate.

5-6.3 TERRESTRIAL WILDLIFE SPECIES AND HABITAT (ISSUE 4)

Past management activities and natural disturbance processes have altered the diversity and distribution of wildlife populations and the condition of wildlife habitat.

- Key question 1: How has the diversity and distribution of Proposed Endangered, Threatened, and Sensitive Species (PETS) and their habitat changed from historical conditions?
- Key question 2: How has the diversity and distribution of non-PETS terrestrial wildlife and their habitat changed from historical conditions?

The species that appear to be most impacted by the changes from historical conditions are those associated with the old forest single-stratum stand structure, riparian areas, and aspen and large-diameter snag habitats. The viability of these species is a concern from the perspective of both the ESA and the standards and guidelines set forth in the Malheur National Forest LRMP and Regional Forester's Amendment 2. These standards and guidelines were designed to maintain suitable habitats for certain species during project design and implementation. The changes in diversity, abundance, and distribution of these species and their habitat from historical conditions as well as the causes of those changes are discussed below.

5-6.3.1 Proposed, Endangered, Threatened, and Sensitive Species

5-6.3.1.1 Synthesis

5-6.3.1.1.1 Shrubland and Herbland Associated Species

Pygmy Rabbit and Western Sage Grouse. Sagebrush is a crucial and critical component for both these species. These species have declined primarily because of loss of habitat due to the conversion of sagebrush habitat to grassland and agricultural uses (Howard and Bushey 1996, 1986). Heavily grazed areas can also limit the amount of habitat.

Fire can create a mosaic of sagebrush of different ages and structures that benefits sage grouse (Klebenow 1969). However, in the short term, fire always removes a certain amount of sage grouse food and cover, and sagebrush can be slow to recover from fire in the long term (Griner 1939). If historically the watershed had a higher percentage of suitable sagebrush habitat than it does currently, fire may have helped to maintain that habitat. If historically the watershed had limited sagebrush habitat, fire occurring in areas with limited nesting grounds in any season may have had an adverse effect on sage grouse populations and habitats (Autenrieth et al. 1982).

Sage grouse have one of the lowest recruitment rates of any upland game bird in North America. Loss of habitat, predation, drought and poor weather conditions during hatching and brooding periods have been cited as factors leading to poor recruitment throughout their range (Mattise 1995). Some of these factors may be responsible for the lack of documented occurrences in the watershed.

Upland Sandpiper, Gray Flycatcher, and Bobolink. Habitat is currently limited in the watershed and has been limited historically. These species are not documented to occur in the watershed. This may be due to the lack of surveys for the other species as well as a general lack of preferred habitat.

5-6.3.1.2 Recommendations for Shrubland and Herbland Associated Species

- Manage for the reduction/elimination of livestock grazing impacts from areas of potential suitable nesting habitat for grassland associated species. The amount of late-season grazing should also be limited to encourage and maintain vegetation for forage and cover throughout the year.
- Restore hardwood habitats in the riparian areas prior to the introduction of beaver to facilitate successful establishment and population maintenance. Introduce beaver to reflect the historical distribution of this species in the watershed. The introduction of beaver into the riparian areas may assist in the restoration of wet meadows. See Aquatic Species and Habitat recommendations.

5-6.3.2 Wide Ranging Carnivores

5-6.3.2.1.1 Synthesis

Gray Wolf. As stated previously, wolves in the Blue Mountains are most likely strays that traveled from reintroduced experimental populations in Idaho. This is likely to continue as the Idaho populations grow. Oregon is not part of the federal recovery program for the gray wolf. ODFW will mostly likely be the lead agency for management of this species.

Canada Lynx. Historically, the warm dry PAGs did not provide suitable habitat for the Canada lynx. Due to past timber management and fire suppression, this PAG may contain habitat suitable for this species and its prey. The wilderness area provides suitable denning habitat and suitable foraging and travel habitat occurs throughout the watershed in the SECC, SEOC, and YFMS stands.

Wolverine. Wolverine habitat occurs within the Strawberry Mountains wilderness where human impacts and human disturbance are low in the analysis area. Elsewhere on the District, the Vinegar Hill-Indian Rock Scenic Area and Dixie Butte Wildlife Emphasis Area exhibit characteristics of wolverine habitat as do the Dry Cabin Wildlife Emphasis Area and the Shaketable, McClellan Mountain, and Aldrich Mountain Roadless Areas, which share the same characteristics.

