TUMALO CREEK WATERSHED ANALYSIS

Deschutes National Forest
Bend/Ft. Rock Ranger District
2008

Deschutes National Forest

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2008

An Update to the 1998 Bend Watershed Analysis

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INTRODUCTION

Watershed analysis is a planning process for understanding the ecosystem at a watershed scale. The context of a watershed is used because it is a defined land area with its own unique set of physical, biological, and social features, recurring ecological processes and historical land use patterns. While the focus is on issues causing greatest concern for the watershed as a whole, the purpose of the analysis is to determine when and where management activities such as restoration, fishery protection and enhancement efforts are essential and what conditions require such actions. Success in sustaining healthy ecological functions and the productivity of natural resources would be enhances by the understanding gained through watershed analysis.

The 2008 Tumalo Creek Watershed Assessment is an update to the original Bend Watershed Analysis, completed September 30, 1998. A brief update to the original watershed analysis was undertaken in 2007. This document completes the watershed analysis update. The biggest change in the watershed since 1998 is the change in drainage boundaries and associated names. The original analysis included the Bull 6th field subwatershed, which was outside of the 5th field watershed the rest of the analysis was based on. The 6th field Bull subwatershed was dropped in this updated document to confine the analysis area to just one 5th field subwatershed. In addition, in 2003 a region-wide effort was implemented to refine drainage boundaries, resulting in changes within the Tumalo Creek watershed. This resulted in slight changes in the physical boundaries within the 5th field watershed. See discussion below on watershed changes below under Characterization of the Watershed.

CHARACTERIZATION OF THE WATERSHED

The 5th field Tumalo Creek watershed is 37, 713 acres, of which 34,553 acres is within the Deschutes National Forest boundary, including 6748 acres of private land inholdings. The watershed is composed of (2) 6th field sub-watersheds, Upper Tumalo (20,745 acres) and Lower Tumalo (16,968 acres), the former a Tier 2 Key Watershed. Upper Tumalo closely resembles the former Forks and Bridge subwatersheds from the 1998 watershed analysis, and is a Tier 2 Key Watershed. Lower Tumalo Creek subwatershed closely resembles the former Tumalo Creek subwatershed. The geographic area occupied by the former Bull sub-watershed (26,219 acres) was essentially dropped with the change in boundaries from the 1998 effort (See exhibits 1, 5).

The Tumalo Creek watershed is mostly recognized as a source of high quality water originating in the cool clear springs in the Happy Valley Area and snowmelt of nearby Broken Top. The most visible water features are Tumalo Creek, Tumalo Falls, and Bridge Creek. Its most recognizable land features are Ball Butte, Tumalo Mountain,

Happy Valley, Shevlin Park, and the Bridge Creek Fire area. Historic Skyliner Lodge is a focal point for summer and winter recreation activities close to Bend and easily accessed by Road 4601.

Located west of Bend and northeast of Mt. Bachelor at the northern end of the Bend/Fort Rock Ranger District on the Deschutes National Forest, the highest elevations in the watershed are Ball Butte (8,901 ft.) in the northwest corner and Tumalo Mountain (7,775 ft.) in the southwest corner. Topography gradually slopes in an easterly direction towards Tumalo Creek (4,900 ft.). Known geologically as the broad High Lava Plains, the eruption of Mt. Mazama over 7,700 years ago deposited 2 feet of pumice and ash here.

Key Watersheds may not contain at-risk fish stocks but are important sources of high quality water, and are the highest priority for restoration. Directly adjacent to the north on the Sisters District are Whychus and Three Creek sub-watersheds, which are also Tier 2 Watersheds.

Nearly 60% of the Tumalo Creek Watershed is within the eastern extent of the range of the northern spotted owl. Wilderness and Roadless areas are designated in the Upper Tumalo Creek sub-watershed. The Northwest Forest Plan allocations are Congressional Withdrawal, Administrative Withdrawn, Matrix, and Riparian Reserve. The Deschutes National Forest Plan Management Areas are Wilderness, Dispersed Recreation, Front Country, Scenic View, Deer Winter Range, Winter Recreation, Intensive Recreation, Old Growth, Special Interest Area, and Bend Municipal Watershed. The City of Bend Municipal Watershed manages over 3,000 acres under agreement with the Forest Service.

Table 1. Deschutes National Forest Land Management Allocations

Deschutes NF Land Management Allocation	Acres
Bend Municipal Watershed	4104
Deer Habitat	2471
Dispersed Recreation	3660
Front Country Seen	2357
Front Country Unseen	2288
General Forest	1998
Intensive Recreation	364
Old Growth	448
Scenic View Retention Foreground	2118
Wilderness	4418
Winter Recreation	3579
Other Ownership	6748
Total	**34,553**

An Inventoried Roadless Area (IRA) totaling 10, 496 acres overlays much of the upper elevations within the Upper Tumalo sub-watershed, including the Bend Municipal Watershed.

Exhibit 1. Tumalo Creek Watershed

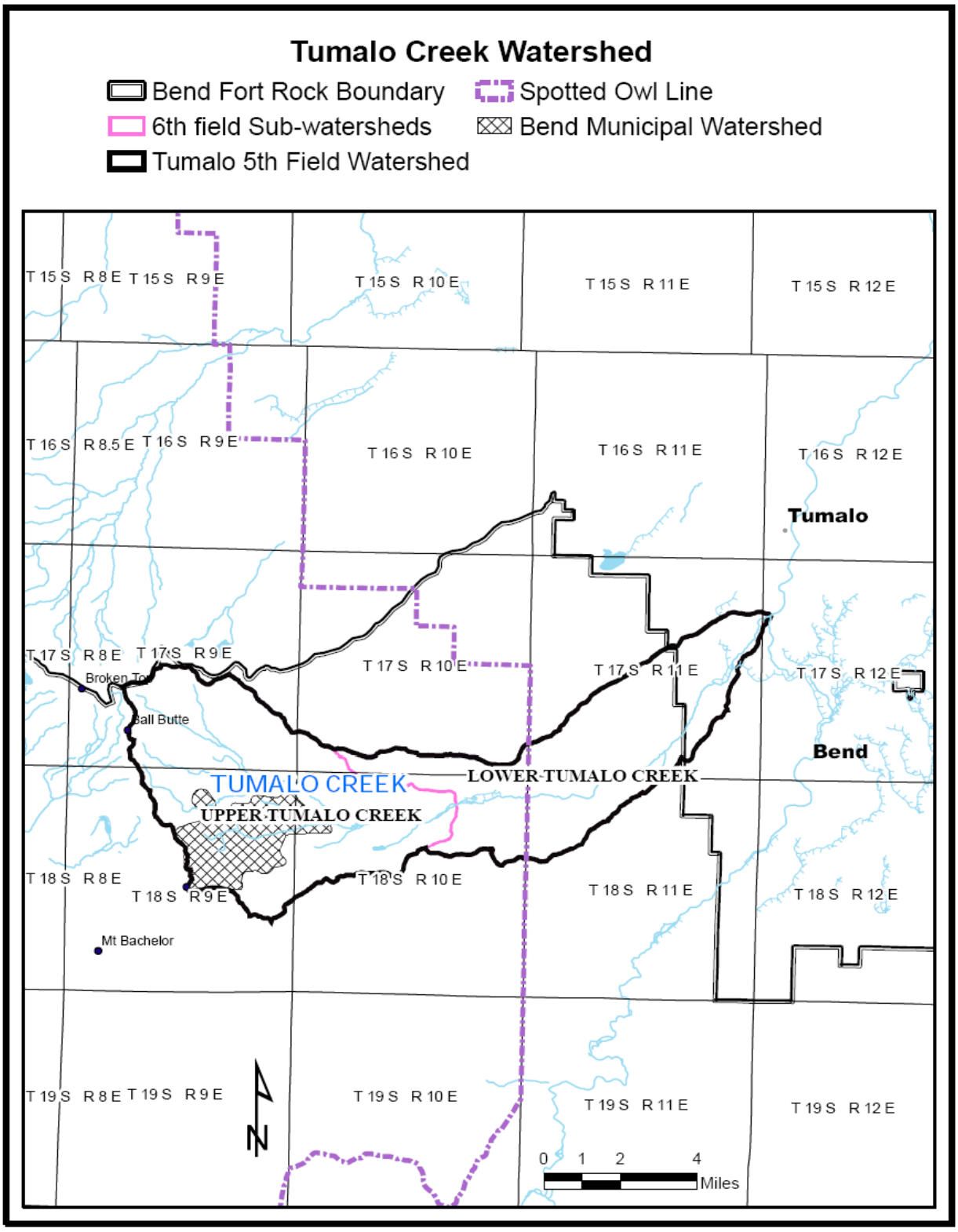


Exhibit 2. Tumalo Creek Watershed Ownership

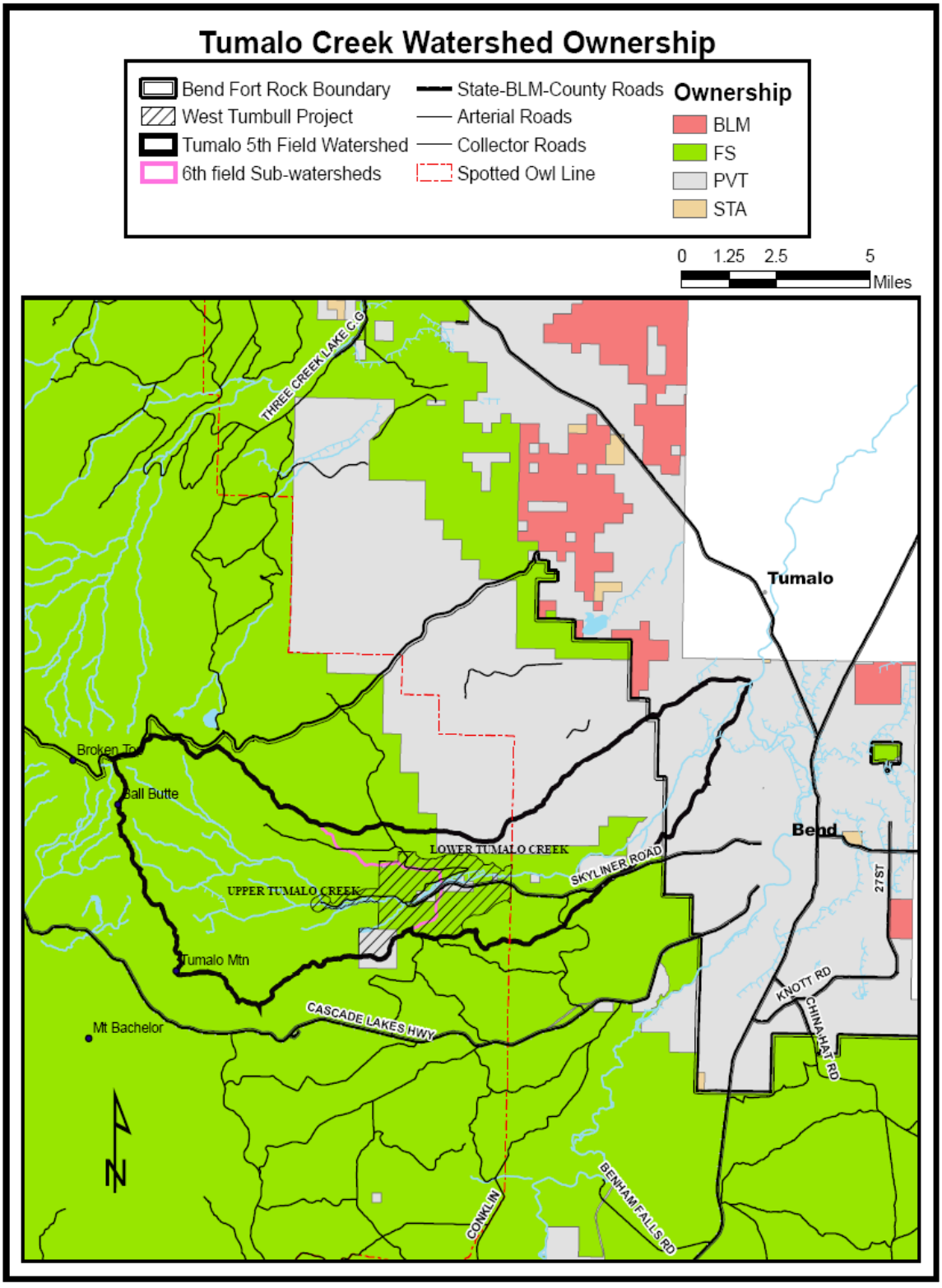


Exhibit 3. Tumalo Creek Watershed Forest Plan Land Management Allocations

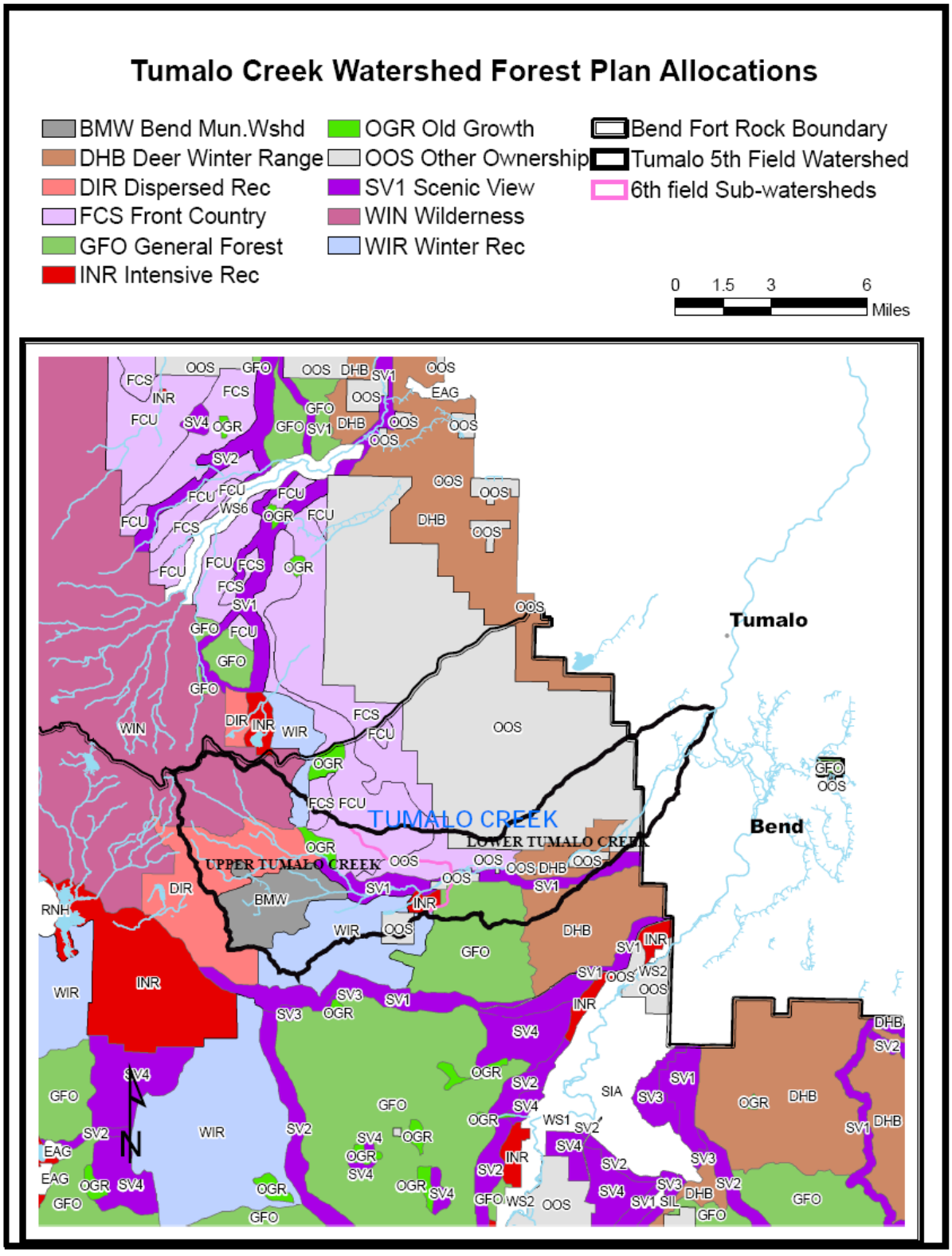


Exhibit 4. Tumalo Creek Watershed NWFP Land Management Allocations

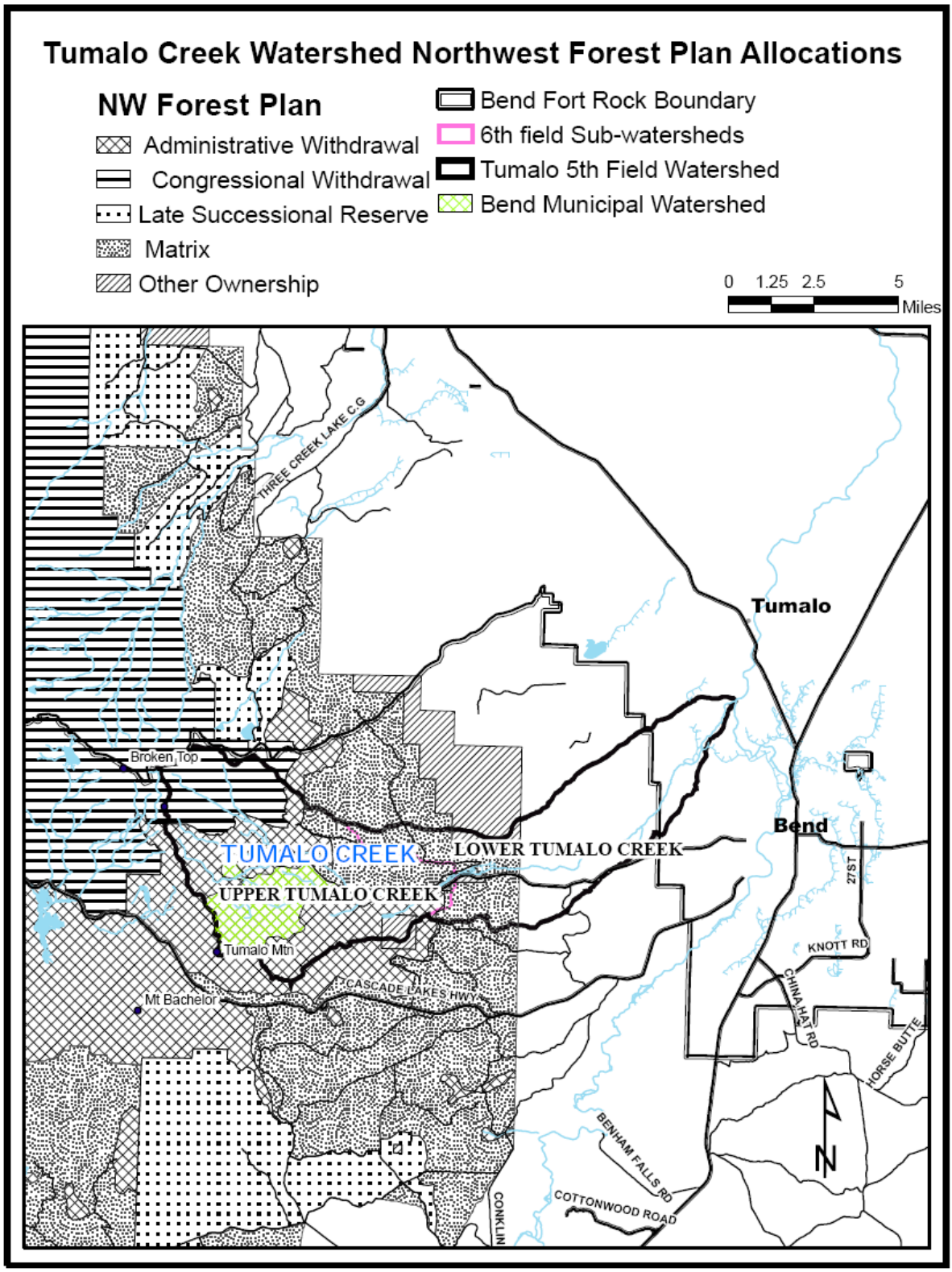


Table 2. Northwest Forest Plan Land Allocations (See Exhibit 4 above)

NWFP Management Allocations	Acres
Administratively Withdrawn	12,155
Congressionally Reserved	4,418
Matrix	7,853
Other Ownership	1,297
*Riparian Reserve	5415
Total	25,723

* Riparian Reserve overlays other land allocations.