The Moist Upland Forests PVG with a Cool/Moist PAG represent the highest quality habitat, particularly where they remain relatively undeveloped and undisturbed. Quality habitat includes both the OFMS and YFMS structural stages. Approximately 10,270 acres of these forest types exist. Structural stage percentages are within the estimated HRV for OFSS and in excess of the estimated HRV for YFMS.

Elsewhere, lesser quality habitat provides sufficient cover and security to meet landscape connectivity between potential home range areas.

5-6.3.2.2 Recommendations for Wide Ranging Carnivores

- Continue to work with ODFW on wolf management in the Blue Mountains.
- Continue to follow the direction outlined in the Lynx Conservation Assessment Strategy (Ruediger et al. 2000).
- The Lynx Conservation Assessment Strategy states that land managers establish Key Linkage Areas (KLA) for lynx habitat connectivity between LAU's. The establishment of these corridors would best be established Forest-wide using GIS and then field verified at the project level to assess connectivity at the stand level.

5-6.3.3 Multiple Habitat Associated Species

5-6.3.3.1 Synthesis

Tricolored Blackbird and Bufflehead. As stated previously, NFS lands within the analysis area appear to not have suitable habitat for these species.

Peregrine Falcon and Columbia Spotted Frog. Both species have specialized habitats that occur in the watershed. For peregrine falcons, known suitable or suspected suitable cliff sites should continue to be monitored for nesting activity. Surveys should be conducted in suitable habitats for the Columbia spotted frog. These surveys should at least be conducted prior to projects and elsewhere as opportunities and budgets allow. Access to existing habitats and the enhancement of that habitat should be considered in projects design especially is there are proposed activities in riparian areas. Riparian restoration activities including road removal and plantings will most likely benefit these species.

Elk. Past timber harvest and fire suppression changed the forest stand structure from a single stratum to a multi-strata condition. This change in structure changed the thermal cover conditions in the watershed. The impact of this change to big game utilization of the watershed is unknown. Ungulate-vegetation interactions in the Blue Mountains are both complex and different from those of pre-settlement conditions. Vegetation composition, productivity, and diversity have been influenced by ungulates, fire suppression, the effects of insects and disease, and past timber management. Despite such complexity, evidence is clear that long-term herbivory by both wild and domestic ungulates has changed vegetation productivity (Irwin et al. 1994). Forage quality is below what is necessary for optimum growth for young deer, elk, and cattle. In the analysis area, hiding cover usually provided by a tall shrub layer have been reduced or replaced by a dense understory of trees created by overstocking and a low fire frequency. Therefore, hiding cover in the analysis area is provided by high densities of understory trees rather than a vigorous shrub layer. It is assumed that this high density of understory trees is most likely still providing some level of security refuge for elk.

Another factor that impacts big game use of the watershed is road density. The tendency for elk to avoid open areas near roads has been the most studied and well-documented aspect of elk behavior. Elk will consistently and dramatically avoid areas near open roads across a variety of seasons and landscape conditions (Wisdom and Cook 2000). Road densities exceed the LRMP standards throughout the watershed.

Hunting regulations have increased the number of elk above documented historical levels in the watershed. Mule deer populations are currently lower than in the 1960s. This decline may be associated with changes in vegetation such as overbrowsing in some areas, some of which was caused by the deer themselves, competition with elk and cattle, and/or increased predator populations. Dense elk populations could preclude increases in mule deer herds, too, by reducing shrubs on mule deer summer and winter ranges (Irwin et al. 1994).

5-6.3.3.2 Recommendations for Multiple Habitat Associated Species

- Seek to reduce road densities in subwatersheds that do not meet the LRMP road density standard for summer range. Roads proposed for closure should be prioritized to areas that would provide the most benefit to elk (i.e., roads adjacent to riparian areas that provide calving and fawning habitat). Where feasible, roads should be decommissioned to discourage motor vehicle use and provide an effective closure for wildlife.
- Monitor livestock and big game use of forage in the watershed. Determine whether the available forage can support current ungulate population levels and still restore/ maintain riparian hardwood and shrubland habitats. Develop management recommendations if necessary to reduce livestock, and/or big game population levels in the watershed.
- Hiding cover should be retained in multi-strata stands that are being managed towards old forest single-stratum in at least 10% or more of the stand depending on current presence of cover and site capability.
- As stated above, conduct surveys at the project level in slow moving permanent water of the watershed for potential of suitable breeding areas for the Columbia spotted frog. During project design include, where appropriate, site enhancement and restoration opportunities.
- For peregrine falcons, known suitable or suspected suitable cliff sites should continue to be monitored for nesting activity.

5-6.3.4 Late and Old Forest Multi-Stratum Structure Associated Species

5-6.3.4.1.1 Synthesis

Bald Eagle. Suitable bald eagle nesting and winter roosting habitat currently is limited along Canyon Creek due to the removal of large ponderosa pines during past timber

management, conversion to agriculture, and water withdrawals. Historically, more nesting and winter roosting habitat may have been available. This species has been documented in the watershed during the winter.

Pacific Fisher. Systematic habitat alteration and overexploitation have reduced historical distribution of fishers in suitable habitat in the interior Columbia Basin to isolated and fragmented populations (Witmer et al. 1998). Current populations may be extremely vulnerable to local and regional extirpation because of their lack of connectivity and small numbers (Witmer et al. 1998). Fishers are thought to occur primarily in the Cascade Range and Rocky Mountains in the interior Columbia Basin (Witmer et al. 1998). No museum-documented occurrences are known in the Oregon Blue Mountains (Verts and Carraway 1998).

Past timber management and fire suppression have provided mature multi-strata mixed conifer stands in portions of the warm-dry PAGs. However, stand conditions in these PAGs typically do not provide the dense canopy closures preferred by this species. These areas may be too high in elevation to provide preferred habitat conditions due to deep snow accumulations. There are no historical documented occurrences, and current populations in the interior Columbia Basin are not thought to occur in the Blue Mountains.

Pileated Woodpecker. The moist upland forest types provides the more favorable habitat conditions for the pileated woodpecker, i.e. mixed conifer stands with high canopy cover. Past timber management and fire suppression have changed the forest composition from a ponderosa pine-dominated forest to a Douglas-fir, grand fir, and ponderosa pine forest. Past timber management has also reduced the number of large-diameter trees that would have provided potential future recruitment for large-diameter snags and downed wood, which are important habitat components for this species. Old forest multi-strata stand structure should be maintained in the warm-moist PAGs that provide habitat conditions for this species.

Northern Goshawk. Past timber management and fire suppression in the watershed have changed the forest structure in the warm-dry PAGs. These changes have provided more multi-strata structural stands in larger patch sizes than occurred historically. Currently, there is probably less suitable habitat due to the loss of the large-diameter trees used for nesting habitat and the increase in small-diameter trees, which may reduce the quality of the foraging habitat.

Three-Toed Woodpecker. Lodgepole pine occurs as a minor component in the grand fir vegetation type in the warm-dry PAGs both historically and currently. This habitat is limited in the watershed and occurs primarily in the Lower East Fork and Canyon Meadows subwatersheds. There is only 771 acres of dominant lodgepole pine stands identified in the watershed most of which is wilderness area. The removal of mature lodgepole pine that is infested with mountain pine beetle may reduce or eliminate habitat for this species (Van Dam et al. 1993). Lodgepole pine should be maintained as a

component of the grand fir vegetation type where appropriate to provide habitat for this species in the watershed.

Black-Backed Woodpecker. Black-backed woodpeckers are dependent on forests containing wood-boring larvae. Past timber management and fire suppression have reduced the historical abundance of suitable habitat for this species. Past timber management activities have reduced the amount of late and old forest stand structures in the watershed, which provide habitat for this species. Because this species is associated with early post-fire conditions, fire suppression has limited its habitat. This species population probably fluctuates over time in response to disturbances such as fire and windthrow.

5-6.3.4.2 Recommendations for Late and Old Forest Multi-Strata Structure Associated Species

- Retain patches of old forest multi-strata stand structure in the stands identified as young multi-strata that provide suitable nesting habitat for goshawks. Continue to monitor goshawk nesting territories and establish a PFA around Table Mountain if goshawks are documented.
- Maintain lodgepole pine as a component of the grand fir vegetation type where appropriate to provide habitat for the three-toed woodpecker. Lodgepole dominated stands greater than 75 acres in the Canyon Meadows subwatershed should be field verified to determine if a DOG unit could be established.
- Seek opportunities to manage (enhance or maintain the components depending on the field verification of existing condition) the DOG and ROG areas in Fawn and Sugarloaf subwatersheds that are outside the wilderness area. Review of the PI data indicates the presence SECC and SEOC stand structures within the units and therefore there may be opportunities for silvicultural treatments in these stands to facilitate the stands in moving towards a OMFS condition. Manage the replacement areas for future old-growth conditions to provide habitat for the pileated woodpecker and other old forest-associated species.
- To provide snag habitat for deadwood-associated species in the watershed, continue to retain existing large-diameter snags, to meet forest standards in DOG areas, which is the retention of 2.39 snags, 21 inch and over dbh, per acre.
- During project design consider managing the young forest multi-strata stands in the warm/dry PAGs (grand fir vegetation type) to move toward old forest multi-strata stand structure with associated snag and downed wood components to provide more suitable habitat for the pileated woodpeckers in the future.
- Prevent further fragmentation of the old forest multi-strata stand structure in the warm/dry PAG's that provide suitable stand structures and snags and downed wood for pileated woodpecker.