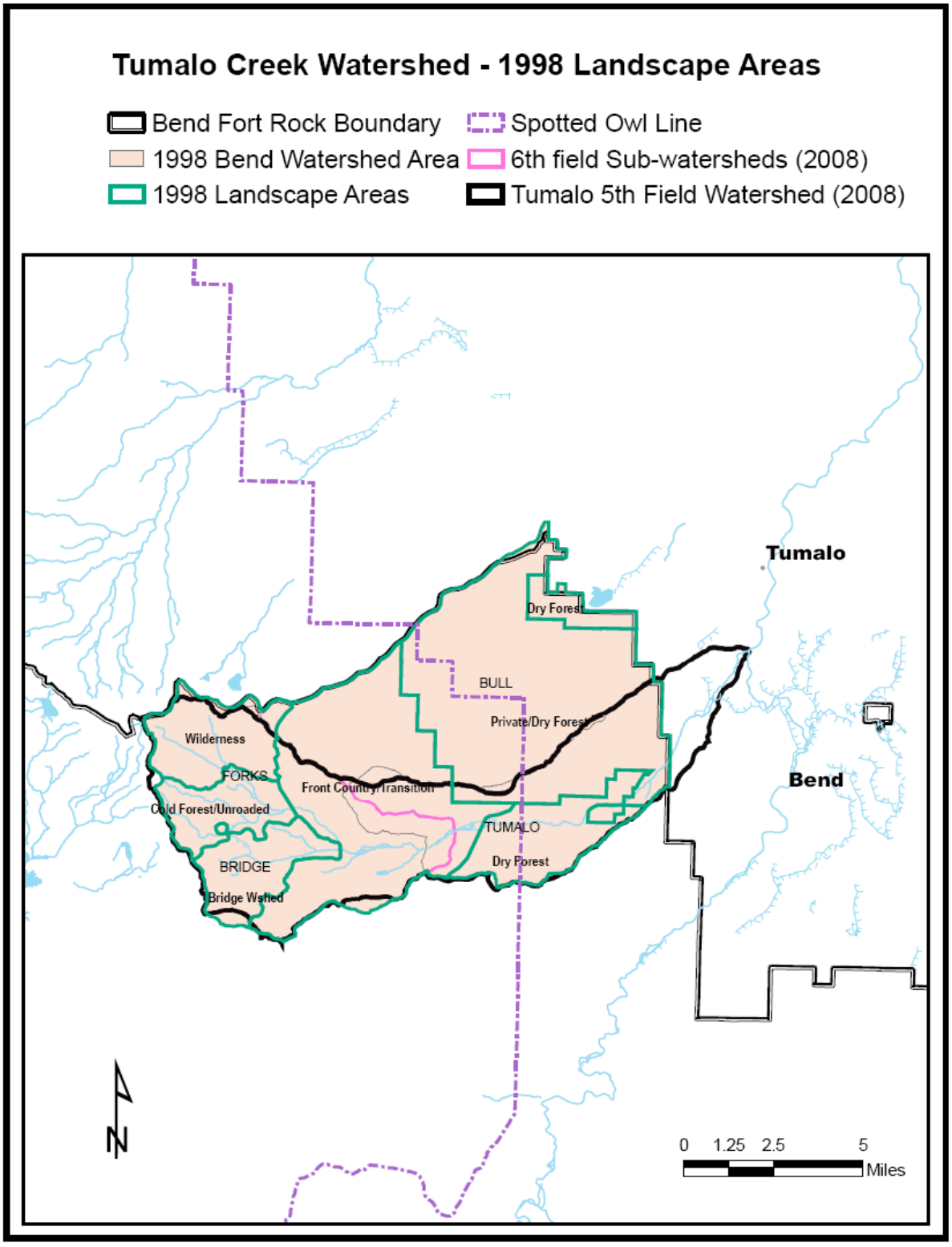
A land exchange within the watershed was finalized in August 1998 between the Deschutes National Forest and Crown Pacific. The purpose of the exchange was to achieve mutual long-term management of restoring and maintaining ecological function on more contiguous areas of federal land rather than on an intermingled pattern of existing ownership which often results in the disruption of ecological processes. Cascade Timberlands LLC was formed by creditors after Crown Pacific went bankrupt and obtained ownership of the former Crown Pacific Lands in 2002.

LANDSCAPE AREAS AND FLOWS

A comprehensive picture of the interactive processes of significant elements within the watershed was defined by the team as Landscape Flows. These elements are essentially the migration of wildlife and the movement of human activities, water flow and climate. Water from glacial snowmelt and spring-fed streams flows in a southwesterly direction from the Cascade Range to Tumalo Creek. Canals divert water to Bridge Creek and Tumalo Creek at different locations. People move through the watershed on the west side using Road 370 to travel to Todd Lake, the Broken Top Trailhead, and to Three Creeks Lake from Bend via the Cascade Lakes Scenic Byway. To the east, people use Road 4601 to visit Skyliner Lodge and the Tumalo Falls Overlook. Wildlife migrates along a west-east axis with some migratory routes between the Sisters Late-Successional Reserve to the north and the Cultus-Sheridan Late-Successional Reserve to the south. Major transportation corridors and access points for the recreation activities can often become a source of conflict with wildlife migratory movements, an increase in the risk of fire, and can also result in the fragmentation of wildlife habitat areas. Recognition of those patterns is one-way of seeing how the ecosystem works, what potential conflicts exists, and where current of future problem areas is location.

The team then divided the watershed into 6 Landscape Areas (carried over from 1998) based upon the following criteria: predominant physical, biological and social characteristics, resource conditions, road densities, primary issues, and associated key questions. Representing an integrated view of inherent ecological functions and capabilities of the land to support changes from historic and current conditions, the Landscape Areas are further described by resource in Chapters III and IV. The 6 Landscape Areas are: Wilderness (4,338 acres), Cold Forest/Un-roaded (3,630 acres), Bridge Watershed (3,987acres), Front Country/Transition (11,123 acres), Private/Dry Forest (6052 acres) and Dry Forest (5,082 acres). The acreages reflect what is within the Forest Service boundary (See Exhibit 5 below).

Exhibit 5. Tumalo Creek Revised Landscape Areas



WATER RESOURCE

Although snowmelt and precipitation are the major sources of stream discharge, springs are also a significant contributor. Tumalo Creek and its tributaries are unusual for Upper Deschutes River Basin streams in that they respond immediately to rain on snow events with large increases in flow. This may be partially due to the somewhat impermeable glaciated soils underlying a relatively thin layer of Mazama ash. Also contributing and of greater significance are the steep slopes, which exceed 60 degrees in some areas. Perennial, intermittent, and ephemeral streams drain snowfall accumulations from Broken Top to Tumalo Mountain and travel in easterly directions, collecting into Tumalo Creek which eventually flows into the Deschutes River approximately 8 miles north of Bend. There are few lakes in the watershed - the largest totaling 16 acres in size. The Bend Municipal Watershed is a significant feature within the Upper Tumalo sub-watershed. The City of Bend diverts water from Bridge Creek for a significant portion of its drinking water.

WATER QUANTITY

The drainage basin encompasses 59 square miles above the gaging station in Shevlin Park. Tumalo Creek fluctuates between about 50-75 cubic feet per seconds in the winter months to a normal run-off of 300 to 400 cfs in May and June with an average annual mean flow of around 100 cfs.

WATER QUALITY

The streams are cool and generally clear with maximum summer temperature in Tumalo Creek in the mid-50's (Fahrenheit). The tributary streams have similar temperatures or are cooler. Turbidity increases during periods of snowmelt and thunderstorm events. Sloping hillsides along Bridge Creek and Tumalo Creek within the Bridge Creek Fire area continue to become more vegetated with time, providing more ground cover to trap sediments and reduce overland flow of sediments that would lead to turbidity increases. Stream restoration work on Tumalo Creek within the bridge Creek Fire area reduced streambank erosion and associated sedimentation and turbidity. The water quality of Bridge Creek is among the best in the Unites States for a surface water system (Prowell, 1997). Water extracted from Bridge Creek for municipal use is filtered only via gravitational methods and chlorinated before delivery. Despite the cold water temperatures driven by springs and snowmelt, Tumalo Creek from river mile 0 to 12.5 (near Skyliner Bridge) was listed on the 2004-2006 Oregon Department of Environmental Quality (ODEQ) list of water quality impaired water bodies (303)(d) list) because of elevated water temperatures. The criteria are salmonid rearing and migration.

DIVERSIONS

During the past 100 years, the natural hydrology with in the watershed has been greatly altered. Water from Crate Creek, a tributary to Soda Creek, which is within an adjoining watershed, is diverted through a small canal to the Middle Fork of Tumalo Creek.

Tumalo Irrigation District owns the water rights. Flows from springs destined for the Middle Fork of Tumalo Creek are diverted into Bridge Creek. This is the source of a large portion of the drinking water for the City of Bend, approximately 50%. The Columbia Southern Canal had historically withdrawn irrigation water during the summer months from Tumalo Creek downstream of Skyliner Bridge, often reducing in stream flows to less than 5 cfs. This canal has not been used since 1998, as water is withdrawn downstream off-forest at river mile 2.4, allowing the water to remain in stream an additional 8.5 miles during the irrigation season. Tumalo Creek is no longer on the 303(d) list for flow modification and habitat modification. These were de-listed in 2002, and not considered a pollutant.

SOIL RESOURCE

The soil resource is dominated by ash and pumice from Mt. Mazama on the surface and glacial till or other localized volcanics in the sub-surface. Sub-surface material is generally course textured and has very low cohesion properties. Sub-surface materials on the eastern edge of the watershed include basaltic lavas and glacial outwash. Greater amounts of cinder, colluvium, and residual buried soils are present in the sub-surface of the western half of the watershed, as the lands are barren of soil materials. The inherent productivity of the soils is moderate 50% (18,942 acres), low 27% (10,225 acres), high 22% (8209 acres), and barren 1% (353 acres). Lands classified as unsuited for timber management, both for social as well as physical site capability reasons are located at higher elevations (generally within Wilderness) and on the eastern fringe (Soil Resource Inventory Map #36).

Soil productivity is directly influenced by annual precipitation, elevation, aspect and soil profile depths, each of which can be limiting with in the watershed. Annual precipitation ranges from 15 to 40 or more inches on an east to west trending scale, elevations range from approximately 3,500 to 8,000 feet, aspects are predominately easterly in nature, and soil profile depths to bedrock range from moderately deep (greater than 60 inches) to shallow, (less than 24 inches). Erosion processes are steep enough to exhibit mass wasting. Summer thunderstorm events are most likely to influence surface erosion of the low cohesion soils present.

AQUATIC SPECIES

The Region 6 Sensitive Species Redband trout and non-native eastern brook trout can be found in many of the streams. Bull trout could have been present in Tumalo Creek at one time. Tumalo Lake contains eastern brook trout and there are no fish in the other lakes. Redband trout are native to the watershed but rainbow trout were stocked for several years, ending in the 1970's. Tissue samples of redband trout were collected from Tumalo Creek in 2006/2007. The U.S. Fish and Wildlife Service determined that there was only minimal genetic introgression from hatchery stocks in the redband population (Matala, et al, 2007). Additional analysis of redband genetics above Tumalo Fall and other upstream falls is in progress, with results expected in 2009. Eastern brook trout, native to the east coast of North America were introduced over 50 years ago and have established a self-

sustaining population. Fish sampling is limited within the watershed, but in Tumalo Creek within the Bridge Creek Fire area, approximately 75 percent of the fish populations are eastern brook trout. The flow regime appears to favor the fall spawning eastern brooks over the spring-spawning rainbows, as high flows that can dislodge freshly laid eggs in the gravel are more frequent in the spring during the snowmelt period. Additional fish distribution sampling has occurred in recent years and is planned for the next several years. Aquatic invertebrate communities are moderately diverse and abundant (Wissmann, 1991, 1993, 1996, 1998).

HABITAT CONDITIONS

Diversion of water for irrigation purposes and municipal use has altered flow regimes in Bridge Creek and Tumalo Creek. The Bridge Creek Fire of 1979 burned through and caused heavy impacts to the riparian zones of Tumalo Creek (3 miles), South Fork (0.5 miles), and Bridge Creek (1 mile). Salvage operations removed wood from the streams and along stream banks. Along with recruitment of gravel to the streams, elevated quantities of fine sediment were added from stream bank and adjacent hillside erosion. In contrast the riparian zones outside of the fire damage area remained in good condition with stands of large spruce, fir, and mountain hemlock.

Restoration of Tumalo Creek began in the early 1990's. Whole trees were placed and anchored into the channels within the Bridge Creek Fire Area. Willow, cottonwood, and Engelmann spruce were planted along the banks. The wood structures shifted during high flows in the 1995 and 1996 from rain on snow events. This caused stream bank erosion and created a few very large logjams. Loss of canopy along the stream after the fire likely resulted in slightly increased although still relatively cool water temperatures. The stream has likely become more biologically productive due to additional exposure to sunlight with the loss of the streamside canopy. Eventually, as the canopy becomes re-established, biological productivity will return to pre-fire levels.

The Bridge to Bridge Restoration Project was implemented during 2004-2007 on 2.8 miles of Tumalo Creek within the Bridge Creek Fire area, restoring channel stability, riparian vegetation, pool habitat, and large woody debris instream and on the floodplain. Over 2100 whole trees were used to create numerous log jams and pools, several hundred boulders were used for structures and grade control, side channels were created, and over 71,000 trees and shrubs were planted

The streams are bountiful in gravels, cobbles, and boulders for spawning, rearing, and aquatic macro invertebrate habitat. Cool water temperatures and shade have limited the food supply and fish growth. Historically, the streams were heavily shaded, cool and clear with good gravels and abundant large wood. Habitat above the numerous falls was likely not utilized by fish.

FISH COMPOSITION AND DISTRIBUTION

Fish introductions by man have allowed distribution of brook trout and likely rainbow trout to occur above Tumalo Falls, which would have ordinarily acted as a natural fish barrier. Rainbow trout have also been documented in Tumalo Creek up to the third set of falls above Tumalo Falls, near the headwaters of Bridge Creek, and in the South Fork of Tumalo Creek. Brook trout have been documented in Tumalo Creek, the Middle Fork past the confluence with Bridge Creek Canal, the North Fork up to Happy Valley, Tumalo Lake, and the creek that drains it, the South Fork up to the junction of the two channels, and in Bridge Creek up to the diversion dam. They are also found in many of the small springs and beaver's ponds in the floodplain of Tumalo Creek. Fish are unable to migrate further upstream on Bridge Creek because of the dam.

Surveys for bull trout conducted in August 1998 within the Bridge Creek Fire area of Tumalo Creek did not locate any individuals. Historically, redband trout and possibly sculpin and bull trout were distributed up to migrational barriers or large gradient increases. The majority of occupied habitat was Tumalo Creek up to Tumalo Falls, Bridge Creek up to the first falls, and the South Fork of Tumalo Creek. Redband trout are currently on the Regional Forester's Sensitive Species List. As of June 13, 1998, bull trout of the Columbia Basin were listed as threatened by the U.S. Fish and Wildlife Service.

VEGETATION

In the Tumalo Creek Watershed, there exists a great variety in forest types. Variations in climate, soils, elevation, and topography have combined to provide diverse forest assemblages that differ in species composition, structure and density.

Existing vegetation within the watershed follows an elevational and associated moisture gradient that ranges from high elevation, sparsely vegetated, "krummholtz" forest types on rocky zones; down through moist forests composed of dense mountain hemlock stands into mid-elevational zones of mesic lodge pole pine and mixed conifer landscapes, and finally to xeric forested stands of ponderosa pine. Disturbance processes also follow this elevational transect with the greatest change from the native ecological regimes increasing in the descent through the elevational zones. Riparian communities pass through the elevation gradient and provide connection to these different landscape features.

Additionally, the degree of change from the native or natural forest setting generally follows this elevational gradient with the most pristine composition high in the watershed, and the highest degree of departure from the pristine, becoming apparent in the approach to high-density population centers such as the nearby city of Bend. Alterations in the native forest, both in terms of the forest architecture and ecological function, are the result of human intervention within the past century, most fire suppression, timber harvest, road building, and general human access. Fire suppression has created more potential for larger and more intense fires.

PLANT ASSOCIATION GROUP (PAG)

The major forest communities and the typical species found within them are listed from dry to moist to cold environments. Note that nearly 95 percent of the total watershed acreage can be grouped into 5 major forest vegetation types (Source: Forest-wide PAG layer).

FOREST VEGETATION STRUCTURE

At a very general description, forest structure at the landscape level is dominated by the following: early conditions within the Bridge Creek Fire area on approximately 3,400 acres, mid-structure stands within the previously manipulated ponderosa pine and mixed conifer zones outside the Bridge Creek Fire area, and late structure in the passively managed lodge pole pine and mountain hemlock zones (Source: Photo Interpretation/Most Similar Neighbor (MSN) Database Analysis, 1998).

FOREST VEGETATION DENSITY

The existing stand densities that occur across the entire watershed ranges from low to high density with each of the 3 density classes nearly evenly split. However, densities tend to be less variable and tied to Landscape Zones found in the watershed (See Chapter III and IV for more information).

INSECTS AND PATHOGENS

Insect activities have been recorded from aerial reconnaissance annually for the past three decades. Maps of current insect agents at work within the watershed indicate the most apparent insect agents are barks beetles and defoliators (source: 1997 Aerial Survey). Forest pathogens are well represented throughout the watershed also and include but are not limited to root rot, stem decay, and dwarf mistletoe.

TERRESTRIAL WILDLIFE SPECIES

HABITAT

Types of wildlife species present in any given area are determined by characteristics of the environment. For example, variations in elevation, topography, fire, vegetation structure and type, latitude, climate, and precipitation are all factors which in combination with countless other variables, form the assemblage known as habitat. In addition to the physical environment, nearly all species on the planet are subject to some level, whether direct or indirect of human interaction.

Habitats and human interactions within the Tumalo Creek Watershed vary widely. Portions of the watershed have changed only slightly in comparison to historic conditions. Other areas within the watershed have been altered dramatically by wildfire, fire suppression, timber harvest, road construction, and general human access. The scope of changes in habitat structure has been significant enough to create unsuitable conditions for species historically found in the same area.

Both scope and intensity of altered environmental conditions as well as basic habitat types within the watershed generally follow the elevation gradient. At lower elevations, areas once dominated by large stands of mature ponderosa pines now consist primarily of small and medium diameter cultivated stands of the same species.

Mixed conifer and lodge pole pine stands in the middle elevations of the watershed area have experienced varying levels on insect outbreak, timber harvest, and stand replacement fire that reduced late and old structure. However, some stands are largely intact and fragmentation across the watershed is low to moderate. Fire suppression has led to unnaturally dense stands subject to a higher level of instability. Road densities range from low to high and recreation activity is heavy in some areas, and continues to grow throughout the watershed.

The upper elevations have undergone relatively little change in comparison to historic conditions. These acres are dominated by late structure mountain hemlock forests as well as alpine meadow and rock. Roads are minimal or nonexistent and recreation access and activity is considered light to moderate and continues to grow as the population of Bend continues to grow. A lack of timber harvest and significant natural stand altering events has minimized the effects of fragmentation.

SPECIES DIVERSITY

Wildlife species composition varies widely throughout the watershed both seasonally and spatially. Significant changes in elevation allow a wide representation of habitat types including high desert shrub, upland wet and dry forest, riparian, and alpine communities. In excess of 200 wildlife species are estimated to inhabitant the watershed. Since fragmentation and disturbances are moderate to low at the middle and upper elevations respectively, immigration, emigration, and exchange of genetic information are relatively unobstructed. High road densities and intensive timber harvest in the lower levels of the watershed have created movement barriers for many species.

The following threatened, endangered, candidate, proposed, and sensitive species have suitable or potentially suitable habitat within the watershed: northern spotted owl, Oregon spotted frog, northern bald eagle, American peregrine falcon, Lewis' woodpecker, white-headed woodpecker, harlequin duck, California wolverine, Pacific fisher, Crater Lake tightcoil, silver-bordered fritillary, and Johnson's hairstreak. Other selected wildlife species that could occur within the watershed are: raptor species including the northern goshawk, red-tailed hawk, and flammulated owl, woodpecker species including the pileated and black-backed woodpeckers, songbird species including the brown creeper, hermit thrush, and olive-sided flycatcher, and mammal species that include deer, elk, and the American marten.

Portions of the watershed were surveyed for the threatened northern spotted owl in 2007 and 2008. There was a response from a pair during the 2008 survey season, but no nest was found. Other species such as the Pacific fisher (proposed), and the Crater Lake tightcoil (sensitive), are known to occur in the watershed.

The watershed functions as summer, transition, and winter range for both deer and elk. Areas near water also serve as suitable fawning and calving habitat. Both deer and elk migrate between summer and winter ranges in a west-east direction.

FIRE/FUELS

There are currently a variety of vegetation types and fire regimes within the Tumalo Creek Watershed that represent the effects of historically repetitious fire with variable spread rates and intensities. A modern day sampling of fire occurrence data from1980 to 2007 revealed 68 fire starts, roughly equivalent to 3 fires starts annually. Most of these fires were ignited by natural causes. The area could still be accurately described as "fire environment" with a human component that is increasing the likelihood of fire starts in the area.

The 1979 Bridge Creek Fire was a human caused event, which burned most of the vegetation within its boundaries over a total of 3,364 acres. This fire has minimal mosaic patches, which are scattered only along a small portion of the fire boundaries. The intensity of fire may have contributed to the short-term hydrophobic character of the pumice soils in some areas. Structures were placed on slopes following the fire to reduce downhill flow velocities and sedimentation rates into Tumalo and Bridge Creeks. The slopes have generally become re-vegetated and become more stable.

In recent history this is the only large-scale fire event to occur within the Tumalo Creek Watershed. A potential risk exists for a similar event given the right combination of weather patterns and fuel conditions. Although the probability is low due to the right conditions occurring only on about 6 days throughout the entire year, these identified conditions would still require monitoring during the summer months.

RECREATION

Primary access routes are Road 370 to Todd Lake and to the Broken Top Trailhead from the Cascades Lakes Scenic Byway, Road 4601 to Skyliner Lodge and Tumalo Falls Overlook, and the northern portion of Road 370 which joins the Three Creeks Road (Road #16) from Sisters. The Tumalo/Skyliner recreation area is only 10 miles from Bend and apart from paved roads, routes accessing recreation facilities varying in standards and maintenance levels with some roads minimally maintained for high clearance vehicles at moderate to low levels. Other access routes along the Cascade Lake Scenic Byway are Road 4615, Road 4612, and several other minor roads, which include access from private lands.

The developed recreation facilities providing access to the watershed are trailheads, snow parks, and Skyliner Lodge which operates through a special use permit to the Oregon Museum and Science Industry for environmental education. Primary trailheads that access the area are Farewell Trail, Tumalo Falls, Skyliner Lodge, Shevlin Park (Bend Metro Parks and Recreation), Todd Horse Camp, Broken Top Trailhead, and Phil's Trail, a popular mountain biking trail. Primary snow parks are Meissner, Wanoga, Swampy and

Dutchman. The Recreation Opportunity Spectrum classifies the watershed as mostly Semi-Primitive (non-motorized in the summer and motorized in the winter) and Roaded Natural.

An extensive network of summer and winter trails provide opportunities for hiking mountain biking, equestrian riding, Nordic skiing, snowshoeing, dog sledding, and snowmobiling. Areas closed to motorized use in the summer. Dispersed camping is mostly hunting related and is popular along Road 370 and Road 4601. Big game hunting season begins with archery season in August and goes through November when snowfall usually becomes substantial.

CHAPTER II
ISSUES AND KEY QUESTIONS

Issues were identified by the team as a way to focus on the primary elements of the ecosystem that are most relevant to the watershed in terms of management objectives, human values, and resource conditions. Also formulated were key questions from indicators commonly used to measure or interpret critical ecosystem elements. The issues and key questions were then used by the team to identify resource management concerns and trends as a way to provide a basis for the management recommendations in Chapter VI.

ISSUE 1. SUSTAINING WATER QUALITY AND RIPARIAN HEALTH

Background:

The water quality of the Bend Municipal Watershed is among the best in the United States for surface water system that is generated primarily by a constant flow of cool, clear spring water. Increased recreational use and the greater risk of ire potential as fuels accumulate may affect the future ability of the Bend Municipal Watershed to provide water quality that complies with the standards of the Safe Drinking Water Act of 1986. The desired condition for water quality, riparian health, fish habitat, and stream function in Tumalo Creek is not currently being met within the Bridge Creek fire area. Even after 20 years following the fire event, recovery is still slow and occurring at a rate that may be improved through selective restoration activities.