- Late and old forest stand structure is more fragmented currently than historically. Reconnect the DOG, ROG and old forest multi-strata structural stands with travel corridors by managing the young forest multi strata and stem exclusion open canopy structural stands towards old forest single-stratum to reflect two-thirds of site potential canopy closure.

5-6.3.5 Late and Old Forest Single-Stratum Structure Associated Species

5-6.3.5.1 Synthesis

White-Headed Woodpecker. Historically, the white-headed woodpecker was probably more abundant and well-distributed in the watershed. The old forest single-stratum was the most prevalent stand structure in warm dry and hot dry PAGs, covering 15% to 55% and 20% to 70% respectively. This preferred habitat type currently does not exist in the watershed. The removal of the large ponderosa pines and subsequent suppression of fire resulted in the loss of suitable habitat for this species in the watershed.

Lewis' Woodpecker. As discussed above, open ponderosa pine habitat was historically more abundant and well distributed in the watershed. Hardwood communities, including cottonwood, were also more abundant historically in the riparian areas. Currently, a majority of the lower elevation riparian areas and hardwood communities has been eliminated due to domestic livestock, deer and elk, timber harvest and associated road construction, and fire suppression. Lewis' woodpecker has not been documented in the watershed, which may be due to the lack of habitat.

Williamson's Sapsucker. Historically, the open ponderosa pine forests were more abundant and well distributed in the watershed. Open ponderosa pine is absent and aspen habitats are currently lacking, but conifer-dominated stands occur throughout the watershed. Past timber management removed trees of large diameter (i.e., above 20 inches in diameter), which limit nesting habitat for this species.

5-6.3.5.2 Recommendations for Late and Old Forest Single-stratum Structure-Associated Species

- Where appropriate, seek opportunities to move the young multi-strata stands toward single-stratum stand structure that reflects the historical range of 15% to 55% in the warm/dry PAGs and 20% to 70% in the hot/dry PAGs to provide habitat for the white-headed woodpecker and other species associated with this stand structure. This could include, where appropriate, managing the old forest multi-strata stand structures to provide habitat in the short term and the young forest multi-strata and stem exclusion with open canopy stand structures to provide habitat in the long term. See *Vegetation* recommendations.

5-6.3.6 Deadwood-Associated Species

5-6.3.6.1 Synthesis

Downy Woodpecker and Red-Naped Sapsucker. Historically the riparian areas consisted of a mixture of grasses, shrubs, and hardwoods. Currently, a majority of these riparian areas and hardwood communities have been reduced due to the effects of domestic livestock, deer and elk, timber harvest and associated road construction, and fire suppression. Aspen is preferred habitat for both these species. Scattered clumps or small groves of aspen currently occur in the watershed. The condition of aspen throughout the watershed is generally believed to be poor, and regeneration is very limited, with the dominant age classes being decadent. It is generally accepted that aspen occupies a much smaller portion in both riparian areas and among forested PAGs than was found historically. Preferred habitat conditions were more evenly distributed in the watershed historically.

Hairy Woodpecker and Northern Flicker. These species use a variety of habitats but prefer open habitat, which was more abundant historically. Although habitat conditions have changed, because these species use a variety of habitat types, suitable habitat may occur throughout the watershed. Past timber management has limited the large-diameter soft snags used by the northern flicker for nesting habitat. The distribution of nesting habitat for the northern flicker is thought to be patchy in the watershed. For nesting, the hairy woodpecker uses smaller diameter snags, which are not lacking in the watershed.

5-6.3.6.2 Recommendations for Deadwood-Associated Species

- Aspen provides habitat for a variety of wildlife species. Aspen is less abundant than it was historically in the watershed, is in poor condition, and has a low rate of regeneration. Measures such as fencing and conifer removal should be taken to protect the remaining aspen groves and enhance regeneration of this species.
- Hardwoods are lacking in the watershed. Restoring hardwoods through plantings where project design indicates, especially aspen, to the riparian area would improve habitat conditions for those species dependent on this habitat.
- As mentioned above, retain existing large-diameter snags, to meet forest standards, which is the retention of 2.39 snags, 21 inch and over dbh, per acre. Retain large-diameter soft snags to provide habitat for the northern flicker.
- Continue to meet to down wood requirements specified in the Amendment 2 at the project level.

5-6.3.6.3 LRMP Featured Species

5-6.3.6.3.1 Osprey and other raptors

Osprey are successfully nesting and reproducing along lakes and large lakes throughout the state as the persistence of DDT levels continue to lessen in intensity in the environment. Canyon Creek in the Fawn subwatershed continue to provide potential

habitat but the watershed does not have a high density of large, fish-bearing water bodies. Other raptors discussed in *Chapter 3* continue to use the watershed for nesting and foraging.

5-6.3.6.3.2 California bighorn sheep

As stated previously, bighorn sheep were extirpated from Oregon by the mid-1940s and last seen in the John Day area around 1915. The size of the reintroduced population throughout the Blue Mountains managed by ODFW is not known.

5-6.3.6.3.3 Blue Grouse

Grouse, which prefer large mistletoe-infected Douglas-fir trees for winter roosts currently have an abundance of available habitat. This mistletoe however is currently posing a fire danger due to the absence of the frequent fires that historically kept the infection present in the watershed but at lower level.

5-6.3.6.3.4 Pronghorn

As stated before, this species is associated with open grasslands, precludes it's presence in the analysis area.

5-6.3.6.3.5 Neotropical migratory land birds

As stated previously, neotropical migratory land birds, probably had access to a greater quantity available habitats than the current day situation. Studies have shown a slow but steady decline of habitats through the range of these species especially in riparian areas. The restoration of these habitats is an issue, not only in watershed or the Malheur National Forest, but range-wide throughout North and South America.

5-6.3.6.4 Recommendations for LRMP Featured Species

- For osprey, continue to retain large old growth along Canyon Creek for suitable nesting trees.
- For bighorn sheep, no recommendations for this particular watershed as ODFW continues to work with the re-introduced population.
- For blue grouse, the LRMP directs to maintain mistletoe infected trees however some of these trees will need to be thinned to reduce the fire danger in the WUI and elsewhere in the watershed.
- For pronghorns, no recommendations.
- For neotropical migratory land birds, the Partners in Flight, Northern Rocky Mountain Bird Conservation Plan calls for a number of restoration objectives to occur with species and their habitats over the next 25 years. *The Large Scale Conservation Assessment for Neotropical Migratory Birds in the Interior Columbia River Basin* (Saab and Rich 1997) conducted for ICBEMP also calls for basin –wide

coordination of inventory and monitoring results and site specific management plans. Implementation of such recommendations in the watershed may be of benefit to many of the neotroprical bird species that occur in the watershed. At a project design level within the watershed, opportunity should be taken improve riparian and grassland habitats and retain and improve hardwood habitats.

- For raptors, continue to protect known nest trees, monitor nesting success and avoid disturbance in the nesting season through seasonally restricting the implementation of projects until after the nesting season.

Plate 5-6.1. Vance Creek along 3920 road. Note dense riparian vegetation along creek to left of road; however, the road encroaches too closely to the stream (photo taken November 19, 2002).

Plate 5-6.2. Canyon Creek mainstem, upstream of the Middle Fork Canyon Creek confluence. Riparian area shows effects of cattle grazing. Note shallow stream, trampled banks, high width/depth ratio (photo taken November 19, 2002).

Plate 5-6.3. Beaver dam in mainstem Canyon Creek, immediately upstream of confluence with East Fork Canyon Creek (photograph taken November 19, 2002).

Plate 5-6.4. Head cut in small stream on private land. Photograph taken from 6510 road (photograph taken November 19, 2002).

Plate 5-6.5. Small stream along 1500651 road. Area may have been wet meadow with undefined channel prior to burn in contributing area (photograph taken November 19, 2002).

Plate 5-6.6. Canyon Meadows Reservoir, looking downstream at the dam (photograph taken November 19, 2002).

Plate 5-6.7. Canyon Meadows Reservoir, looking upstream from same location as Plate 5-6.6 (photograph taken November 19, 2002).