A large-scale stream and riparian restoration project was completed during the years of 2004-2007 on Tumalo Creek within the Bridge Creek Fire area, a reach of 2.8 miles (approximately river mile 12.7 to 15.5). Channel stability, stream bank stability, fish and wildlife habitat, and riparian vegetation were restored. With reduced stream bank and channel erosion, turbidity and sedimentation will be reduced, improving water quality.

Tumalo Creek is no longer included on the Oregon Department of Environmental Quality (ODEQ) 303-(d) list of water quality limited water bodies for flow modification and habitat modification, being de-listed in 2002. These parameters are not considered to be pollutants. However, Tumalo Creek from the mouth to river mile 12.5 is now on the 2004-2006 303(d) list for water temperature. Irrigation water has not been diverted into the Columbia Southern Canal since 1998. The new diversion supplying Tumalo Feed Canal, located at river mile 2.4 and nearly 8.5 miles downstream of the old diversion, has been used since that time.

Key Questions

1. **What is the status of water quality within the Bend Municipal Watershed and what level of use in current activities is appropriate in order to maintain high water quality in the long term?**

The status of water quality is excellent, although the turbidity limits imposed by the City of Bend are exceeded on approximately 20 days annually, primarily during snowmelt season, thunderstorms, or rain on snow events. Restricting recreational activities within the watershed since 1991 has been an effective means of maintaining water quality, although no significant improvement is shown in the turbidity data. The majority of trail areas do not contribute sediment directly to perennial streams. Stream crossings typically have boardwalks or bridge crossings. Water bar installation and maintenance has occurred on the Bridge Creek Trail since mountain bike use was eliminated to prevent sedimentation. If future monitoring shows degradation of water quality, limits would need to be imposed upon the numbers of uses and types of activities.

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2. What fire risks exist due to present fuel loadings?

Fire risk is moderate to high for this area although the potential for large fires is mitigated to some degree by the close proximity of the Tumalo Creek Watershed to the Redmond Air Center. The risk of fire continues to increase over time as the upper extent of natural fire return intervals in these forest types are approached or exceeded and fuels continue to build. Fires that do occur are likely to be stand replacement events capable of exposing extensive areas of bare mineral soil susceptible to erosion from rainfall and snowmelt accumulations.

ISSUE 2. PROTECTING RESOURCE VALUES WHILE MAINTAINING A QUALITY RECREATION EXPERIENCE WITH APPROPRIATE USE LEVELS AND ACCESSS.

Background:

Soil quality within the watershed has been affected in some areas by accelerated erosion from recreational uses, primarily foot traffic off of designated trail routes to overlooks or down to the stream course. A few isolated trail locations are susceptible to contributing sediment into stream habitats. The South Fork of Tumalo Creek has had portions rerouted to address sediment delivery. Road 4601 has some soil erosion problems on steep grades that need to be stabilized or restored. Roadwork in the past decade has addressed drainage problems on Road 370. Wildlife populations and habitat may also be adversely impacted from increased recreation use and development within the watershed.

Key Questions:

1. How do we maintain water quality as upland recreation activities increase the chance of water quality degradation via sedimentation?

Water quality can be maintained through seasonal closures to motorized use, restricted access to detrimental uses, development and implementation of an educational program through the City of Bend, State DEQ, Oregon Health Division, and the Forest Service, relocation or rehabilitation of problem trail and road sections, and maintenance of roads and trails at the prescribed minimum level. Additional and improved stream crossing

structures and specific measures such as uphill use only for mountain bikes are recent activities that have been implemented to reduce potential sedimentation.

2. What management actions are necessary to minimize the risk for detrimental impacts from Road 4601, and continued recreation use and development of trail systems?

Risks for detrimental road-related impacts can be minimized through surface treatment and spot hardening, enforced road closures with seasonal closures to allow dry season use only, selective water bar locations, and relocation or rehabilitation or problem grades. Future development of trails needs to involve resource specialists in the site analysis and design phases of the planning process phases of the planning process in order to be more effective in recommending ways to protect the site from detrimental impacts. The continued monitoring of recreation uses and associated impact levels are critical and necessary in order to repair and restore damaged areas quickly.

3. What kinds of recreation use conflicts between users or with resources need to be prevented or resolved?

Current recreation users are primarily mountain bikers, hikers, and horseback riders. Recreation experiences can be improved and conflicts prevented between mountain bikers and horseback riders by providing separate user trails. Providing access to information would increase user awareness and promote trail etiquette. Conflicts between mountain bikers and hikers usually occur in downhill and straightway situations. Designing trails with lower grades, multiple curves, or trail turnouts can be used to control the high speeds of mountain bikers. Downhill mountain biking has been restricted on the North Fork Trail - the Farewell Trail has been constructed to allow downhill mountain biking access as a replacement. Resource impacts from recreation use are primarily associated with deterioration of drainage structures, soil erosion, and the loss of vegetation leading to an increase of fine sediment to streams.

4. What limits to recreation use would protect wildlife habitat?

Wildlife habitat protection would occur by limiting motorized use through seasonal closures. Restricting inappropriate uses from certain areas needs to be enforced by trail signing and rerouting.

ISSUE 3. SUSTAINABILITY OF FOREST CONDITIONS WHERE RESILIENCY IS BEING LOST

Background:
Forest resilience to insects and disease agents has diminished outside the Bridge Creek Fire area as stand densities have increased and shade tolerant species populate warmer and drier sites, a result of practices such as fire exclusion and selective harvesting. The mountain pine beetle infestation has reduced the health of many stands within the watershed, increasing mortality and fuel loading. Insect and disease has affected nearly

40% of the watershed. Vegetative conditions include an extensive area of un-fragmented forest at mid and upper elevations, a loss of large tree structure at lower elevations, and forest encroachment in meadow areas. Mid-elevation, dry mixed conifer stands are the most significantly affected by an increase in density, including a potential loss of large trees from increases competition, and a greater risk of stand replacement fire. The Bridge Creek Fire of 1979 has created the only significant break in connectivity within these mid-elevation stands.

Outside of firewood harvests, pest management activities within the mid-elevation lodge pole pine stands have been relatively minimal and with a skeleton road access system in place, few stand management treatments have been implemented in the past 30 years. Lower elevation ponderosa pine stands (mostly private lands) have been heavily harvested in the past, with railroad era clear cuts creating large clocks of middle-aged forests that are found today. Most treatments have occurred within the stands located on lands owned and managed currently by Cascade Timberlands. Currently, most of these stands are more at risk to fire disturbance due to their uniform crown cover and shrub component. Increased access provided by a much greater road network on private lands can lead to faster fire suppression response times on the ground.

Key Questions

1. How do we maintain an existing un-fragmented landscape in the mid-elevation stands while reducing the risk of insect epidemics and stand replacement fire events such as the Bridge Creek Fire of 1979?

Difficulties exist in maintaining an un-fragmented landscape that was naturally disturbed through fire cycles and insect and disease agents. Realistically, most proposed situations would actually end up trading one kind of fragmentation for another. Active management would create smaller, patch size openings and passive management would result in larger areas of disturbance from insects and disease or from stand replacement fires such as the Bridge Creek Fire. The fragmentation causes by a fire at that scale and level of disturbance opens up the potential for another fire to occur there in the future.

In some cases, the desire for passive management of these stands to maintain important values such as wildlife habitat and positive recreation experiences. Currently, the stands are relatively healthy although the risk of loss due to stand replacement fire vents would continue to increase over time.

2. Where can conifer encroachment in wetlands be reduced while still maintaining healthy watershed function?

Reduction can occur in aspen pocket areas and wetlands, especially adjacent to Tumalo Creek within the Bridge Creek fire, and isolated wet meadows in upland areas.

3. What stands would benefit from stocking level (density) reduction to promote stand resilience?

Drier forest types such as dry mixed conifer and ponderosa pine stands would reap the greatest benefits from stocking level reduction, expressed primarily in activated vigor of residual trees. Moist or upper elevation cold forest types would receive the least benefits. Lodge pole pine may actually benefit from increased density, especially in more mesic zones although these types are considered to have fewer economical benefits. Stands within the mid-elevation zone appear to have the least amount of changes from natural disturbance regimes although the risk of larger scale fire disturbances is increasing. Current trends in land management with continued fire suppression would create greater numbers of older forests with fewer openings than may have existed historically.

ISSUE 4. PROTECTION OF WILDLAND URBAN INTERFACE WITH INCREASING FUEL LOADS AND FIRE RISK.

Key Questions

1. How do we implement Hazardous Fuel Reductions (HFR) within the Community Wildfire Protection Plan (CWPP) boundaries along Skyliner Road and Road 4603 to protect private land in holdings and provide ingress/egress while maintaining other forest resources including wildlife habitat, water quality, soil resources, and recreational activities?

Two CWPP's are relevant to the watershed; the Greater Bend (2006) and the East and West Deschutes County (2007).

Both CWPPs included the following in the purpose:

- Protect lives and property from wild land fires;
- Instill a sense of personal responsibility for taking preventive actions regarding wild land fire;
- Increase public understanding of living in a fire-adapted ecosystem;
- Increase the community's ability to prepare for, respond to and recover from Wild land fires;
- Restore fire-adapted ecosystems; and
- Improve the fire resilience of the landscape while protecting other social, economic and ecological values.

In addition, the East and West Deschutes County CWPP included the following in the purpose:

- Provide guidance to federal agencies for implementing fuels reduction treatments;
- Prioritize the use of limited funds for the treatment of hazardous fuels;
- Promote biomass utilization.

Greater Bend CWPP

Skyliners, with a size of 257 acres, 46 structures, and a population of 39, was identified in the plan as a Community at Risk and an Area of Special Concern (See Exhibit 6 below).

To rank the 10 Communities at Risk in the Greater Bend Community Wildfire Protection Plan, two risk assessment methodologies were utilized: the Oregon Department of Forestry Assessment of Risk Factors and a combined risk assessment that considers Fire Regime - Condition Class, Fire Starts & Large Fire History. A composite rating using the two methodologies ranked Skyliners as number six, placing it in the second of three priority categories.

As an Area of Special Concern, the CWPP described the need for Skyliners to develop an additional safe ingress/egress route and a "shelter in place" area should emergency egress be cut off.

The CWPP also included the Bend Municipal Watershed within the WUI boundary, and as an Area of Special Concern, because approximately half of Bend's water comes from this area. A wild land fire occurring in or near this watershed could severely affect water quality in the Bridge Creek watershed. The CWPP encouraged treatment for hazardous fuels as identified in this plan to prevent damage from catastrophic wild land fires to the watershed.

East and West Deschutes County CWPP

This CWPP is the final one for Deschutes County and encompasses the remaining unincorporated and/or unprotected wildland urban interface areas in Deschutes County not included in the six existing CWPPs, including the Greater Bend CWPP.

Hazardous Fuels Reduction

The ability to conduct hazardous fuel reduction in the Tumalo Creek watershed is challenging because of the proximity to Skyliners, the Cascade Science School at Skyliners Lodge, the Skyliners Sno-park, the Bend Municipal Watershed, Spotted Owl habitat, heavy, dense fuels, steep topography, and the Tumalo Creek riparian area.

Strategic Placement of Treatments (SPOT)

The SPOT process allows resource managers, the public, and partners to participate and collaborate in NEPA planning. Key components of the process include: 1) definition of the analysis area, 2) identification of assets and protection targets, 3) definition of the "Problem Fire", 4) design of treatment patterns to mitigate a problem fire and meet a range of objectives, 5) test treatment patterns with FlamMap, then adjust and re-test, 6) display the trade-offs, and 7) follow-up with monitoring/adaptive management.

FlamMap is a fire behavior mapping and analysis program that computes potential fire behavior characteristics (spread rate, flame length, fireline intensity, etc.) over a landscape for constant weather and fuel moisture conditions.

It is recommended that the SPOT process and FlamMap be utilized to evaluate potential treatment locations once the Preferred Alternative is determined.

2. What kinds of treatments can be implemented in the CWPP boundary and how do we evaluate their potential effectiveness?

Treatment Options

Opportunities for treatment are limited to thinning, mowing, and underburning. Steep topography and the proximity to private land and Tumalo Creek limit treatment options. Project planning will use authorities from the Healthy Forests Restoration Act.

Evaluation of Effectiveness

Treatment units within the watershed will be monitored as part of the Central Oregon Fire Management Service monitoring program, using the FireMon protocol, which meets national standards.

The CWPPs also identified a process for monitoring and evaluation:

- Identify and assess new or treated risks.
- Evaluate and track progress toward goals, and update maps.
- Adopt new and/or revised priorities, with specific projects.
- Identify specific fuels treatment projects.
- Discuss grant opportunities and determine which communities at risk will seek funding for identified projects.
- Review grant opportunities, write grants.
- Identify appropriate projects to decrease structural vulnerability, address issues with evacuation routes, condition of roads and water supply.
- Identify appropriate projects to address educational needs.
- Review grant opportunities, write grants.

Exhibit 6. Greater Bend Community Wildfire Protection Plan Boundary.

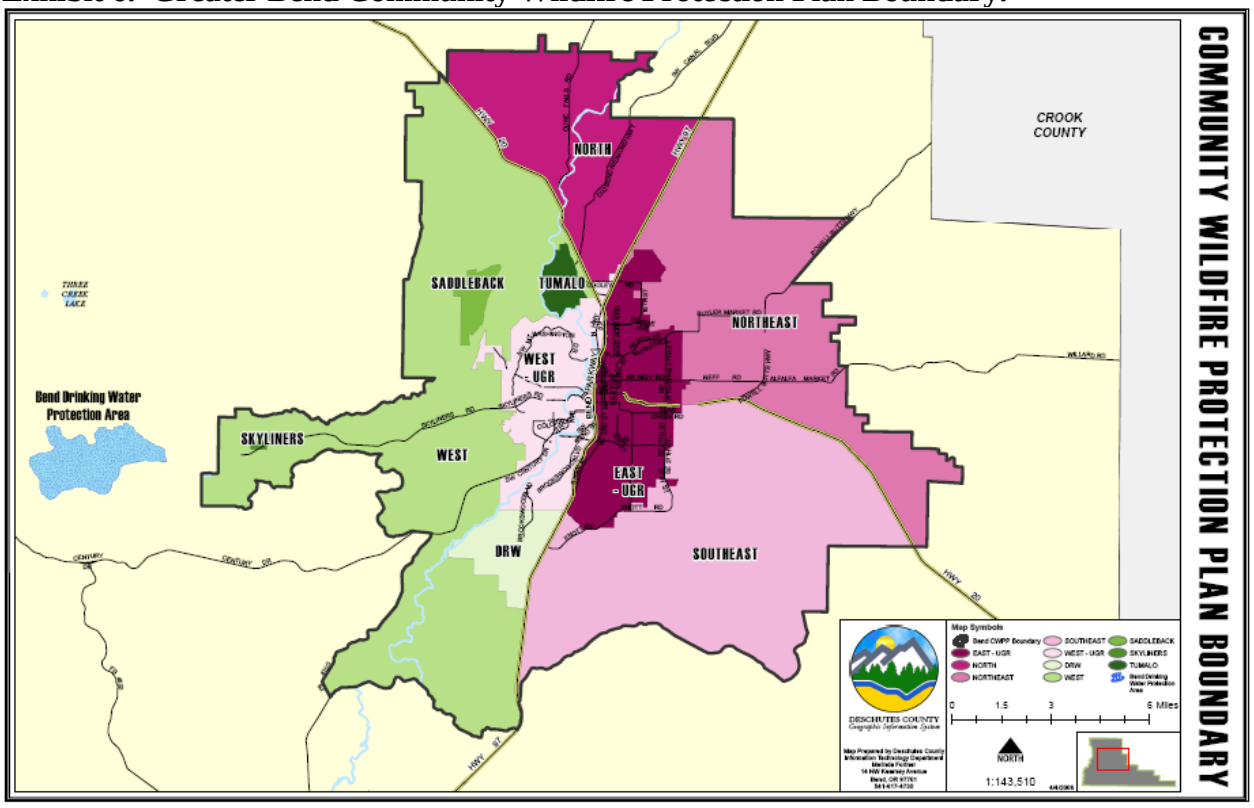
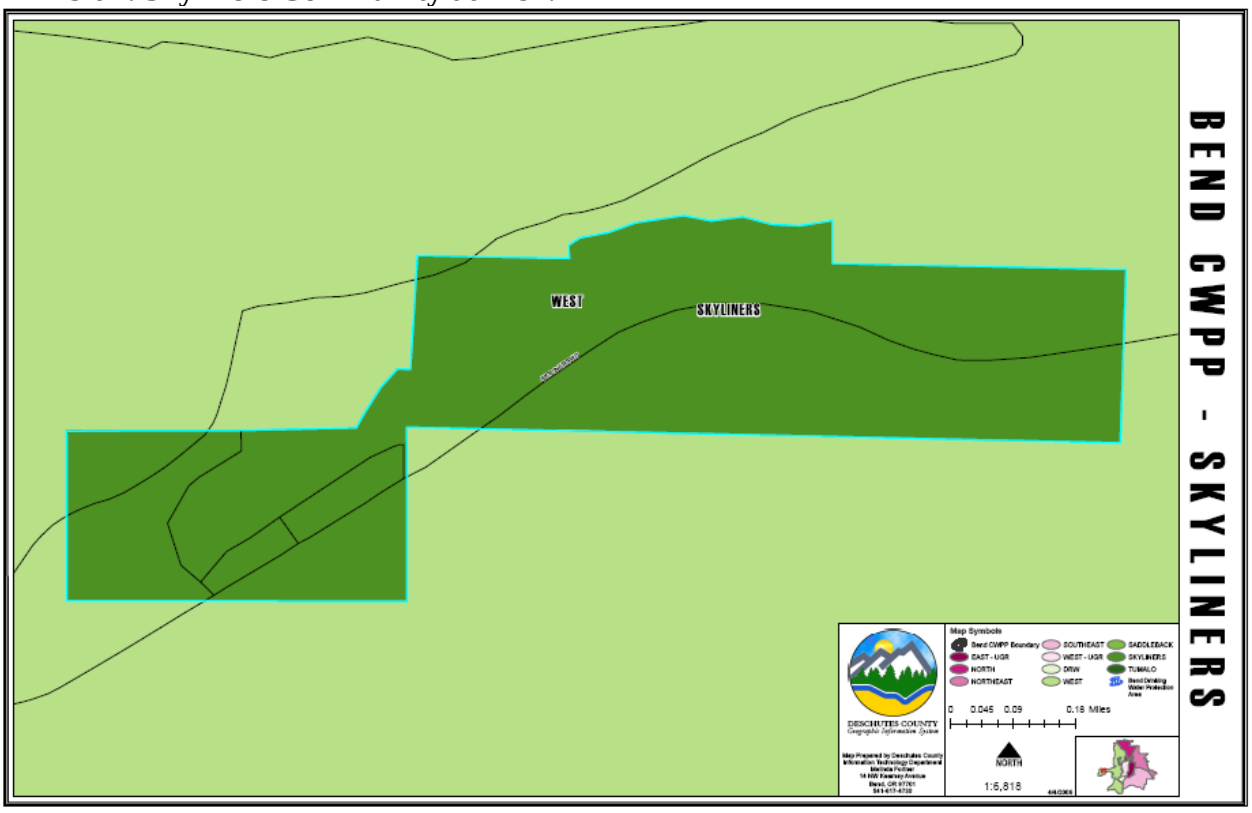


Exhibit 7. Skyliners Community at Risk.



The West Tumbull HFRA Project is presently being analyzed that would address hazardous fuels adjacent to the Skyliner Community at Risk and egress routes along Skyliner Road, Road 4601, Road 4603, and others. Over 1300 acres are planned for treatments including thinning, mowing, and underburning.

Chapters III and IV - HISTORIC AND CURRENT CONDITIONS

Chapter III, IV -1. HYDROLOGY

The Upper Tumalo sub-watershed within the Tumalo Creek Watershed is a source of high quality water, providing municipal drinking water and irrigation water. The watershed is recognized as Tier 2 Key Watersheds in the Northwest Forest Plan. Key watersheds have the highest priority for restoration activities and require watershed analysis to be completed prior to long-term management activities occurring. Special standards and guidelines apply, and are found on page C-7 of the Record of Decision for the Northwest Forest Plan.

Annual precipitation ranges from approximately 40 inches in the western portion of the watershed to 15 inches at the eastern edge. Perennial streams are Bridge Creek, Spring Creek, Tumalo Creek, South Fork, Middle Fork, and North Fork of Tumalo Creek, an unnamed stream that drains Tumalo Lake and several other unnamed springs. Intermittent streams include Bottle Creek and Rock Creek. Streams drain the higher elevations of Broken Top and Tumalo Mountain to the west where the heavy snow pack melts and generally glows in an easterly direction through glaciated valleys. The water collects in Tumalo Creek and eventually enters the Deschutes River approximately 8 miles north of Bend. Very little surface water exists in the eastern portion of the watershed.

Although perennial streams are more numerous in the western portion of the watershed than in other areas on the Bend/Ft. Rock Ranger District, most of the area is still considered to be a groundwater recharge area. Numerous springs provide cook, clear water. Snowmelt and precipitation are major contributors to surface water discharges. Tumalo Creek and its tributaries are unusual for Upper Deschutes River Basin streams in that they respond immediately to rain on snow events with large increases in flow. This may be partially due to the somewhat impermeable glaciated soils underlying a relatively thin layer of Mazama ash. Also contributing and have greater significance are the steep lopes, which exceed 60 degrees in some places. The few lakes within the watershed are small and shallow.

The potential for mass wasting is low because of the absence of indicators of past or recent landslides. Erosional processes are generally from lateral scour of stream banks and side slope rill, especially during thunderstorms and snowmelt. There is some channeling of water on Road 370 and on trails during storm events and snowmelt resulting in overland flow of sediments. The diversions of water for the municipal water supply and irrigation and the Bridge Creek Fire are the most significant factors that have changed current hydrologic conditions from historic conditions.

HISTORIC CONDITIONS

Water quality in the streams has historically been excellent with cool temperatures moderated by flow from springs. Summer temperatures ranged from the low 40’s to the

mid-50's Fahrenheit. Erosional processes were limited primarily to lateral migration of channels, adjustments of channels to log jams, and rill from hill slopes during thunderstorms and snowmelt periods. Stream banks were well vegetated and stable. Stream types were primarily Rosgen B types, high in gradient and dominated by riffle habitat. There were some reaches of C type where gradients were lower and pools were more abundant. In stream large wood was abundant in the lower gradient reaches but less in the high gradient reaches where it was moved out at high flows. Vegetation ranged from mixed conifer in the higher elevations to primarily ponderosa pine in the lower elevations. Seral stages were mid to late adjacent to streams. There was a component of deciduous species such as mountain alder, willow, cottonwood and aspen.

Prior to diversions, Tumalo Creek would have had more in stream flow for much of the year. The withdrawal for the City of Bend Municipal water supply is offset by the input from the Crater Creek Canal about 3 months out of the year. Tumalo Creek below the diversion at river mile 2.4 near Shevlin Park would have had higher summer flows and provided better fish habitat. More volume would have been provided to Sparks Lake due to increased summer flows from Crater Creek and Soda Creek, which is in an adjacent watershed, prior to the Crater Creek diversion.

CURRENT CONDITIONS

WILDERNESS LANDSCAPE AREA

Surface water resources within the Wilderness Landscape Area are limited to an unnamed small perennial stream, the upper portion of the North Fork of Tumalo Creek, and the upper reaches of the intermittent Bottle Creek and Rock Creek. The channels are generally high gradient from 5 to 30 percent dominated by riffles, habitats, and are classified as A and B types in the Rosgen method of stream classification. In July 1996, stream flow was measured at 3.7 cfs on the unnamed perennial stream. Water temperatures are cool, generally less than 57 degrees Fahrenheit. Headwaters originate in alpine fire or subalpine fir surroundings then descend through forests of mountain hemlock, subalpine fir, and lodgepole pine.

COLD FOREST/UNROADED LANDSCAPE AREA

Surface water resources include the North Fork and the Middle Fork of Tumalo Creek, a small reach of Tumalo Creek and an unnamed spring-fed tributary of the North Fork. The channels are generally entrenched and of moderate gradient from 3 to 5 percent with some reaches over 10 percent. Waterfalls are numerous, sinuosity is low and the Rosgen stream type is predominately B with some reaches of A and C. Slide slopes are moderate to steep with box canyons. Instream wood is abundant in the lower gradient reaches. Habitat types are dominated by riffles and bedrock is common in the substrate. Streamside vegetation included old growth mountain hemlock, lodgepole pine, and whitebark pine, Engelmann spruce, and subalpine fir. Stream flow data is limited although instantaneous readings measured 91 cfs in Tumalo Creek on July 1993, and 9.4

cfs in the North Fork on September 1996. Summer water temperatures range from mid-40's to the low 50's Fahrenheit.

The Middle Fork receives additional flow from the Crater Creek Canal but loses flow by the diversion of spring water into the Bridge Creek Canal. The water rights in the Crater Creek Canal, in operation since 1914, are owned by the Tumalo Irrigation District. The maximum flow of the canal is 20 cfs which generally runs from July to October and provides 4,000 acres feet of water annually. The volume of water diverted to the Bridge Creek Canal generally runs 15 to 17 cfs though out the year.

The flow diversions and Road 4601-3701, which cross all the aforementioned channels, is the most significant human caused effects to the water resources within the Cold Forest/Unroaded Landscape Area. The crossings at the North Fork and the unnamed stream are fords where there is limited introduction of sediments into the streams. There are neither current grazing allotments nor history of logging.

Additional information on stream conditions can be found in the district stream survey files; Upper Tumalo Creek 1993, North Fork Tumalo Creek 1996, Happy Valley Creek 1996, and West Fork of North Fork of Tumalo Creek 1997.

BRIDGE WATERSHED LANDSCAPE AREA

The Bridge Watershed Landscape Area essentially mimics the Bend Municipal Watershed. Surface water resources include Bridge Creek, Spring Creek, and the Bridge Creek Canal. The summer natural flow is normally 5 to 10 cfs but is augmented with the diversion from the springs via the Bridge Creek Canal near the headwaters. The discharge from the springs is normally 17 to 20 cfs most of which ends up in the canal. The earthen canal, completed in 1955, is approximately 0.5 mile long and for the most part occupies a natural draw. The canal is head cutting near its origin, adding sediments to the stream.

The City of Bend withdraws up to 13.6 million gallons/day (21 cubic feet/second) from Bridge Creek (City of Bend, 2006) for drinking water production, totaling 1.6 to 1.7 billion gallons annually. This amounts to 50 to 60 percent of the city's total drinking water production. The water is withdrawn from Bridge Creek approximately 0.1 mile upstream of the confluence with Tumalo Creek, and is piped several miles to storage tank where it is chlorinated before distribution to the city. Surplus water is released prior to chlorination back into Tumalo Creek on the western edge of Shevlin Park. Presently, there is no filtration system. However, due to regulatory actions imposed by the Environmental Protection Agency, a treatment facility for the Bridge Creek system will be required by 2012. Upgrades to the infrastructure of system are also planned in the next several years, such as replacing main pipelines (City of Bend, 2007).

The water quality of Bridge Creek is among the best in the United States for a surface water system (Prowell, 1997). Water filtration is not required if these is compliance with water quality standards of the Safe Drinking Water Act of 1986, established by the Environmental Protection Agency. The fecal coliform test has been met or exceeded in

over 98 percent of the samples since testing began in 1988, exceeding the minimum requirement of 90 percent. Turbidity is monitored continually, and is normally only 0.2 to 0.3 Nephelometric Turbidity Units (NTU). The City does take water over 1 NTU from time to time, especially when demands are high in mid to early spring but they usually try not to exceed 2.5 NTU as a matter of policy. There are several factors that decide when to preclude surface water use such as user demand, chlorine demand, and chlorine residual in the system and an estimate of how long the turbidity event will last. There are approximately 20 days annually when the turbidity is elevated above 1.0 due to snowmelt, thunderstorms, or temporary bank erosion from the channel adjusting to a newly fallen tree. Water temperatures range from 34 to 50 degrees Fahrenheit.

Bridge Creek has numerous falls and generally has a gradient of 7 to 8 percent, and predominately riffles. There is one 1.2-mile reach that is lower in gradient (2 percent) where pools are more numerous. The sideslopes are generally more moderate but steeper near the mouth where the Bridge Creek Fire consumed the streamside and upslope vegetation. Overland flow of sediments from hill slopes during storm events is becoming less severe as the vegetation and ground cover continue to increase. The unburned reaches of the stream descends through an undisturbed forest of medium to late seral stage mountain hemlock, sub-alpine fire, whitebark pine, Douglas fir, and lodgepole pine. The Rosgen stream type is B.

Spring Creek, a small tributary to Bridge Creek, had a discharge measured at 0.62 cfs in August 1995. The overall gradient is 8 percent and the habitat types are dominated by riffles. The sideslopes are moderately steep and are vegetated with medium to late seral stage Douglas fir and mountain hemlock. The lower 0.2 mile was impacted by the Bridge Creek Fire of 1979. The falls at the mouth of the creek presents a migrational barrier to fish. Water temperatures range from the mid-40's to the mid-50 during the summer.

Additional information can be found on stream conditions in the district stream survey files; Bridge Creek 1994-5, 2003, Spring Creek 1995.

Tum Lake is a small 2-acre lake that is shallow and has no fish. Water quality data is not available at this time.

FRONT COUNTRY/TRANSITION LANDSCAPE AREA

Surface water resources include Tumalo Creek, South Fork of Tumalo Creek, the first 0.1 mile of Bridge Creek, the lower reaches of Bottle and Rock creeks, Tumalo Lake and an unnamed creek that drains it, and several small springs that are tributaries to Tumalo Creek.

Tumalo Creek is the major water resource within the Front country/Transition Landscape Area. The stream flows through an entrenched channel with numerous scenic waterfalls until descending into a wide, glaciated valley composed of underlying glacial tills. Tumalo Creek is a Rosgen stream type B above the confluence with Bridge Creek, but

below the confluence, the stream fluctuates between types B and C. Fish habitat has been decreased and fine sediment input has increased.

The dominating feature within this area is the Bridge Creek Fire area. The fire burned 3.0 miles of floodplain vegetation along Tumalo Creek within the glaciated valley, destroying the root masses that provided stream bank stability. Before the fire, stands of large Engelmann spruce, subalpine fire, and ponderosa pine line the stream. The loss of vegetation from the fire also decreased evapo-transpiration rates and increased snow accumulations, providing more runoff into the stream. The trend is for increased evapotranspiration as the vegetation becomes re-established. Currently, the landscape within the burn is dominated by early seral stage pine trees and brush species. The combination of the loss of stream bank stability and increased runoff (peak flows and total water yield) resulted in stream bank erosion and lateral migration of the channel in some locations. Bar formations, sedimentation, braiding of the channel, and the width/depth ratio were increasing prior to restoration. Fish habitat was decreasing.

The streambank erosion, decreased channel stability, and lateral channel migration occurring in Tumalo Creek were addressed in the restoration project. Stream restoration design was based on established principles, using past and present aerial photography and data collected on reference reaches, which are undamaged areas of Tumalo Creek and other nearby streams. The channel was designed to decrease channel gradient, make the channel narrower and deeper, and increase the channel sinuosity (meandering) and length. Restoration was accomplished through the physical reshaping of sections of the channel, placing boulder and log jam structures, forming gravel bars, and creating side channels and small ponds.

Tumalo Creek within the restoration area was stream surveyed pre and post project. The pre-project survey (2004-2006) noted pools/mile of 14.3, large wood at 89 pieces/mile, bank stability at 87.5%, and the range of width:depth ratios of 17-181. Post-project survey in 2008 found pools increased to 20.7 pools/mile, large wood increased to 212 pieces /mile, bank stability increased to 96.7%, and the range of width:depth ratios had decreased to 19-37.3. The project provided increased fish habitat, including that of the sensitive species redband trout. Additional large wood was used in bar formations, streambank construction, off-channel habitats, and for floodplain roughness. In all, over 2100 whole trees were used in the project. Over 71,000 native riparian shrubs and trees were planted along the stream to re-establish bank stability and provide future shade and large trees instream.

Discharge in Tumalo Creek fluctuates from about 50 cfs during late summer to about 300 to 400 cfs during the spring snowmelt period or rain on snow events. The average flow between 1936-1986 was 102 cfs with a maximum of 1140 cfs and a minimum of 25 cfs. The gaging station near Skyliner Bridge has been discontinued since 1987.

Water temperatures within Tumalo Creek range from the mid-40’s to the upper 50’s during the summer months. Turbidity increases during thunderstorms and snowmelt periods. Macroinvertebrates monitoring (prior to restoration) indicated that diversity and

abundance of populations was slightly impaired, likely due to the presence of fine sediments. Post-project analysis has not been undertaken, although students at Summit High School did collect and analyze samples as part of a comprehensive student monitoring program for the restoration project. Several private residences are located adjacent to Tumalo Creek on the eastern edge of the Front Country/Transition Landscape Area, some of which withdraw water for domestic use.

The South Fork of Tumalo Creek experienced riparian damage from the fire in the lower 0.5 miles but has recovered well and is not experiencing lateral migration of braiding. The lower reach which is within the Bridge Creek Fire has a gradient of 1 percent and is a Rosgen stream type C with habitat types dominated by pools (59 percent).The upper reach has a gradient of 5 percent and is a Rosgen stream type B with habitat types dominated by pools (65 percent). Large wood is abundant throughout the stream. Within the Bridge Creek Fire area the vegetation is of early seral stage pines and mountain alder. Further upstream the seral stages are medium to late stands of subalpine fir and Engelmann spruce. August water temperatures range from the low to upper 40's. Flow was recorded at 6.4 cfs on September 30, 1992.

Additional information on stream conditions within this landscape area can be found in the district stream survey files; South Fork Tumalo Creek Survey 1992, Tumalo Creek Survey 1989, 1996, 1999, 2004-2006, Tumalo Lake Creek Survey 1996, Lower Tumalo Creek 1990.

Tumalo Lake is a shallow 16 acre lake located on both private and Forest Service lands. The Swampy Lakes are several small and shallow ponds that have no fish. Water quality is unavailable for these lakes.

DRY FOREST LANDSCAPE AREA

Tumalo Creek and a few intermittent channels are the surface water resources within the Dry Forest Landscape Area. Historically, the Columbia Southern Canal operated by the Tumalo Irrigation District withdrew water from Tumalo Creek near the western fringes of this landscape area. However, the Columbia Southern Canal has not been used since 1998 with the creation of the diversion lower in the drainage, allowing discharge to remain instream an additional 8 miles. Tumalo Creek within this landscape area is no longer on the ODEQ 303(d) list for flow modification or habitat modification. These were de-listed in 2002. However, the stream from the mouth to river mile 12.5 is on the 2004-2006 303(d) list for summer water temperature.

The stream channel is a Rosgen type B with gradients 2 to 3 percent habitat type dominated by riffles. The valley is narrow and sideslopes are steep with streamside vegetation dominated by Engelmann spruce, Douglas fir, and ponderosa pine in the mid to late seral stages. Mountain alder is also prevalent. Within the eastern portion of this landscape area, the dominant vegetation becomes mid-seral stage ponderosa pine with some white fir, lodgepole pine and juniper. The stream banks are relatively vegetates and stable. This landscape area has been modified by timber harvest activities. Some riparian

harvest of timber has occurred in the past. Stream survey data for Tumalo Creek within this landscape area is available in the district files; 1999 Tumalo Creek Survey.

PRIVATE/DRY FOREST LANDSCAPE AREA

Steam characteristics, stream bank stability, water quality for Tumalo Creek are similar to those within the Dry Forest Landscape Area. Landscape modification from timber harvest activities is evident.

SOIL RESOURCE AND EROSIONAL PROCESSES

The soil resource within the Tumalo Creek Watershed is dominated by ash and pumice from Mt. Mazama, glacial till and other reworked volcanics. The eastern edge of the watershed also includes glacial outwash in the subsurface profiles. Less amounts of cinders, colluvium, and residual buried soils (paleosols) weathered from basaltic lavas or from ash tephras older than Mazama are present as subsurface components throughout portions of the watershed. Alpine lands barren of fine soil are located at the highest elevations of the Upper Tumalo sub-watershed. Glacial activity occurred in the upper elevation portions of the Tumalo Creek drainage. Volcanic activity associated with the adjacent Tumalo Highland Plateau caldera and glaciation are two of the primary influences on landform formation and duration with the watershed.

The following table summarizes the soil stratum profiles within the Tumalo Creek Watershed:

Table 3. Soil stratum/land types of the Tumalo Creek Watershed

Land type	SRI landtype #'s	acres	percent
alpine meadows	4	2,724	7%
wet meadows	5	632	2%
juniper scab flats	53	45	0.05%
lodgepole frost pockets	7, 15	127	0.05%
ash/paleosol/cinders	80, 81, 82, 83	358	0.1%
ash/paleosol/lavas	72, 73, 84, 8A,HM, MV	2,579	7%
riparian or ephemeral drainages	2, 8, 10	2,536	7%
barren lands **	3, 6, 9, 13, 18, HB and HJ	2,043	5%
ash/till	16, 19, 21, 22, 24, 25, 26, 32, GB, GF, GH, GJ, GK, HG, MC, MG, MK	19,329	51%
ash/outwash	36, 37, GP, XD	3,070	8%
ash/residuum or colluvium	50, 56, 58, 59, 64, 66, 67, 68, 69, 76, 8T, LG	4,286	11%

* NOTE: The land type groups were stratified primarily by parent material and underlying geology using groupings of the Deschutes Soil Resource Inventory (SRI) land type mapping units. The stratification of land types was slightly altered for this update and was expanded to break out lower elevation wet meadow areas from alpine meadow areas. Changes in percentages of land types from the original stratification also reflect the changes in the sub-watershed boundaries identified for the 2008 watershed update process.

PHYSIOGRAPHIC AND CLIMATE FACTORS INFLUENCING INHERENT SOIL PRODUCTIVITY

Annual precipitation, elevation, aspect, and soil profile depths all directly influence the productivity of the soil resource and combine to provide a variety of vegetation plant associations within the watershed. Annual precipitation ranges from15 to 40+ inches and elevations range from approximately 3,500 to 8,000 feet, both on an east to west trending scale. Aspects are predominately easterly in nature but include steep north and south slopes within the Tumalo Creek drainage, and soil profile depths to bedrock range from moderately deep (60 inches +) to shallow (less than 24 inches). The combination of these factors provides primarily moderate and low inherent productivities with a less amount of high site class lands in some areas. Lands considered to be unsuited for timber management are present, including lands at higher elevations (generally within Wilderness) and on the eastern fringe (Soil Resource Inventory Map Unit #36).Table 4 provides a summary of the inherent productivity of the soil resource bases upon the cubic foot site class production figure associated with each Soil Resource Inventory Map unit.

Table 4. Inherent productivity of soils in the Tumalo Creek Watershed

productivity class	acres	percent
high	8,209	22%
moderate	18,942	50%
low	10,225	27%
barren (SRI #3 only)	353	1%
water	10	0.1%

* NOTE: the acres of land types considered unsuited for timber production were excluded from this table as a distinct productivity class for the 2008 update. Acres of SRI land type #36 identified in the 1998 watershed analysis as unsuited are included in the acres of low productivity represented by cubic foot site class 6 or 7. Changes in the percentage of productivity classes within the sub-watersheds reflect this inclusion and the watershed boundary changes for the 2008 watershed analysis update. In addition, land type units from the NRCS Upper Deschutes Soil Survey that are mapped on private lands in the Lower Tumalo Creek sub-watershed to the east of the Deschutes National Forest boundary were correlated as best as possible with SRI land types in order to determine their productivity class for this summary.

EROSIONAL PROCESSES

Erosional processes within the watershed are primarily surface in origin, although some slopes in the upper portions of the Upper Tumalo sub-watershed are steep enough to exhibit mass wasting. Summer thunderstorms and rain on snow events can produce sediment transport despite the rapid infiltration rates of the surface mineral soil component. These transport despite the rapid infiltration rates of the surface mineral soil component. Their infiltration rates are offset in part by the low cohesion properties of the ash and pumice mineral soil and in the mountain hemlock and portions of the mixed conifer plant associations, by a thick and relatively impervious organic litter layer. Soil particles are readily detached by raindrop impact and overland flow energies, especially in areas where bare mineral soils is exposed and slopes and impervious little layers contribute to overland flow accumulation and rates.

AREAS OF CONCERN

Soil quality within the watershed could be reduced by continued recreational development and use. Some trail and road locations within the watershed are susceptible to contributing sediment into perennial stream habitats. Soil quality on upland forest sites could be reduced by harvest and fuels reduction activities in the future. Soil quality is currently at or slightly below inherent quality levels within most of these areas. Upland soils within the private boundaries have received most of disturbance and reduction in soil quality from past activities. Although soil stability and productivity within the Bridge Creek Fire area is improving slowly, south facing slopes on the Bridge Creek drainage remain susceptible to erosion from wind or thunderstorm events.

HISTORICAL CONDTIONS

SOIL CHARACTERISTICS

Soil profiles within the watershed generally have distinct horizons stratified according to the timing of material deposition and the amount of weathering of the mineral components of the stratum. The majority of the watershed has a moderately deep cap layer of win deposited ash and pumice overlying glacial till or reworked volcanics. Glacial till is absent from the eastern most portion of the watershed where either a layer of residual soil weathered from basaltic lavas or glacial outwash underlies the ash cap. The ash cap material has weathered into a mineral soil A, A/C and C-horizon profile with A and A/C horizons generally comprising the rooting zones of the forest vegetation.

The bulk density and soil strength of the surface mineral horizons and rooting zones of the soils present within the watershed are naturally low due to the inherent characteristics of the ash and pumice material comprising these fractions. Physical disturbances capable of compacting mineral soil or mixing the natural stratification of soil horizons were historically limited, although landslides had the potential for increasing the soil strength of the rooting zone by exposing higher density subsurface materials such as glacial till or by accumulating material in a deep mass down slope. Evidence of this mechanism operating on a measurable scale within any of the sub-watersheds is limited. Glaciation

was the primary historic disturbance within the watershed prior to the deposition of the ask cap material. This sequence of events formed a higher density sub-surface soil layer comprised of till or outwash material underneath a relatively unconsolidated and low bulk density surface layer of ash.

Soil productivity within the watershed was influenced primarily by precipitation levels and soil temperatures, both of which are directly related to the elevation changes from the western highlands to the eastern fringe. Annual precipitation ranges from over 40 inches in the higher country to 15 inches on the eastern fringe. Soil temperatures directly influence the length of active biological growth during the growing season and range from frigid to cryic. Slope aspect and soil stratum also influence site productivity, examples of which include the lower productivity on landforms comprised of cinders and those located on some of the southern aspects within the sub-watersheds. Table 4 previously summarized the inherent productivity of the soil resource within the Tumalo Creek Watershed.

EROSIONAL PROCESSES

Erosional processes within the watershed were primarily surface in origin, although some slopes in the upper portions of the watershed are steep enough to have exhibited mass wasting. Landforms and cyclic climatic patterns probably generated rain on snow and thunderstorm events that accumulated significant overland flows capable of eroding the low cohesion material on the surface. Slope stability within a given sub-watershed was primarily influenced by the level of fire disturbance that had occurred in the years prior to a significant rainfall run-off event, most notably the extent of surface mineral soil exposed as a result of biomass consumption from fires. Although fire was a part of all the plant associations present within the watershed, the frequency and behavior of these events varied enough to provide different degrees and extents of slope susceptibility to erosional processes.

Natural fire cycles in the mixed conifer and mountain hemlock plant associations often lead to stand replacement fires capable of consuming the majority of live and dead organic matter on the soil surface. These conditions left bare mineral soil susceptible to wind and water erosion in the immediate years following a fire. These areas also coincide with some of the steepest slopes in the watershed, increasing the rate and extent of erosional events when they did occur. Fire cycles within the ponderosa pine plant associations were likely lower intensity fires that occurred at return intervals of 5 to 20 years. These types of fire events did not generally consume all of the organic cover on the soil surface and resulted in the exposure of less bare mineral soil following each event. Slopes in these areas are also more gradual and less susceptible to accumulating high-energy overland flows.

CURRENT CONDITIONS

HARVEST AND ROAD HISTORY

The soil resource on federal lands within the Upper Tumalo sub-watershed is in a relatively low impact condition due to limited amounts of past management activities and road development. The construction of roads and trails has converted a relatively small percentage of the soil resource into non productive areas dedicated for transportation and recreation. Approximately 1,344 acres or 6.5 percent of the Upper Tumalo sub-watershed has had documented harvest activities within the past 40 years, the majority of which are associated with Bridge Creek Fire salvage. The Bridge Creek Fire salvage area is the largest area of soil disturbance on lands under federal jurisdiction within the watershed. Although units adjacent to Tumalo Creek and a few units on steeper slopes along the canyon walls had salvage material yarded with helicopters to minimize soil disturbance, the majority of units incurred greater amounts of soil compaction and the mixing of naturally stratified soil horizons from tractor yarding.

The Lower Tumalo sub-watershed incurred extensive soil impacts as a result of railroad era logging during the 1930's and 40's and various prescription harvests during the late 1970's and 80's. Photoreconnaissance of 1943 photos reveals significant coverage of railroad era operations, including rail spurs and ski trails, on all lands that were dominated by ponderosa pine. Many of the railroad spurs remain today as part of the railroad transportation system. Impacts are present on lands under both private and federal ownership, although it appears that the extent of impacts on the privately owned lands containing ponderosa pine forests is greater.

Since the last watershed analysis in 1998, documented management activities include approximately 447 acres of commercial thinning associated with the Feline, Katalo and Kit timber sales within the Lower Tumalo sub-watershed, and approximately 320 acres of private forestland in the Upper Tumalo sub-watershed.

Road density calculations reveal an extensive network of roads throughout the approximately 6,400 acres of private forest land within the Lower Tumalo sub-watershed. Skid trail patterns and densities visible in 1995 photos support the occurrence of intensive ground-bases operations on the majority of acres under private ownership over the past 20 years. Single end suspension cable yarding did occur on steep slopes within portions of the Bridge Creek Fire Salvage area. The federal acres in the Lower Tumalo sub-watershed were intensively harvested by railroad era logging and have had limited amounts of recent thinning and selective harvest.

SOIL IMPACTS

Soil resource has been impacted to varying degrees from these past management activities as a result of compaction, displacement of surface organics, and loss of the mineral soil A horizon. The productivity of the soil resource as a result of these conditions has been altered to some extent, although the majority of sites continue to support second growth forests and herbaceous vegetation. Since the slopes in the majority of impacted areas are relatively gentle and organic little layers relatively think and non-contiguous, the effect of the energies on the surface and the increase in the percent of rainfall that is able to infiltrate the soil surface. Despite these conditions, road systems,

skid trails, and landings are extensive enough to contribute to concentrated overland flows capable of eroding productive surface horizon material from many upland sites. Most of the private and federal acres that are impacted from past activities are outside the immediate canyons of perennial streams, although there are the acres on the steep slopes within Bridge Creek Fire area that form the canyon sides of Tumalo Creek. Helicopter and cable yarding of salvage material limited the amount of impact that was incurred on these sites and the majority of these acres have also been stabilized to varying degrees by planted trees and regenerated shrubs.

The type and extent of past management activities within a sub-watershed is useful in identifying areas that will most likely have detrimental conditions as a result of compaction from machine traffic or exposure of mineral soil. Areas with harvest records can be further stratified into condition classes bases upon the type of harvest system used, the volume of material removed and the density of skid trails remaining on the landscape. The following table summarizes the extent of harvest activities since 1970 within each of the 4 sub-watersheds included in this analysis.

Table 5. Acres of documented past management activities within each sub-watershed since 1970.

Sub-watershed	Total acres	Acres of activity	% of watershed	Acres of activity since 1998
Upper Tumalo	20,754	2,073	10%	0 / 320
Lower Tumalo	16,975	1,915 / 5332 *	11% / 31%	447 / 0

* NOTE: Table 5 reflects the watershed analysis boundaries of the Upper and Lower sixth field sub-watersheds of Tumalo Creek for this update. Acres of activity was substituted as a column title for acres impacted from the original 1998 watershed analysis to better represent the acres reported on which management activities have occurred.
***** Acres of activity include those on federal land / private land in the subwatershed. Impacts on federal acres do not reflect railroad era logging, which are estimated to have covered 30% of the land currently under federal jurisdiction in the Lower Tumalo sub-watershed. Private land acres impacted reflects primarily railroad era logging impacts and cumulative selective harvest entries in the past twenty years. Approximately 447 acres of documented management activities have occurred within the Lower Tumalo sub-watershed since 1998, including commercial thinning associated with the Feline, Kitty, Electra, Katalo and Kit timber sales. Approximately 320 acres of private forestland were harvested within the Upper Tumalo sub-watershed in 1998 and 1999.

CONDITION CLASSES

The existing condition of the soil resource is stratified into 4 condition classes as determined by the percentage of a given area considered to be a detrimental state. Detrimental conditions include compaction, displacement, burn damaged and/or puddling to such a degree that site productivity is reduced. Condition Class A includes areas with

Detrimental damage of 0 to 10 percent, Class B: 11 to 20 percent, Class C: 21 to 40 percent and Class D:>40 percent. The following table summarizes the existing condition classes within each of the 4 sub-watersheds using past activity databases and photo interpretation. The figures are estimated acres and are not yet digitized. Condition class D areas are roads only and are overlap areas.

Table 6. Existing condition classes within each sub-watershed

Subwatershed	Class A (ac./%)	Class B (ac./%)	Class C (ac./%)	Class D (ac./%)
Upper Tumalo	18,291 (88%)	511 (2%)	1,913 (9%)	39 (<1%)
Lower Tumalo	1,205 (7%)	10,447 (62%)	5,138 (30%)	164 (1%)

* NOTE: Due to the change in sub-watershed boundaries approximately 880 acres of the Bridge Creek Fire salvage area were added to the Upper Tumalo sixth field sub-watershed from the Tumalo sixth field sub-watershed designated in the 1998 analysis. These acres were added to the Class C condition class for Upper Tumalo and subtracted from the same condition class for Lower Tumalo for this summary. Additionally, approximately 320 acres of private land in the Upper Tumalo sub-watershed (T18S R10E Sec 16) were heavily harvested during the summers of 1998 and 1999 using ground based equipment without any sub-soiling rehabilitation and were converted from Class B to Class C in this table. There have been no documented timber management activities on federal lands within the Upper Tumalo sub-watershed since 1998.

The 447 acres of documented management activities associated with the Feline, Katalo and Kit timber sales within the Lower Tumalo sub-watershed since 1998 are primarily commercial thinning of black bark ponderosa stands that were railroad harvested in the early 1930's and 40's. Impacts in these activity areas were minimized through the use of designated harvest systems and/or winter logging and included sub-soiling to ameliorate compaction incurred on primary skid trails and landings. The condition class of these acres likely was upper class B or lower class C prior to entry and is considered to be class B following these activities. The class acres were not changed in this table as a result.

EROSIONAL PROCESSES

Erosional processes within the watershed are dominated by overland flows during higher volume rain events. The area is most susceptible to those erosive forced during rain on snow events when run-off volumes can become very significant in a short period of time. The Tumalo Creek Watershed and the Tumalo Creek drainage were heavily tested during a 3 day, February 1996 rain on snow event that produced high volume run-off from the melting of an estimated 4 feet of snow pack. Sediment movement that did occur was the result of overland flows since no landslides occurred within the watershed during that event. Rates of erosions appear to be slightly elevated from historic levels as result of past harvest activities and the road systems that are in place. The minimal amount of erosion that did occur is attributable to the low levels of impact present within the upper

sub-watersheds, specifically the low density of roads and lack of harvest units in which skid trails or landings contribute to the volume and energy of accumulated run-off.

The discussion of sediment contribution related to litter and duff levels on the forest floor as a result of fire suppression can be distinguished between plant association groupings (PAGs). While areas within the Mt. Hemlock zone have thick and relatively impermeable mats of litter and duff that contribute to overland flows during high intensity rainfall events, increased litter and duff layers in drier Ponderosa and Mixed Conifer PAGs tend to reduce raindrop impacts and slow overland flow accumulations and energies. Nearly three decades of growth within the Bridge Creek fire area has provided ground cover from tree and shrub leaf litter within primarily Ponderosa and Mixed Conifer PAG types. The succession of vegetation over time also affects the amount and type of organic input on the soil surface and varies noticeably by aspect within the fire area. North and gentler east aspects are beginning to lose shrub cover as tree canopies begin to close, while south aspects remain quite full with shrub cover as tree densities, heights and canopies are somewhat reduced compared to the north and east aspects. No additional changes to litter or vegetative cover within the Tumalo Creek watershed as a result of fire disturbances have occurred over the past decade since the last watershed analysis was completed.

The greatest movement from overland flow processes occurred within the Bridge Creek Fire area in the 1990's, where exposed mineral soil having a low cohesion properties and slopes exceeding 30 percent elevated the risk of soil movement during rain events. Sheet erosion within the Bridge Creek Fire area contributes the majority of sediment that reaches Tumalo Creek, although evidence of rill of gully erosion following the 1996 event was minimal. Re-vegetation of this area has occurred in the nearly 30 years following the fire to levels capable of minimizing soil loss during major run-off events.

While the type of erosional processes have not been altered within the watershed, the construction of roads and trails, along with the suppression of fire, have likely changed the extent of soil movement during run-off events. Overland flows probably have increased in some areas adjacent to constructed roads and within areas where road densities are high. Sediment transport from upland areas to perennial streams are occurring and are primarily related to existing roads and recreational trails that are within the immediate canyons in which these streams are located. These areas are not extensive and are related to a few specific roads and trails discussed in Chapter V. Road 370 and Road 4601 as well as the North Fork Trails, are the primary contributors of sediment, although total amounts are limited to some extent in terms of volume and time. Recent work has been completed on Road 370 and the North Fork trail system that has addressed some erosion concerns.

Although quantitative measurements are difficult, the suppression of fire within the watershed has also affected sediment movement both positively and negatively. While suppression has limited the amount of soil resource directly exposed to erosional mechanisms, the increased depths and aerial extent of little and duff layers in some areas as a result of reduced fire consumption likely contributes to a reduced rate of infiltration

during rainfall events and a subsequent increase in the amount and erosive energy of overland flows.

Fire suppression over the last 80-90 years may have actually decreased the extent of sediment movement within the watershed from that which occurred historically. Although the Bridge Creek Fire created the most extensively disturbed area within the watershed due to the high consumption rate during the event and the salvage activities that followed, there are no other areas of significant size that have had a stand replacement event in the last 80 plus years. As a result, the total amount of bare mineral soil susceptible to rain and wind erosion is likely less than at a given point of time in the historic past if historic fire return intervals in the various plant associations are considered.

The volume of sediment movement as a result of past harvest activities and the road and the trail systems that are in place have not been quantified in all the sub-watersheds, but are reflected by sediment measurements as the City of Bend Municipal Watersheds intake. Turbidity levels at the downstream end of Bridge creek Fire area most likely increased in the immediate years following the fire, although no samples were recorded. Bedload sedimentation measurements within this reach of Tumalo Creek do support a trend of increased deposition of sediment during the years following the fire. The rates of sediment movement from within the fire area are likely to continue to decrease as vegetative growth stabilizes adjacent watershed slopes.

Soil conditions within the Upper Tumalo sub-watershed has not been altered significantly from those present historically due to their primary designation as Wilderness, Municipal Watershed, or Roadless area. This has resulted in the minimal development of roads and has limited soil disturbance activities such as timber harvesting. A section of private ownership in the southeastern portion of the Upper Tumalo sub-watershed (T18S, R10E, section 16) was harvested during the summers of 1998 and 1999 and represents the most recently impacted area in the sub-watershed. Approximately 320 acres within the Upper Tumalo sub-watershed was harvested and is accounted for in Table 5. Approximately 25 acres associated with this activity were harvested within the adjoining Lava Island Falls sub-watershed. The Bridge Creek Fire area is the only other area of appreciable size that has been impacted from harvesting activities in this sub-watershed. The primary soil disturbance activity in this sub-watershed has become the construction and use of recreational trails and the low maintenance of high elevation roads such as Road 370 and Road 4601. Both activities have resulted in isolated areas of soil compaction and vegetative removal. Use trends are expected to increase over time, likely with an associated increase in resource impacts.

The Lower Tumalo sub-watershed has had more harvest activates in the past than the Upper Tumalo sub-watershed and has an extensive supporting transportation system developed within. The area impacted as a result of these activities appears to have been enough in some areas to alter soil productivity through the loss of surface mineral soil via erosional mechanisms and the compaction of mineral soil A and A/C horizon material. Lands acquired by the Forest Service under the land exchange with Crown Pacific (now

Cascade Timberlands), especially those on the north side of the Tumalo Creek Canyon, are highly impacted from past activities and have relatively high road densities.

The majority of harvest activity on federal lands in the Lower Tumalo sub-watershed occurred during the railroad era harvest of the 1920's and 30's leaving middle-aged, second growth ponderosa pine stands that are beginning to reach commercial size. Commercial thinning of middle aged, second growth Ponderosa stands has begun to occur on federal lands in recent years. Activity areas since the 1998 watershed analysis include the Katalo, Kit, Kitty, Electra, and Feline timber sales mentioned below Tables 5 and 6. Soil conditions would be expected to remain at moderately disturbed levels, improving slowly as litter and duff accumulated underneath a maturing forest. Soil conditions on private forestlands would also be expected to remain near existing conditions, although impacted from selective harvest have been a greater component of management on private forest land in the past 30 years and have incurred higher levels of soil disturbance. Harvest levels on these lands would be expected to continue at current levels into the future. Lands acquired by Crown Pacific from the Forest Service in the 1998 land exchange and now owned by Cascade Timberlands have had an increase in harvest activity within the last 10 years. Recently, treatments have focused on removal of diseased white fir and non-commercial thinning of ponderosa pine. Additional non-commercial thinning, along with some commercial harvest, is anticipated in the next 10 years.

SOIL NEED ASSESSMENTS

-Forest lands within the Lower Tumalo sub-watershed in condition Class C or D are in need of the amelioration of compaction levels to maintain site productivity and reduce sediment movement off site and into perennial streams.

-In order to reduce the risk of resource damage in the short-term, the design and maintenance levels of recreational trails within the watershed need to keep pace with changes in the type and amount of use.

-Trails constructed without properly designed grades and locations for their intended uses have an elevated risk of creating resource damage via erosional and sedimentation pathways.

-In some areas, trails originally constructed for hiking that are now used by mountain bikes and are in need of relocation and redesign. Proposals for new construction of acquisition of trails need to include resource specialist and trial user input on locations, design, and maintenance.

-Trail additions, reconstruction, and management use decisions have been implemented within the Upper Tumalo sub-watershed since the 1998 analysis, including the following. The South Fork trail in the Upper Tumalo sub-watershed has had grade and location changes implemented; the Farewell trail has been constructed; and uphill only mountain bike traffic has been implemented on the North Fork trail. Anecdotal monitoring of these

trail corridors by the soils resource specialist while riding these trails includes the following observations: Actions on the South Fork have improved function for mountain bike use by reducing skidding damage and moving some trail locations capable of directly contributing sediment and runoff further away from the stream. Construction of the Farewell trail with grades and locations sufficient to minimize impacts from mountain bikes has allowed for the implementation of uphill only mountain bike traffic on the North Fork trail, further reducing erosive impacts and potential sediment contribution to Tumalo Creek. Monitoring of resource conditions along trail corridors needs to continue in order to track impacts that are a result of use or management designations.

-The appropriate use and maintenance levels of roads need to be assessed at the project level in order to reduce resource impacts which are currently occurring as a result of erosion and sedimentation.

-Soil restoration associated with compaction from past mechanized harvest operations should occur in upland areas within the Tumalo Creek drainage, especially forestlands acquired by the Forest Service from Crown Pacific (Cascade Timberlands). Activity areas identified as being in condition Class C or D under the existing condition analysis are included in these recommendations.

-The use and maintenance levels of Road 370 and Road 4601 are the highest priority identified for the transportation system within the Tumalo Creek Watershed. Road 370 has had culvert and surface improvements since the 1998 analysis intended to reduce sediment contribution to stream drainages. Despite seasonal closures, impacts to the sensitive soils and high meadow vegetative resources continue to occur as use of Road 370 continues to increase. Breaches of off-road restrictions and gated closures reflect the need to assess the management of these roads in a sensitive, high elevation location. Roads 370 and 4601 are currently managed at level 2 maintenance levels.

-The grade of Road 4601 as it climbs out of the Tumalo Creek drainage is also in need of reassessment. Current grades exceeding 10 percent in a direct line upslope have created rill and gully erosion on the road bed with direct movement of sediment into the Tumalo Creek drainage. Direct contribution of sediment and overland flow to Tumalo Creek is not apparent, although erosion from water movement is occurring. To ameliorate the erosion problems, options include relocation of the roadbed with appropriate switch backs to reduce grades, installation of drivable water bars, or paving the surface. The road segment with these grades was acquired by the Forest Service as a part of the Crown Land Exchange, although the entire road remains a cost share road with Cascade Timberlands and would need concurrence for all proposed actions.

-Some spur road and skid trail restoration and obliteration is recommended on slopes within the Bridge Creek Fire area.

AQUATIC SPECIES

HISTORIC CONDITIONS

Composition and Distribution

Redband trout may have been the only fish species occupying waters within the Tumalo Creek watershed. There are no historical records of any other fish species. Their distribution was most likely throughout Tumalo Creek up to Tumalo Falls, in Bridge Creek to the first falls approximately 0.3 miles upstream from the confluence with Tumalo Creek, the South Fork close to the headwaters, and an unnamed creek draining Tumalo Lake (lake may have been fishless due to shallow depths).

In the early and mid 1990's, there were unverified reports of bull trout sightings in Tumalo Creek. According to the Oregon Department of Fish and Wildlife, highly fluctuating flows and lack of deep pools are the limiting factors keeping bull trout and mountain whitefish from residing in Tumalo Creek. There were and still are several habitat features favorable to bull trout. Cool water temperatures throughout the season are within a range tolerated by bull trout. Cooler water temperatures occur during the fall months (less than 9 degrees Centigrade) which are critical to induce spawning in bull trout. Water temperatures approaching 2 to 4 degrees Centigrade in mid to late fall are the optimum temperatures for embryo survival and increased size of alevins. There are adequate gravels for spawning in some reaches, especially within the Bridge Creek Fire area although the fine sediment volumes are higher than desired. Fine sediment volumes prior to the fire were likely lower, although no data is available. The large accumulations of the Instream wood are a preferred habitat feature for bull trout. Within the Bridge Creek Fire area, numerous side channels and beaver ponds provide rearing habitat and refugia from high flows. The stream restoration project within the Bridge Creek Fire area has improved habitat for bull trout. Recent electrofishing surveys within the restoration area (2004-2008) have not revealed any bull trout.

Besides the lack of deep pools, another characteristic of Tumalo Creek and its tributaries that would be unfavorable to inhabitance by bull trout is the occasional fall storm event that could dislodge embryos in the gravels.

The introduction of eastern brook trout in the watershed jeopardized the existence of bull trout, if they were indeed indigenous. The 2 species compete for food resources and commonly hybridize. Offspring are usually sterile.

Stream invertebrate communities were relatively diverse, abundant, and widespread, and composed of species typical of cool, eastern Cascade streams.

Habitat Conditions

The habitat conditions were similar to current conditions, with the exception of the effects of the fire, roads, and the flow diversions. Waterfalls prohibited fish distribution into the headwaters. Shade and instream wood were abundant, substrates were cobble, gravel, and small boulder dominated, streambanks were vegetated and stable, and habitat types were dominated by riffles. Fine sediment volumes in the spawning gravels were

likely lower than current conditions, as stream banks had higher stability and there were no road crossings. The restoration project within the Bridge Creek Fire area restored habitat conditions to approximate those of pre-fire conditions. The streamside forest canopy will take decades to approximate those of pre-fire conditions.

Water temperatures were probably lower than current because all streams reaches were shaded with large conifers and the cools springs currently feeding the municipal water supply would have cooled the Middle Fork. Bridge Creek and the upper reach of the Middle Fork were likely exceptions. The water temperatures of Bridge Creek have been cooled from the spring water and the upper reach of the Middle Fork above the spring source has likely been cooled from the input from the Crater Creek Canal.

The diversity of boulders, gravels, organic debris, and stream velocities provided various habitat types for invertebrate communities.

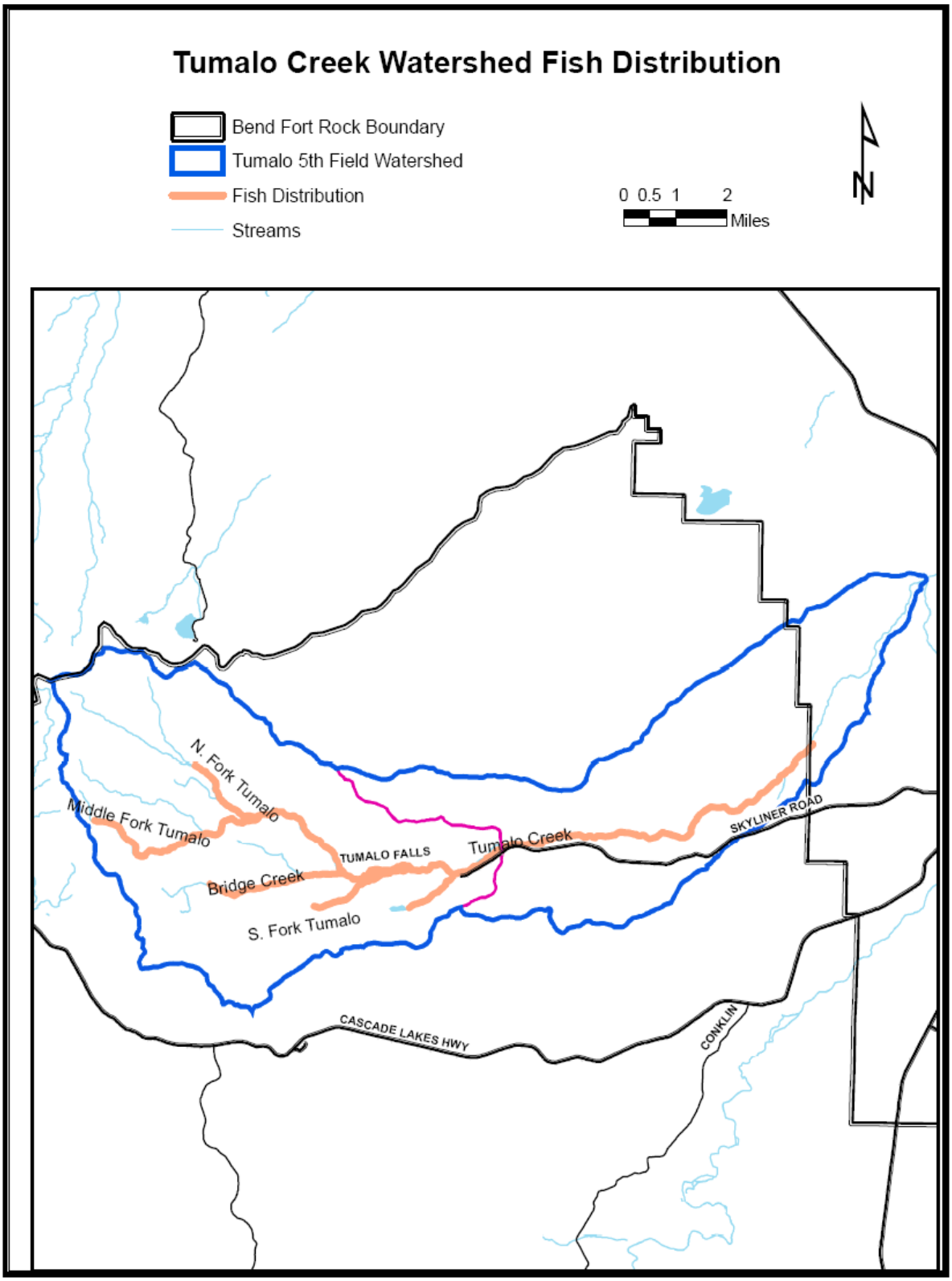
Current Conditions

Composition and Distribution

Self-sustaining stream populations of redband trout and eastern brook trout overlap and are widespread, found even above migrational barriers. Fish populations were likely established above the barriers either from official stockings conducted by the Oregon Department of Fish and Wildlife (rainbow trout and brook trout) or by private citizens seeking to increase the area of distribution. Populations are generally distributed in streams up to where low flow or high velocities due to high gradient becomes limiting. The dam on Bridge Creek at municipal water intake is a migrational barrier. There are no fish found in any of the lakes except for Tumalo Lake which may contain eastern brook trout. A majority of the fish in the watershed are small in size (less than 8 inches) resulting in relatively light fishing pressure (see Exhibit 8). Rainbow trout were stocked in the watershed annually from 1948 until 1972, but genetic analysis of redband samples collected in 2006-2007 within and downstream of the restoration area revealed there has been little hatchery rainbow introgression (Matala, et al 2007). Some samples have been collected on redbands/rainbows above Tumalo Falls and other falls upstream of Tumalo Falls, but have not yet been analyzed. Additional samples are needed to complete the data set, and are planned for the immediate future. These redband/rainbow are present up Tumalo Creek up to the second set of falls above Tumalo Falls, approximately 2 miles upstream (near mouth of Bottle Creek). Above this point, only brook trout are found.

The eastern brook trout, native to the east coast of North America, were widely introduced to the western United States early in the 20th century. The Tumalo Creek drainage was stocked with eastern brook trout for the first time in 1948. Specifically, they are not a trout but a char, being closely related to the bull trout. Brown trout are suspected to inhabit Tumalo Creek at the eastern edge of the watershed. Brown trout are exotic to

Exhibit 8. Tumalo Creek Watershed Fish Distribution



North America, having been introduced to the Deschutes River over 60 years ago and have spread their distribution into Tumalo Creek.

The eastern brook trout are very prolific and can overpopulate a stream or lake resulting in numerous fish of small size. There is evidence for this occurring in the burned area of Tumalo Creek based upon electrofishing sampling. Very few of the fish exceeded 6 inches in length. Sampling has indicated that brook trout make up approximately 75 percent of the population within the Bridge Creek Fire area while the other 25 percent are rainbow trout.

The stream invertebrate community is likely similar to historic conditions. There has likely been an increase in species that graze on algae within the Bridge Creek Fire area with the opening of the canopy.

Wilderness Landscape Area

There are no known fish populations in the Wilderness Landscape Area.

Bridge Watershed Landscape Area

Redband and or rainbow trout have been documented in Bridge Creek and have likely been distributed up to the junction with the Bridge Creek Canal. Eastern brook trout are speculated to inhabit Bridge Creek and would have a similar distribution.

Cold Forest/ Unloaded Landscape Area

Eastern brook trout inhabit the North Fork of Tumalo Creek close to the Wilderness boundary, a small spring-fed tributary to the North Fork, Tumalo Creek, and the Middle Fork of Tumalo Creek upstream to the confluence with Crater Creek Canal.

Front Country/Transition Landscape Area

Eastern brook trout and redband/rainbow trout occupy Tumalo Creek, the South Fork of Tumalo Creek upstream close to the headwaters, and Bridge Creek upstream to the dam at the municipal water intake. Redband/rainbow have been documented in Tumalo Creek up to the second set of falls above Tumalo Falls, while eastern brook trout likely are distributed to near the headwaters of the Middle Fork. They have been documented as far up as the origin of the Bridge Creek spring diversion. Trout, primarily eastern brook trout, are also found in the many beaver ponds formed in the small tributary streams to Tumalo Creek within the Bridge Creek Fire area. Eastern brook trout may also reside in Tumalo Lake and are present in the small stream that drains it. Fish population sampling was conducted pre and post project within the restoration area of Tumalo Creek. Results are included in the appendices. In summary, prior to restoration eastern brook trout outnumbered redband trout approximately 2:1. The restoration project increased populations for both species, but more so for eastern brook trout because of the large numbers of small fish rearing in newly created off-channel habitats.

Dry Forest Landscape Area

Eastern brook trout and redband trout inhabit Tumalo Creek. There may also be brown trout in the downstream reaches of Tumalo Creek.

Private/Dry Forest Landscape Area

Eastern brook trout, redband trout, and likely brown trout inhabit Tumalo Creek in this area. The other small streams within this landscape area do not contain any known fish populations.

Habitat Conditions

Within the streams, the numerous falls and the paucity of pool habitat are the major habitat features that limit the fish populations. Most stream reaches are generally riffle dominated, having only 5 to 10 percent pool habitat. Streamflows have been altered for downstream irrigation purposes, but there are some favorable instream habitat conditions. With the exception of the area burned by the Bridge Creek Fire, the riparian zones are relatively intact with mature stands of mixed conifer and brush providing shade, overhead cover, and instream large wood recruitment. There are adequate amounts of gravels, cobbles, and boulders for spawning, rearing, and macroinvertebrate habitat. Water temperatures are relatively cool, generally less than 55 degrees Fahrenheit, even in the summer. The cooler temperatures likely limit growth rates of fish. Instream large wood is fairly abundant, decreasing in higher gradient reaches where it is displaced with high flows. Habitat conditions were improved within the restoration area through channel modification, log jam placements and the planting of over 71,000 trees and shrubs during 2004-2007.

Wilderness Landscape Area

The perennial streams within this landscapes area are relatively small and high in gradient and do not provide fish habitat.

Bridge Watershed Landscape Area

Shade and potential instream wood recruitment was nearly eliminated in the lower 0.5 mile of Bridge Creek by the 1979 fire and subsequent wood salvage. Shade is increasing as the new stands mature. The natural flow of Bridge Creek is increased substantially from the input from the canal (up to 21 cfs) which has increased available fish habitat. Waterfalls and the lack of pools limit the fish population. Instream large wood is relatively abundant with over 200 pieces per mile which provides fair to good hiding cover.

Cold Forest/Unroaded Landscape Area

The habitat conditions are relatively undisturbed with the exception of a few trail and road crossings and flow alterations within the Middle Fork Tumalo Creek. Fish habitat is limited by the presence of waterfalls, high gradient and a lack of pools. The upper reach of the Middle Fork receives additional flow during the summer from outside the watershed via the Crater Creek Canal which originates on the flanks of Broken Top. The increased volume improves fish habitat but also introduces fine sediments. The diversion of spring water into the Bridge Creek Canal, flow that would naturally enter the Middle Fork, decreases fish habitat within the Middle Fork. However, this loss of flow is largely offset by the flow from the Crater Creek Canal during the summer months. Stream fords along Road 4601-370 (fords) contribute some fine sediments to watercourses. Drainage improvements have been made in the last decade on this road.

Front Country/Transition Landscape Area

Fish habitat conditions were greatly altered by the Bridge Creek Fire which burned approximately 3 miles of riparian habitat along Tumalo Creek and another 0.5 mile on the South Fork of Tumalo Creek. The tall pine, spruce, and fir were replaced by brush species such as mountain alder. Planted ponderosa pine and naturally regenerating lodgepole pine and fir species are 30 feet or more in height and are providing some stream shading. Despite the loss of shade, the water temperatures remain relatively cool, rarely exceeding 55 degrees Fahrenheit. Stream bank erosion and channel widening within the fire area were addressed in the restoration project. Bank and channel stability, pool habitat, instream large wood, and floodplain roughness were increased. Improved channel and bank stability will decrease the intergravel fine sediment volume. Over 2100 trees with root wads and crowns were added to the stream and floodplain. Additional information is available in district files under Tumalo Creek Bridge to Bridge Restoration Project. Re-vegetation efforts include the planting of over 2,000 Engelmann spruce.

Instream flows to Tumalo Creek are decreased with the withdrawal of water from Bridge Creek for the municipal water supply. During the summer months, this is largely offset by the input from the Crater Creek Canal.

The small creek that drains Tumalo Lake is also within the fire perimeter. The creek does not provide much fish habitat due to its small size, high gradient , and lack of pools. The volume of Tumalo Lake, nearly entirely on private land, has been increased with the construction of a small dam at the outlet, increasing the potential for available fish habitat. Maximum depth is unknown.

Dry Forest Landscape Area

Tumalo Creek is well shaded with mixed conifer at the western edge, switching to primarily ponderosa pine moving downstream to the east. The stream flows through a canyon with steep sideslopes. The stream from Shevlin Park Market Road (river mile 3.4) upstream to Skyliner Bridge (river mile 12.7) was surveyed per regional protocols in 1999. The stream survey is available in the district files. Stream gradients ranged from 1.4% to 3.2%. Habitat types were composed of 14% pool, 80% riffle, and 6% side

channel. Instream large wood abundance was relatively low to moderate. ODFW completed a restoration project within Shevlin Park that increased large wood in the first approximately 1 mile of the survey. Substrates are dominated by cobbles and gravels. Some past riparian zone harvest of conifers is evident. Portions of this landscape area adjacent to Tumalo Creek are within private ownership.

Private/Dry Forest Landscape Area

Stream characteristics are similar to those in the Private/Dry Forest Landscape Area. Water from Tumalo Creek is diverted at river mile 2.4 into the Tumalo Feed Canal during irrigation season, nearly drying up Tumalo Creek down to its confluence with the Deschutes River.

Vegetation

Plant Associations

Vegetative composition is an important component in understanding, analyzing, and evaluating the physical, biological, and social processes of climate, geomorphology, plant succession, and disturbance events yield changes in vegetative composition and trend (species, structure, density). Climate, soils, and topography generally remain constant over time. Succession and disturbance continually work in concert to change the vegetation condition, both in terms of structure and distribution, as well as in processes and ecological function.

Plant associations are an organizing framework for establishing known vegetation species ranges and were used in the analysis. Species distributions and their potential distribution range have been mapped for the entire watershed. These plant associations vary from high elevation, cold, sparsely vegetated upper regions dominated by rock and alpine meadows to warm, dry ponderosa pine stands found throughout the lower elevation.

Broadly categorized into plant association groups (PAGs), 7 general communities of forest vegetation emerge. These are: ponderosa pine dry/wet (PPD/W), mixed conifer dry (MCD), mixed conifer wet (MCW). Lodgepole pine dry/wet (LPD/W), mountain hemlocks dry (MHD), meadow/riparian (MDW/RIP), and rock/alpine meadow (ROCK/ALP) (See Table 7 and Exhibit 12)

Table 7. Plant Association Groups by Sub-watershed

Major PAG	% of Total Landscape	Dominant tree Species coverage	Upper Tumalo	Lower Tumalo
PPD/W	28%	Ponderosa pine	0%	66%
MCD	13%	Ponderosa pine	13%	14%
MCW	17%	White fir	20%	13%
LPD/W	11%	Lodgepole pine	15%	6%
MHD	24%	Mt. hemlock	40%	0%
MDW/RIP	4%	Mdw/riparian	7%	0%
ROCK/ALP	3%	Rock/alpine shrub	5%	1%
TOTALS	100%		100%	100%

Historic or Reference Conditions

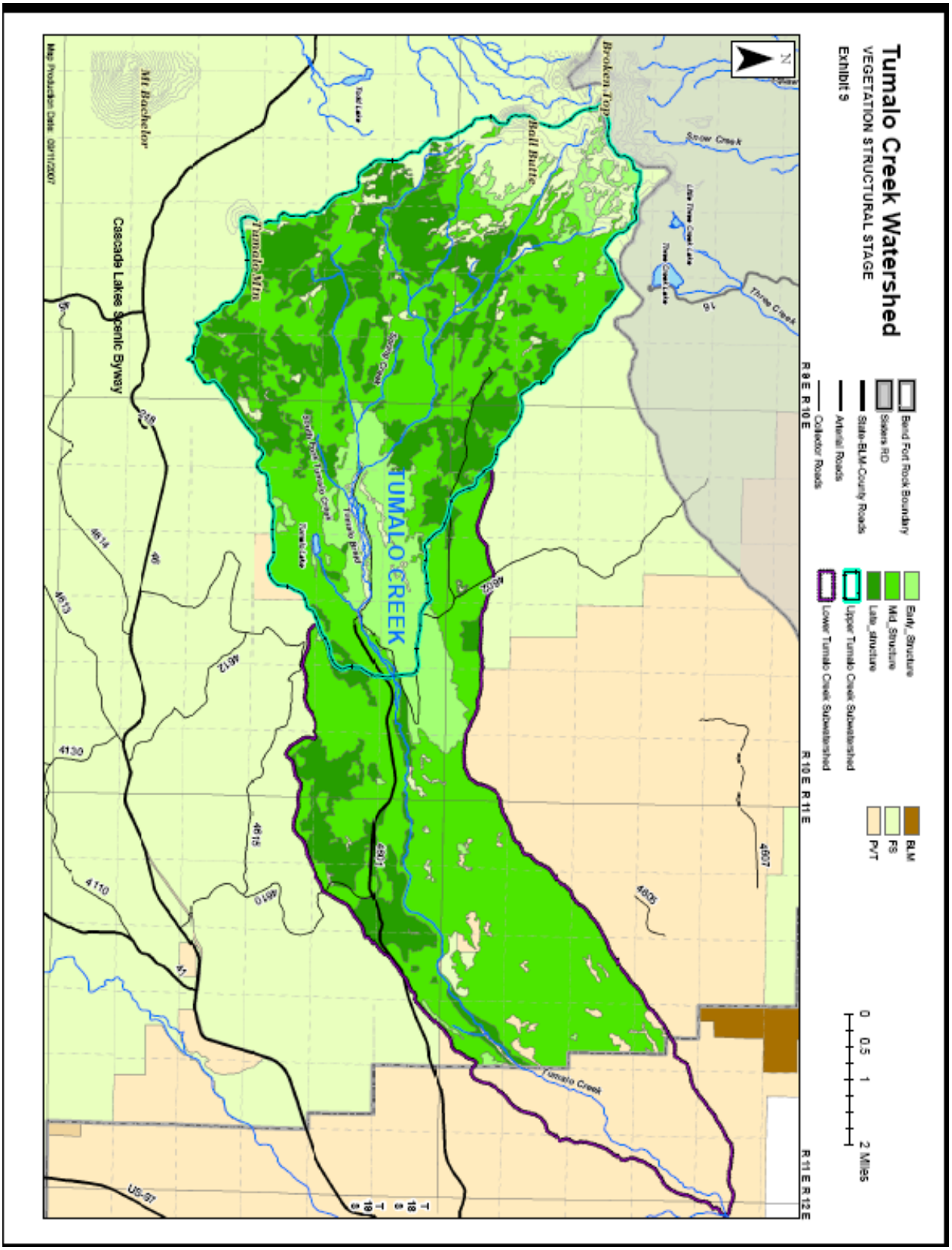
The following discussion summarizes the differences between the current forested vegetation conditions and those conditions thought to exist under native disturbance cycles in previous centuries. Where possible, explanations of reasons for those differences are given.

The historic vegetation in this section is based on estimates of reference conditions, in order to establish a general picture of probable landscape conditions under native disturbance regimes. This is set to conditions that most likely existed prior to European settlement, when fire dominated conditions are thought to have existed (circa 1850-1910). This procedure, termed historic range of variability (HRV) analysis, was completed using the Vegetation Dynamics Development Tool (VDDT, Hann et al. 1997) successional pathway model to establish likely reference points.

Structural Stage Classifications: Forest structures and species composition (often termed seral stage) provide a basis for describing both the existing condition of the landscape, as well as the theorized condition under more native disturbance cycles (e.g., conditions under which the landscape is believed to have evolved prior to fire suppression, timber harvesting, and road building for example). In order to simplify the analysis, three structural stages have been assigned and are described as follows:

Early structural stages are those newly establishing stands, such as the many acres of pine populations that are reclaiming the Bridge Creek Fire area. The early structural stage (SS1) is less than 30 years old. Middle structural stages are those stands that are neither young nor old, but are middle-aged, such as the "second growth" ponderosa pine stands that dominate the environment on the lower portions of the watershed, closest to the urban interface with Bend. The mid structural stage (SS2, 3, 4, 5) is between 30 and 130 years old. Late structure stages are mountain hemlock stands that occupy much of the upper portions of the watershed. The late structural stage (SS6, 7) is more than 130 years old.

Exhibit 9. Tumalo Creek Watershed Structural Stages



In this procedure, plant community associations and stand structures are project into the future, for 10, 50, and 100 year projections, and mid-point estimates of species composition and structural classification are made. Simulations of HRV conditions include the most common native disturbance agents (fire, insects, disease pathogens), but more recent disturbance agents (timber harvest, thinning, exotic species) are suppressed).

Table 8. Historic Structural Stages by Plant Association Group (Percentage)

Major PAG	% of total Landscape	Dominant tree species coverage	Open Areas	Early Structure	Mid Structure	Late Structure
PPD/W	28%	ponderosa pine	0%	10%	10%	80%
MCD	13%	ponderosa pine	0%	10%	20%	70%
MCW	17%	white fir	0%	20%	45%	35%
LPD/W	11%	lodgepole pine	0%	30%	45%	25%
MHD	24%	mt. hemlock	0%	15%	55%	30%
MDW/RIP	4%	meadow/riparian	100%	0%	0%	0%
ROCK/ALP	3%	rock/cinder	100%	0%	0%	0%
Totals (Range)	100%	all species	5% (5%)	14% (10-20)	27% (20-35)	54% (40-65)

The table above was calculated for the 1998 watershed analysis. Historic structural stage was not re-calculated for the 2008 update. The 1998 historic structural stage determination was based on a larger area and the historic structural stages developed in 1998 are assumed to remain valid for the smaller 2008 analysis area.

Disturbance Processes

The following discussion centers on the role of disturbance in shaping vegetation patterns, processes, and ultimately trends in the watersheds. Forest vegetation disturbance provides a process to interrupt the ongoing process of succession. There are many disturbance agents present within the watershed area. See Table 9 for dominant historic disturbance by PAG.

Fire: The role of fire in shaping the vegetation within the watershed is described in the Fire History summary.

Insects and Pathogens: Insects have the potential to cause substantial vegetative changes, resulting in the emergence of new landscape patches and patterns. Ponderosa pine and mixed conifer stands are imminently susceptible to defoliator insect attacks, as well as to those by bark beetle. Although there is no certainty of these events occurring, there is a greater predisposition for outbreaks to occur, relative to other forest vegetation types, both in terms of structure and composition. Thus, if an outbreak of defoliator or bark beetle species occurs at an epidemic level, then large patches may be created across the landscape, as the ponderosa pine and mixed conifer dominated vegetation zones are the dominant plant associations within the lower portions of the watershed.

Exhibit 10 Tumalo Creek Watershed Insect and Disease

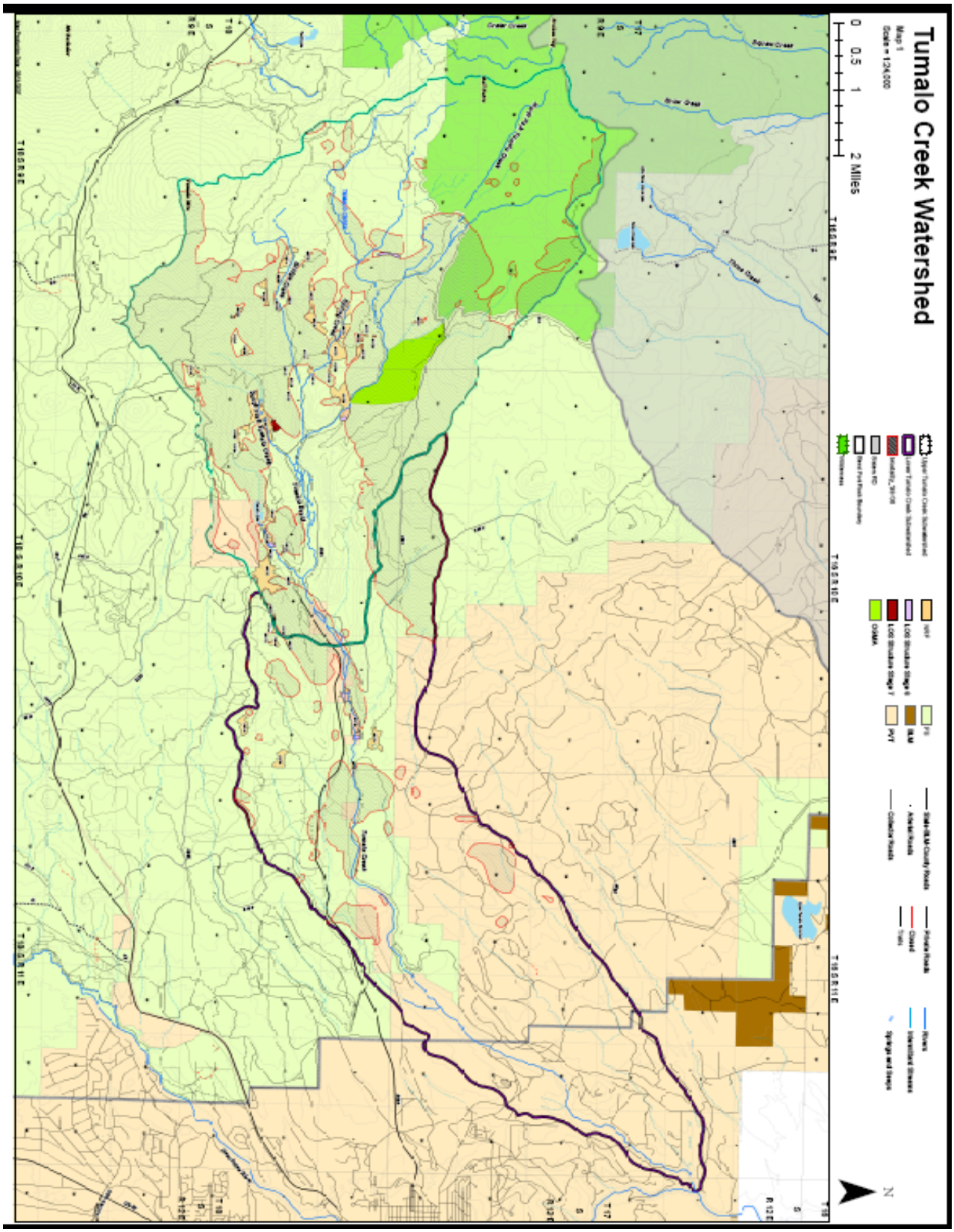


Table 9. Dominant Historic Disturbances by Plant Association Group (PAG)*

Potential Vegetation(Major PAG)	Dominant Disturbance Factors	Disturbance Regime Intensity	Average Disturbance Size/Patch Created (Ac)	Primary Geomorphic Zone	Typical Elevation Zone
Water	Floods	Low	1-100		3500'-8000'
Riparian and Meadow	Fire	Low	1-50	Valley bottoms and hanging basins	5500'
Alpine Meadow and Sparsely Vegetated	Fire	Low	1-50	Glaciated Uplands	7000'
Ponderosa Pine Dry/Wet	1)Fire 2) Insects and Disease	1) Low 2) Low	1) <5 2) <5	Upland Lava Plains	3500'-5500'
Lodgepole Pine Dry/Wet	1)Fire 2) Insects and Disease	1) High 1) High	1) 50-100 2) 10-1000	Plateaus and Basins at Elevations	5000'-6800'
Mixed Conifer Dry	1)Fire 2) Insects and Disease	1) Moderate 2) Low	1) 20-300 2) 1-5	Volcanic Highlands and Toeslopes	4200'-5600'
Mixed Conifer Wet	1)Fire 2) Insects and Disease	1) High 2) Moderate	1) 100-500 2) 100-500	Volcanic Uplands and Glacial Bottomlands	5000'-6200'
Mountain Hemlock	1)Fire 2) Insects and Disease	1) High 2) Low	1) 50-150 2) 50-200	Volcanic Uplands at Elevations	5700'-7500'

*Low severity disturbance regime: 1-25 year interval, 0-20 tree mortality;
Moderate severity disturbance regime: 26-100 yr. Interval, 21-70% tree mortality
High severity disturbance regime; >100 year return interval, >70% tree mortality

Root pathogens, in addition to insects have also contributed to landscape patterns and patches. As a root disease center expands, trees on the edges of openings become susceptible to infection and ultimate mortality. Over time, these openings may be colonized by species more resistant to the root disease, thus regenerating a new stand of different composition. Often, species presence, seed production and pathogen specificity limits the re-establishment of the created opening. Lodgepole pine and western white pine are shade-intolerant species typically more resistant to root pathogens that the shade-tolerant firs, thus allowing a mechanism that promotes species diversity over succession advance. Root disease pockets are casually observed in aerial photography within the

mountain hemlock zone. Fire patterns currently will differ greatly from historic patches and patterns, simply as a result of chronically increasing stand densities and fuel loadings.

Mountain Pine Beetle

The effects from mountain pine beetle activity continues to be the most significant agent of mortality in recent years. Large expanses of lodgepole pine stands have succumbed to these insect attacks, and mapping has occurred from the 1980's to present with shifting "hot spots" occurring each year. Lodgepole pine dry and wet plant association groups have been hardest to hit and interspersed mortality has shown up in the ponderosa pine dry, mixed conifer dry, and some high density mountain hemlock PAGs as well.

Cultural stand treatments can reduce the risk of epidemic beetle attacks before they occur. This necessitates the reduction of density levels to ensure that individual tree health and vigor is maintained. Stand regeneration to a new forest structure can also reduce the potential for beetle attack, and is most appropriate in lodgepole pin stands nearing the end of their natural lifecycles, whether from pathogens of high density stress. Salvaging dead lodgepole pine resulting from such beetle outbreaks can reduce the larger increase in fire hazard, but will not stop the outbreak, as stand conditions that favored the outbreak have not been altered elsewhere (Eglitis, 1996).

Western Pine Beetle

Large diameter ponderosa pine are particularly vulnerable to epidemic attacks by the western pine beetle, especially within mixed confider dry PAGs. These trees are stresses by a variety of factors, yet this can be tied to competition for scarce resources. The vulnerability of loss from epidemic levels of bark beetles is correlated to growth rates and life cycles of ponderosa pine trees.

Older trees with thin crowns and slow growth rates are most likely to be attacked and killed by western pine beetle, and are typically found in highly dense stands.

Fir Engraver

The fir engraver is a bark beetle that attacks most fir species in the western United States. Most susceptible are the true fir species found within the mixed conifer dry and wet PAGs. Mass attacks occur coincident with drought conditions, and precipitation zones are key to understanding fir mortality management risk. Annual precipitation of 20 to 25 inches defines an extreme risk of white fir attacks by the fir engraver. These are typically fir trees at the lower end of their elevation range and generally conform to mixed conifer dry PAGs. In typical non-drought years, most fir engraver attacks occur in conjunction with root disease agents. Silvicultural treatments that maintain trees in a healthy, vigorous state will often minimize stand mortality risk and manage the fir engraver at endemic population levels.

Douglas Fir Beetle

The Douglas fir beetle, a large bark beetle, is similar to the mountain pine and western pine beetles in life cycle. This beetle infests trees damaged by windfall, fire or other disturbance event and attacks Douglas fir trees, particularly those found within the mixed conifer dry PAGs. Outbreaks are typically sporadic and of short duration, yet are likely to kill large numbers of trees. Damage is greatest in dense stands of mature Douglas fir trees (Eglitis 1997).

Western Spruce Budworm

Douglas fir and white fir are the tree species most at risk to western spruce budworm infestations. Conditions that favor outbreaks are large expanses of nearly pure host trees, primarily those with multi-layered canopies and host stands on warm, dry sites. Silvicultural practices that maintain trees in a healthy and vigorous condition will tend to reduce the risk to tree composition and move to more seral species also helps in minimizing the risk of epidemic budworm attacks.

Armillaria

Armillaria root disease can exist as a saprophyte on dead woody material for decades or as a lethal tree parasite. Armillaria spreads from colonized stumps or infected trees to nearby healthy trees. Tree species have varying amounts of resistance to the disease due to natural biochemistry. Resistance fades however when the tree is under stress, creating pockets of mortality, or in some cases wiping out an entire stand over time. Stress elements include overstocking, drought, and soil compaction.

Effects from armillaria are mixed. It creates canopy gaps and snags that are representative of a late-successional forest during the early phases of the disease. These conditions are considered ideal for the prey base of the spotted owl. As mortality increases in distribution and abundance, an opening is created that is no longer at a scale suitable for owl foraging. Unless resistant species are established or introduced, the opening is likely to persist for decades.

Annosus Root Disease

Annosus root disease spreads from colonized stumps from windborne spores that germinate following disturbance, typically logging. Secondary attacks by bark beetles often follow initial infections. Disease centers usually focus around old infected stumps, but also can be from wounds on live trees. Host trees are pine, mountain hemlock and true fir.

White Pine Blister Rust

This fungal disease was introduced into North America in the early 1900’s from Europe with host species for white pine blister rust being the five-needled pines (includes

western white pine and whitebark pine). Ribes species (gooseberry plants) are the alternate hosts for the disease, providing the mechanism for blister rust infections. This blister rust is currently infecting western white pine trees that are a minor component of stands within the mixed conifer and mountain hemlock zones of this watershed.

Dwarf Mistletoe

Dwarf mistletoe is found within the mountain hemlock, mixed conifer, lodgepole pine, and ponderosa pine types and is ubiquitous within the watershed. Native to this region, these parasites have increased in distribution and abundance as a result of fire suppression, and selective harvest practices during the past century, the distribution and intensity of mistletoe has no doubt substantially increased over time.

Heavy infections of mistletoe slow tree growth, compounding over time to the point where it may not be possible to grow stands that exhibit characteristics of large, old trees. Silvicultural treatments that are effective in reducing or controlling dwarf mistletoe include thinning, retaining mistletoe-free trees, pruning, mistletoe over story removal and species replacement.

Other Agents of Change

Several other disturbance agents of concern exist within the watershed, including Doug fir tussock moth, Pandora moth, and laminated root rot, and windstorm, but are not discusses in this section. The reader is encouraged to review the Cascade Lakes Watershed Analysis and/or the Cultus/Sheridan LSR Assessment (Deschutes National Forest, 1995/1996) for more detailed descriptions.

Landscape Area Descriptions of Current Conditions

The existing vegetation condition in this section has been summarized from aerial photo interpretation effort, using photography taken in 1995. Vegetation assignments were made, on a stand basis, for tree species, structural or developmental stage, and stand density, made on a stand basis, for tree species, structural or developmental stage, and stand density. This photo-interpreted data was used to classify the entire watershed area into one landscape summary, from which to describe the major conditions and trends. Similarly, reference conditions were estimated in order to establish a general picture of probable landscape conditions under native disturbance regimes, prior to European settlement (circa 1850-1910). This procedure, termed historic range of variability (HRV) analysis, was completed using a successional pathway model to establish likely reference points. For information on methods used to characterize the landscape environment, see the appropriate chapter in the appendices of this report.

Current Cover Types and Structural Stages

To establish a picture of the current condition of forested vegetation, cover type and structural stage is and structural stage is added to the underlying PAG foundation. The

utility of this approach is for: 1) further exploration of current landscape in terms of existing species composition and structure; and 2) to establish a baseline of the most likely past structures and general composition (e.g. Historic Range of Variability of HRV estimates) to see how far the landscape has departed from out understanding of the natively-evolved landscape of the past. Note that the second item requires that a good deal of assumptions be made (See Table 8 and Exhibit 9).

Table 10. Existing Forest Structural Stages by Plant Association Group (Percentage)

Major PAG	% of Total Landscape	Dominant Tree Species Coverage	Open Areas	Early Structure	Mid Structure	Late Structure
PPD/W	14%	Ponderosa Pine Dry/Wet	5%	1%	62%	33%
MCD	14%	Mixed Conifer Dry	0%	20%	60%	20%
MCW	20%	Mixed Conifer Wet	1%	37%	49%	13%
LPD/W	13%	Lodgepole Pine Dry/Wet	1%	2%	47%	50%
MHD	29%	Mountain Hemlock Dry	6%	6%	48%	40%
MDW/RIP	1%	Mesic/Wet Shrublands	46%	5%	31%	17%
ROCK/CINDER	3%	Rock	100%	0%	0%	0%
Landscape Totals	100%		10%	13%	48%	29%

Vegetation Summary by Landscape Areas:

The following narrative characterizes the entire four sub-watershed area into 6 Landscape Areas, in a summary of existing vegetation condition.

<u>Landscape Area 1: Wilderness-</u>

Fire suppression has allowed more stands to age without substantial disturbance. As a result, many more acres have advanced to late structural stages. Additionally, meadows

have been encroached upon by lodgepole pine and mountain hemlock trees, in the absence of disturbance.

Landscape Area 2: Cold Forest/ Un-roaded-

Similar to Landscape Area 1, stands continue to advance in age in the absence of disturbance. For the mountain hemlock stand, less openings remain relative to the historic condition, and about twice as much late/old structural stages are added through the years. Fire suppression remains the major reason for this long term shift to old, dense forest types.

Landscape Area 3: Bridge Creek

Much like Landscape Area 2, the dominant forest structure is one of late/old composition. Meadow encroachment by conifers continues in the absence of disturbance. The relatively recent Bridge Creek burn is the one exception to this continuous advancement of forested stands, as roughly 5 percent of this landscape area was recycled to open and early stages about 30 years ago.

Landscape Area 4: Front Country/Transition

Predominately mid-structural stages throughout, this area represents a dramatically different composition of forest vegetation than the primitive watershed conditions (above) and heavily manipulated portions (below). The Bridge Creek Fire set succession back to pen and early conditions on over 15 percent of this portion, and remnant old forest conditions exist on another similar acreage. However, a full two-thirds of the landscape area resides in middle-aged, medium-sized forest stands, due to a combination of factors. Previous, selective harvesting of large, old trees during the past century has reduced acreage of late and old structures stands in the ponderosa pine and mixed conifer dominated stands. Perhaps more impactive has been the suppression of fire and subsequent insect epidemics of mountain pine beetle that have recycled many acres of late/old lodgepole pine stands, allowing an understory of mountain hemlock and/or white fir to flourish. It is thought that periodic fires would have replaced these stands, perhaps at an infrequent, but high intensity fire cycle. In the continued absence of fire, these hemlocks to a lesser degree true fir, stands will continue to advance successional, and a greater proportion of the landscape will grow into late/old structure, if insect and disease agents remain endemic.

Landscape Area 5: Private/Dry Forest

This portion of the landscape has seen tremendous change from the historic condition, as the majority of acres are in the mid structural stages at present. Timber harvest and thinning has profoundly reduced the average size and density of trees throughout this area, with virtually a 10-fold reduction in late and old forest structure, particularly in ponderosa pine stems. Continued fire suppression and harvest/thinning will continue to

reduce the acreage in early and old forest structures, dependant upon target tree stocking densities and stand rotation lengths.

Landscape Area 6: Dry Forest

Much like Landscape Area 5, this area has seen profound reductions in the amount and distribution of late/old structural stages, to the tune of about a five-fold reduction.

Insect and Disease (I&D) Since 1998

Since the previous analysis done in 1998, insect and disease activity has continued to increase in the analysis area (See Exhibit 10, mortality data mapped from 1998-2006). Since 1998, insect and disease activity has affected 21% of the total acres in Upper Tumalo Creek (9391 acres) and 49% of the total acres in Lower Tumalo Creek (2907acres) sub-watersheds (12, 293 acres - 36% overall). An obvious cause for the higher percentage of insect and disease activity in Upper Tumalo Creek is that fewer density management activities have occurred in this higher elevation, more inaccessible area. Much of the Upper Tumalo Creek sub-watershed is wilderness or un-roaded area. With the increased stress on the trees caused by drier conditions in the past decade, these denser, older structural stage stands in Upper Tumalo Creek are also more susceptible to insect and disease caused mortality. In Lower Tumalo Creek, all PAGS are at continued risk of insect and disease caused mortality; mortality is heaviest in the MCW and LPD/W PAGs. **Note:** A minimum of only 1 tree/4acres triggers the determination that an area has been affected by I&D.

Stand Density Classes:

Stand density has also been classified for the landscape, although there is currently no readily available method to reference existing conditions to the historic. Nonetheless, in the absence of fire disturbance, stands gained higher densities in many areas but mountain pine beetles have reduced densities on other large areas.

Summarizing Conditions to Landscape "Zones"

The following discussion on vegetation collapses the 6 landscape areas into 3 distinct landscape area zones each dominated by a different forest vegetation composite. For each landscape zone the major plant communities are discussed, along with a quantitative estimate of their coverage within the zone. Use of the 3 zones is done in an effort to broadly characterize the 4 watershed areas into discrete biophysical environments that offer strikingly different conditions of vegetation and wildlife habitat, as well as distinct opportunities for management.

In summary, the 6 landscape areas are readily collapsed into 3 landscapes zones, based on their inherent similarities or differences. As they are all dominated by late/old structures of mountain hemlock and mountain hemlock-lodgepole pine mixtures, landscape areas 1, 2, and 3 are combined into Landscape Zone A. Landscape Area 4 remains a distinct

identity and is labeled Landscape Zone B. Landscape Areas 5 and 6 have similar plant associations and species mixtures (decidedly ponderosa pine) and management history (extensive timber harvests), and are combined into a singular Landscape Zone C.

Landscape Zones in Detail
Zone A (wilderness, Cold Forest/ Unroaded, Bridge Watershed Landscape Areas)

Mountain Hemlock (MHD PAG)

Descending down slope, mountain hemlock becomes the dominant vegetation type. This type is characterized by dense stands with closed canopies of pure mountain hemlock to stands with mixes of tree species where mountain hemlock will still be the dominant or co-dominant tree. The latter stands also have dense canopies. Structurally the majority of the mountain hemlock type exhibits a range of diameters at breast height (DBH) from 9 to 21 inches are multi-sized and multi-storied. Old growth encompasses both older forest of early seral species, such as fire dependant species, and forests in later successional stages dominated by shade tolerant species. Mountain hemlock is not considered a highly-desired commercial timber species and is found throughout the dispersed recreation and Bend Municipal Watershed management areas. This PAG is found on all aspects within an elevation band of about 6,000 to 7,500 feet.

Sparsely Vegetated (inc. ROCK, RIP, Alpine Shrub/Meadow PAGs)

Sparsely vegetated areas within this analysis are located predominately at the highest elevations within the sub-watersheds, along the slopes of the Cascade Crest. Included within these are areas of rock ad grass. Shrubs and trees found within this area will often be of an old age and very stunted in form and growth due to the extreme weather conditions at this elevation. The sparsely vegetated area is predominately within the Three Sisters Wilderness Area, at elevations above 7,000 feet.

Also note that riparian areas flow through the sparsely vegetated types, the mountain hemlock types, the mixed conifer types, and the Bridge Creek burn. At higher elevations mountain hemlock will encroach upon meadow openings as a part of the native ecological process, namely forest succession. At lower elevations, lodgepole pine will readily advance into meadow areas. In both cases, the lack of disturbance events such as fire, make the way for succession to proceed.

Lodgepole Pine (LPD and LPW PAGs)

The lodgepole pine PAGs are located mainly within an elevation band of 5,800 to 6,800 feet with some stands located as low as 5,200 feet. This is considered high elevation lodgepole and given the natural disturbance and succession processes, the lodgepole will probably be replaced over time by mountain hemlock and/or true fir species. The majority of the lodgepole type is mapped as pure lodgepole stands and includes mixes of lodgepole and fir species within other stands. Structurally the lodgepole pine is a mix of pole size (5 to 9 inches DBH) multi-sized low density stands and pone size DBH’s in

single storied stands. Many of these structures appear to be of second growth vegetation characteristics.

Mixed Conifer (MCD and MCW PAGs)
The mixed conifer type is composed of a mix of species cover that includes white fir, Douglas fir, mountain hemlock, and lodgepole pine. Occasionally, western white pine and to a much lesser degree, western larch trees, either individually or in patches are found in this zone. These plant associations occur both on north and south aspects and will show differences in stand densities, crown and canopy cover, and species mixtures between aspects. Ponderosa pine is found within the mixed conifer zone at the lowest elevations, which are typically on slightly drier sites. At higher elevations on drier site though, ponderosa pine is a very minor component if present at all. Structurally, the mixed conifer canopy covers of 25 to 75 percent with the majority canopy cover classes towards the low to mid percentage range. Stands are multi-sized and multi-storied with a small number of stands in the multi-sized low density class, meaning a more open stand condition. A portion of the mixed conifer stands show second growth type characteristics and some show more late to old growth characteristics. Old growth structures encompass both older forest of early seral species such as fire dependant species and forests in later successional stages dominated by shade-tolerant species. Included within this mixed conifer zone are timber harvest units that have been planted or naturally regenerated. The mixed conifer has an elevation range of 5,200 to 6,800 feet with some patches found as high as 7,800 feet.

Zone B (Front Country/ Transition Landscape Area)

Mixed Conifer (MCD and MCW PAGs)
The mixed conifer type becomes the dominant plant association found within this land zone and is composed of a mix of species cover that includes white fire, Douglas fir, mountain hemlock and lodgepole pine. Occasionally, western white pine and, to a much less degree, western larch trees are found here. These plant associations occur both on north and south aspects and will show differences in stand densities, crown and canopy cover, and species mixtures between aspects. Ponderosa pine is found within the mixed conifer zone at the lowest elevations which are typically on slightly drier sites. However, at higher elevations on drier sites, ponderosa pine is a very minor component, if present at all. Structurally, the mixed conifer type is composed of mixed of small diameter to large diameter trees (5 to 21 inches DBH) and canopy covers of 25 to 75 percent with the majority canopy cover classes towards the low to mid percentage range. Stands are multi-sized and multi-storied with a small number of stands in the multi-sized low density class, meaning a more open stand condition. A portion of the mixed conifer stands show second growth type characteristics and some show more late to old growth characteristics. Old growth structures encompass both older forests of early seral species, such as fire dependent species, and forest in later successional stages dominated by shade tolerant species. Included within this mixed conifer zone are timber harvest units that have been planted or naturally regenerated. The mixed conifer has an elevation range of 5200 to 6800 feet with some patches found as high as 7800 feet.

Lodgepole Pine (PPD and LPW PAGs)

The lodgepole pine PAGs are located throughout this zone at generally an elevation band above 5,000 feet. Similar to Zone 1, this is considered high elevation lodgepole pine and given natural disturbance and succession process, the lodgepole will probably be replaced over time by true fir species or mountain hemlock. The majority of the lodgepole type is mapped as pure lodgepole stands and includes mixes of lodgepole and fir species within other stands. The lodgepole pine stands are of various sizes (averaging 5 to 9 inches DBH), multi-sized, low density stands and pole size DBH's in single storied stands. Many of these structures appear to be remnant stands following mountain pine beetle outbreak activity over the past few decades.

Mountain Hemlock (MDH PAG)

Mountain hemlock dominance drops away in this zone, as it becomes less of a dominant forest type. The closed canopies of pure mountain hemlock give way to the mixtures of lodgepole pine-hemlock, and lodgepole pine-true fir. The majority of the mountain hemlock type exhibits a range of diameters at breast height (DBH) from 9 to 21 inches are multi-sized and multi-storied. Old growth encompasses both older forests of early seral species, such as fire dependant species, and forests in later successional stages dominated by shade tolerant species.

Riparian (RIP and ROCK PAGs)

Riparian features and rock outcrops make up the remainder of acres within this zone. Within this analysis area, riparian zones include meadows, lakes and perennial stream courses. The riparian flows through the mountain hemlock, the mixed conifer, the Bridge Creek Fire Area, and the ponderosa pine communities. Associated with the mixed conifer and riparian communities along the Bridge Creek Fire Area are Engelmann spruce bottomlands.

Zone C (Private/ Dry Forest, Dry Forest)

Ponderosa pine (PPD and PPW PAGs)

The ponderosa pine PAGs are located entirely within this zone at generally an elevation band generally below 4,800. The majority of the ponderosa pine type is mapped as pure ponderosa pine stands and will include mixes of lodgepole pine and white fir species sporadically. The ponderosa pine stands are of rather uniform size (averaging 7 to 12 inches DHB) and structure (mid-structural stage). As the majority of this zone is in private industrial, forestry ownership, these are typically of low density and are single storied stands. Many of these structures appear to be remnant stands following commercial timber harvesting in the first half of the 20th century.

Mixed Conifer (MCD and MCW PAGs)

The mixed conifer type fades to being the minor plant associations found within this land zone. It is composed of a mix of species cover that includes white fir, Douglas fir,

mountain hemlock and lodgepole pine. Occasionally, western larch trees are found in these communities. These plant associations occur both on north and south aspects and will show differences in stand densities, crown and canopy cover, and species mixtures between aspects. Structurally, the mixed conifer type is composed of mixes of small diameter to large diameter trees (5 to 21 inches DBH) and canopy covers of 25 to 75 percent with the majority canopy cover classes towards the low to mid percentage range. Stands are multi-sized and multi-storied with a small number of stands in the multi-sized low density class, meaning a more open stand condition. A portion of the mixed conifer stands shows second growth characteristics. Old growth structures encompass both older forests of early seral species such as fire dependant species, and forests in later successional stages dominated by shade tolerant species. Mixed conifer stands within this land zone have an elevational range of 4800 to 5500 feet with some patches found as high as 6600 feet.

Riparian (RIP ROCK and Shrub PAGs)
Riparian areas within this zone flow through ponderosa pine and mixed conifer dominated plant communities. The canyon that Tumalo Creek flows through in the lower portion of the watershed area is a good example of riparian vegetation that is confined to a narrow zone. Species diversity increases within this zone, and tree species expand beyond the common ponderosa pine to include Douglas fir, western larch, and quaking aspen. This type of plant associations are readily seen in waling through the lower portion of the canyon at Bend's Shevlin Park.

Landscape Patterns and Patches

Meadow and rock areas are easily identified patched within the sub-watersheds. Most meadows are located within the higher elevations along the fringe between the sparsely vegetated and mountain hemlock areas. The rock areas occur mainly at the highest elevations and are pronounced geological feature. In addition, rock outcrops are readily visible within the Bridge Creek Fire Area.

Definitive vegetation landscape patterns and patches are somewhat difficult to define within the sub-watersheds. Infrequent native fire regimes have allowed for much of the vegetation types to begin development of old growth structural characteristics. This is especially so for undisturbed portions of the watersheds above 6,000 feet elevation. Patch patterns are minimal except for changes in vegetation structure and changes in canopy densities due to past defoliator pests. No large areas of mortality have been found that would contribute to discernible vegetation pattern changes.

Overall within the watershed, meadow areas, rocky areas, sparsely vegetated areas and the Bridge Creek burn are the only contributors to noticeable landscape pattern changes and patch patterns. Defoliators and bark beetle outbreaks create less noticeable changes unless these pests occur in epidemic proportions and major mortality occurs to create open areas. Timber sale units located in the southeast portion of the Forks watershed have created openings within the mixed conifer forest type that is drier and supports more ponderosa pine. These openings have been planted or are naturally regenerated.

Most Recent Historic Information

Bridge Creek Fire: the fire started on July 24, 1979 and burned a total of 3,364 acres. Of this approximately one-half of the acres are within the Upper Tumalo sub-watershed, which is relatively pristine. Current mapping describes the potential vegetation for this area as mixed conifer. The intensity of the fire moved the vegetation from a mixed conifer mid/late/old growth stage to an early seral stage. Due to the variety of tree species planted and the intensity of grass seeding, de facto plant associations are difficult to define. For this reason, the fire has been split out as its own group with no associated vegetation attached (Deschutes NF, 1995).

Additional Fire Information-rehabilitation efforts began immediately. Aerial grass seeding of annual rye grass was accomplished by mid-August 1979. Ten pounds of grass per acre seeded over the entire area except within the Bend Municipal watershed which received 20 pounds per acre. Fertilization was completed after grass seeding to increase the vigor of annual rye germination and growth. Non-fertilization corridors were left along perennial streams. A perennial grass mix was also applied to the Bend Municipal watershed prior to the first snowfall. Debris was removed from Bridge Creek using helicopters due to lack of road access to the area. Log terraces were installed on 22 acres along Bridge Creek and resulted in 63 percent effectiveness of retarding sediment movement. The remaining terraces were either partially effective or did not experience sediment flow. Planting began in the spring of 1980 and continued over the next few years. Species planted included ponderosa pine, lodgepole pine, white pine, and Douglas fir. Species regenerating naturally include white fir, Engelmann spruce, mountain hemlock, and lodgepole pine. Native hardwood species were planted into the riparian areas including thinleaf alder, willow, aspen, black cottonwood, currant, red elder and serviceberry.

TERRESTRIAL WILDLIFE SPECIES

HISTORIC AND CURRENT CONDITIONS

Landscape Zone A (Wilderness and Cold Forest/ Unroaded Landscape Areas)

The wilderness and unroaded areas provide contiguous habitats mainly by natural disturbances (insect outbreaks, fire, etc.). Habitats within these landscape areas are similar to historic conditions, with the exception of increased stand density, increase in LOS acres and a lack of small openings, all of which have resulted from fire suppression. The most prominent change in direct human interaction in this portion of the watershed is the increase in recreational use. Although use many be considered light in relation to other areas of the District, the level of human activity may be significant enough o displace some species, such as wolverine, that avoid any type of human presence.

Landscape Zone B (Front Country/Transition Landscape Area)

This zone represents the middle elevations between the intensively managed Landscape Zone C and the relatively unmanaged, primitive Landscape Zone A. Here, forested vegetation is a mixture of mountain hemlock, lodgepole pine, and mixed conifer stands. Forest structure is predominately mid-structural stage (51%), with 19% of the Zone in early, and 30% in late and old structure. Historically, there was probably much less mountain hemlock represented with more of an equitable distribution of structural stage percentages. Fragmentation is low to moderate throughout most of the zone (and may be lower than what occurred historically) with Bridge Creek Fire and scattered timber harvest units accounting for most breaks in forested continuity. Road densities are higher than Zone A, but still much lower than Zone C. Recreation activity is moderate to high and includes such activities as hunting, fishing, mountain biking, cross country skiing, and snowmobiling.

Landscape Zone C (Private/Dry Forest and Dry Forest Landscape Areas)

The lower elevations of the watershed consist primarily of ponderosa pine wet and dry communities, with less amounts of mixed conifer, lodgepole pine, and juniper stands. Historically this area was dominated by ponderosa pine, the majority of which (80%) was in late and old structural condition with understory species and densities governed by low intensity, short return fire intervals. Tree spacing was variable, with most mature stems being in small (1/2 to 2 acres) clumps. Under the current condition, a vast majority of acres (62%) are mid-structure with little variation in stem spacing. Road densities are highest in this portion of the watershed, with densities exceeding 5 miles per square mile. Recreation intensity is light to moderate. Much of this zone consists of mule deer winter range.

TES, Proposed, Candidate and Selected Species Analysis

Wildlife species represented in this assessment include those given federal status (threatened, endangered, sensitive, proposed and candidate species) that are known to inhabit or potentially inhabit the watershed. Also included are selected species with special status that are also known to occur or have the potential to occur within the watershed. These are management indicator species (MIS) as designated in the Deschutes National Forest Land and Resource Management Plan, and species characterized as Birds of Conservation Concern (BCC) by the U.S. Fish and Wildlife Service, and Landbird Focal Species from the Conservation Strategy for Landbirds of the East-Slope of the Cascades.

Table 11a. Tumalo Watershed Listed Species and their Status, Habitat, and Presence.

Species	Status	Habitat	Presence
Northern Spotted Owl	Federal Threatened, MIS	Old growth mixed conifer forests	Suitable habitat occurs within the watershed.
Oregon Spotted Frog	Federal Candidate	Stream, marsh	Potential habitat occurs within the watershed.

Table 11b. Tumalo Watershed Regional Forester's Sensitive Species and their Status, Habitat and Presence.

Species	Status	Habitat	Presence
Birds			
Northern Bald Eagle	Regional Sensitive, MIS	Lakeside or riverside with large trees	Potential habitat occurs within the watershed.
American peregrine falcon	Regional Forester Sensitive, BCC	Riparian, cliffs	Potential habitat occurs within the watershed.
Lewis' woodpecker	Regional Forester Sensitive, MIS, BCC, Landbird focal species	Open ponderosa pine forests, large diameter dead or dying trees, burned forests	Potential habitat occurs within the watershed.
White-headed woodpecker	Regional Forester Sensitive, MIS, BCC, Landbird focal species	Mature ponderosa pine forests; weak excavator	Potential habitat occurs within the watershed.
Mammals			
California wolverine	Regional Forester Sensitive	Mixed conifer habitat, high elevation	Potential habitat occurs within the watershed.
Pacific fisher	Proposed Federal Candidate, Regional Forester Sensitive	Mixed conifer forest, complex forest structure	Suitable habitat occurs within the watershed.
Western big-eared bat	Regional Forester Sensitive, MIS	Caves and old dwellings	Potential habitat occurs within the watershed.
Invertebrates			
Crater Lake Tightcoil	Regional Forester Sensitive	Wet vegetation zone	Suitable habitat occurs within the watershed.
Silver-Bordered Fritillary	Regional Forester Sensitive	Wet meadows, bogs, and marshes	Potential habitat occurs within the watershed.
Johnson's Hairstreak	Regional Forester Sensitive	Coniferous forests, especially old growth	Potential habitat occurs within the watershed.

Table 11c. Management Indicator Species, Focal Bird Species, and Birds of Conservation Concern, their Status, Habitat, and Presence.

Species	Status	Habitat	Presence
Birds			
Golden eagle	MIS, BCC	Large open areas with cliffs and rock outcrops	Suitable habitat occurs within the watershed.
Red-tailed hawk	MIS	Large snags, open country interspersed with forests	Suitable habitat occurs within the watershed.
Northern goshawk	MIS	Mature and old-growth forests; especially high canopy closure and large trees	Suitable habitat occurs within the watershed.
Cooper's hawk	MIS	Similar to goshawk, can also use mature forests with high canopy closure/tree density	Suitable habitat occurs within the watershed.
Sharp-shinned hawk	MIS	Similar to goshawk in addition to young, dense, even-aged stands	Suitable habitat occurs within the watershed.
Osprey	MIS	Large snags associated with fish bearing water bodies	Potential habitat occurs within the watershed.
Great gray owl	MIS	Mature and old growth forests associated with openings and meadows	Potential habitat occurs within the watershed.
Flammulated owl	BCC, Landbird focal	Interspersed grassy openings	Suitable habitat occurs within the

Species	Status	Habitat	Presence
	species	and dense thickets in mixed conifer forests	watershed.
Pileated woodpecker	MIS	Mature to old-growth mixed conifer forests	Suitable habitat occurs within the watershed.
Northern flicker	MIS	Variety of forest types but more associated with forest edges	Suitable habitat occurs within the watershed.
Hairy woodpecker	MIS	Mixed conifer and ponderosa pine forests	Suitable habitat occurs within the watershed.
Downy woodpecker	MIS	Riparian hardwood forest	Suitable habitat occurs within the watershed.
Black-backed woodpecker	MIS, Landbird focal species	Lodgepole pine forests, burned forests	Suitable habitat occurs within the watershed.
Northern three-toed woodpecker	MIS	High elevation and lodgepole pine forests	Suitable habitat occurs within the watershed.
Red-naped sapsucker	MIS, Landbird focal species	Riparian hardwood forests	Potential habitat occurs within the watershed.
Williamson's sapsucker	MIS, BCC, Landbird focal species	Mature or old growth conifer forests with open canopy cover; weak excavator	Potential habitat occurs within the watershed.
Great blue heron	MIS	Riparian edge habitats including lakes, streams, marshes and estuaries	Potential habitat occurs within the watershed.
Blue grouse	Landbird focal species	Subalpine fir	Suitable habitat occurs within the watershed.
Clark's nutcracker	Landbird focal species	Mature/old-growth Whitebark pine	Potential habitat occurs within the watershed.
Pygmy nuthatch	Landbird focal species	Mature ponderosa pine forests and snags	Potential habitat occurs within the watershed.
Chipping sparrow	Landbird focal species	Open understory ponderosa pine forests with regeneration	Suitable habitat occurs within the watershed.
Brown creeper	Landbird focal species	Large trees in mixed conifer forests	Suitable habitat occurs within the watershed.
Hermit thrush	Landbird focal species	Multi-layered/dense canopy in mixed conifer forests	Suitable habitat occurs within the watershed.
Olive-sided flycatcher	Landbird focal species	Edges and openings created by wildfire in mixed conifer forests	Suitable habitat occurs within the watershed.
Mammals			
Rocky Mountain Elk	MIS	Mixed habitats	Suitable habitat occurs within the watershed.
Mule deer	MIS	Mixed habitats	Suitable habitat occurs within the watershed.
American marten	MIS	Mixed conifer or high elevation late-successional forests with abundant down woody material	Suitable habitat occurs within the watershed.

THREATENED, ENDANGERED, CANDIDATE, PROPOSED AND SENSITIVE SPECIES

Northern Spotted Owl

Historical Condition - Historic distribution and population numbers within the watershed are not known, however, populations would have been likely to inhabit areas dominated by mature or old growth conifer stands with complex structure including multiple canopy layers, large green trees and snags, heavy canopy cover, and ground level coarse wood material. Suitable nesting, roosting, and foraging (NRF) habitat would have been found in stands of mixed conifer, ponderosa pine with white fir understory, or mountain hemlock with sub-alpine fir where the overstory consists of large trees (generally greater than 20 per acre) 25 inched DBH or greater.

Estimates for historic range of variability (HRV) for stand types and structural stages within the watershed show that approximately 39% (22,546 acres) of the watershed would have supported plant association (PAGs) groups normally found in spotted owl habitat (See table 12). Of this 39%, about 53% (11,843 acres) is estimated to have been in late and old structure with multiple-storied canopy. Not all of these acres would have been suitable at any point in time (due to insect activity, fires, blow down, lack of suitable nest trees, etc.) but it could be assumed that at least 50 percent (7,200 acres) was suitable NRF habitat.

Table 12. Historic Conditions – Vegetation Type and Stand Structure (taken from the 1998 Bend WA Analysis)

Major PAG	% of Total Landscape	Dominant Species	HRV Open Areas	HRV Early Structure	HRV Mid Structure	HRV Late Structure
PPD/W	39	Ponderosa Pine	------	2,405	2,405	19,606
MCD	14	Ponderosa Pine	------	864	1,728	6,045
MCW	14	White Fir	------	1,728	3,886	3,022
LPD/W	13	Lodgepole Pine	------	2,405	3,609	2,005
MHD	15	Mountain Hemlock	------	1,388	5,089	2,776
Other	5	Wet Meadow, Shrublands, and Rock	154	------	------	------
Landscape Totals	100%		154 (0.2%)	8,363 (14%)	16,656 (29%)	33,312 (57%)
HRV Range			0-5%	10-20%	20-35%	40-65%

Actual fragmentation patch size and pattern would have varied widely, depending upon levels of precipitation, insect outbreaks, and lightning and Native American-caused fire ignition rates. Agee (1993) describes fire return intervals within the East Cascades as variable, but averaging between 10 to 60 years, depending on aspect and elevation. Fire intensity was normally low as these frequent fires removed understory ladder fuels and consumed material on the forest floor. An accumulation of fuels after a relatively long fire free period would have increased the potential for large acre events, but such large fires were more the exception. At higher elevations, fragmentation in mountain hemlock would have infrequent (300 to 500 years) large acre stand replacement fires. In summary, spotted owl habitat within the watershed historically would have been largely contiguous with small breaks in the canopy ranging from infrequent to frequent, and large breaks (greater than 100 acres) being infrequent.

Current Condition - Surveys have been conducted in the watershed in 2007 and 2008, with a detection of a pair in 2008. No nest or activity center was found with this pair. They were not found again after the initial detection. A response was heard by a spotted owl in the same general vicinity in 2005.

NRF habitats have been mapped in the watershed but field surveys to confirm condition/suitability have not been done. There are presently 2,559 acres of NRF designated in the watershed. About 80% of these acres have been affected by insect and disease.

Characterization of NRF habitat in the current condition is much more restrictive than for the historic condition due to the availability of more site specific data, therefore, direct comparisons in estimated acres of NRF are not necessarily valid. However comparisons in structural stage vegetation by PAG are available and serve as fairly good data for comparison.

To assess historic versus current condition habitat for spotted owls, late and old structural stage acres by suitable PAG will be used. Table 13 shows a total of 4,692 acres of late and old structure areas within the mixed conifer dry (MCD); mixed conifer wet (MCW) and mountain hemlock dry (MHD) vegetation types. In comparison, under the estimated historic condition 11,843 acres of late and old structural habitat existed in PAGs known to be suitable for spotted owl nesting, roosting, and foraging. This represents a net loss of 7,151 acres of potentially suitable habitat, all of which is accounted for within the mixed conifer PAGs. Given the tolerances for the accuracy of HRV analysis (+/- 15 percent) the change may be 6,078 acres or as much as 8,224acres. The main causes for the disparity in suitable habitat include timber harvest as well as the Bridge Creek Fire.

Table 13. Current Conditions – Vegetation and Stand Structure

Major PAG	% of Total Landscape	Dominant Species	Acres Open Areas	Acres Early Structure	Acres Mid Structure	Acres Late Structure
PPD/W	14	Ponderosa Pine	182	42	2,420	1,280
MCD	14	Ponderosa Pine	12	742	2,284	760
MCW	20	White Fir	67	2,056	2,669	703
LPD/W	13	Lodgepole Pine	54	57	1,705	1,847
MHD	29	Mountain Hemlock	507	492	3,873	3,229
MDW/RIP	1	Wet Grasses/forbs	147	17	100	54
MSHB	2	Wet Shrublands	131	45	207	46
ALSH/AMDW	4	Alpine Shrub/Meadow	834	112	126	26
ROCK/CINDER	3	Rock	893	0	0	0
Landscape Total	100%		2,827 (10%)	3,563 (13%)	13,384 (48%)	7,945 (29%)

Spotted owl dispersal habitat encompasses approximately 9,300 acres within the extent of acres governed by the Northwest Forest Plan on Forest Service lands. A majority of dispersal acres occur with in the Front Country/Transition Landscape Area, but stands suitable as dispersal within the central and northern portions of the Front Country/Transition Landscape Area are more scattered than those found in the southern

portion of the same Landscape Area as well as areas within the Cold Forest/Unroaded and Bridge Landscape Areas. Breaks in dispersal habitat continuity throughout the watershed were attributed to small-diameter stands, low canopy closures, timber harvest units, and the Bridge Creek Fire.

A majority of the watershed is managed under guidelines provided by the Northwest Forest Plan (NWFP). Owl Management allocations within the watershed include Congressionally Withdrawn, Administratively Withdrawn, and Matrix (see Table 14). There is no Critical Habitat Unit designated in the watershed, nor any Late Successional Reserves (LSRs), however, the Three Creeks and Sheridan LSRs lie in close proximity to the north and south, respectively (see Exhibit 4).

Table 14. Tumalo Creek Watershed – Northwest Forest Plan Allocations

NWFP Allocation	NWFP Acres Within the Watershed	NRF Habitat Acres
Congressionally Withdrawn Lands	4,418	0
Administratively Withdrawn Lands	12,155	2,121
Matrix	7,853	438
Riparian Reserve	5,415	--
Other Ownership	1,297	0
Totals	25,723	2,559

Trends- Past timber harvest along with the Bridge Creek Fire have reduced and fragmented portions of the watershed that may have been suitable NRF habitat. Barred owls continue to extend their range east, and are better adapted to more fragmented environments. They may also cross genetically with spotted owls and in doing so dilute the spotted owl gene pool. Insect and Disease has affected NRF habitat, reducing its effectiveness. Of the 2,559 acres of designated NRF in the watershed, only 432 acres remains unaffected.

According to the Final Recovery Plan for the Northern Spotted Owl (May 2008), this species is still at risk to decline, and the risk is substantial. In some cases (e.g. threats from the barred owl and catastrophic fire) is expected to increase, absent active management.

Oregon Spotted Frog

Historic Condition – Historically, this species probably did not inhabit much of the watershed given the lack of suitable habitat. The Oregon spotted frog inhabits the margins of lakes, marshes, and pools in streams where there is an abundant growth of vegetation (Csuti et al. 2001). Literature cited in the Conservation Assessment (Cushman and Pearl, 2007) describes spotted frog breeding habitat as moderate to large wetlands with extensive emergent marsh coverage that warms substantially during seasons when Oregon spotted frogs are active on the surface (February to May).

Although there have been no historic sightings, there is the potential that this species may have occurred on private land at Tumalo Lake. The history behind this lake, which was dammed to raise water levels prior to 1959, is mostly unknown. It was most likely a wetland/marshy area.

Current Condition – Most areas within and adjacent to the Tumalo Creek Watershed are characterized as non-habitat (Newton et al.1998) for Oregon spotted frogs. Potential habitat still exists at Tumalo Lake. No surveys to date have occurred at this site.

Trends- No trends within the watershed are identified for this species.

Northern Bald Eagle

Historical Condition - Historic bald eagle use within the watershed is not known. A lack of open foraging habitat would have restricted nesting and home range use. Deer winter range provides sporadic forage resources to bald eagles from mortality of fawns and older adults, which is generally in late winter or early spring, depending upon winter severity and duration.

Current Condition - Suitability for nesting is similar to historic condition. There is no known active nesting or roosting areas within the watershed. Lower elevation habitat may be used as forage sites during winters with significant deer mortality.

Trends - High grading of large diameter ponderosa pine at the eastern edge of the watershed has reduced the opportunity for winter roosting.

American Peregrine Falcon

Historic Condition -There is no known historic nesting sites within the watershed. A lack of suitable nesting and open foraging areas would have limited historical use by this species.

Current Condition – The Bridge Creek Fire exposed cliff sites that may serve as suitable nesting substrate for peregrine falcons and also created a large expanse of openness for foraging. To date, no active nest sites or individual sightings have occurred.

Trends - There is no trend specific to this watershed, but regional populations may be increasing. Pesticide bans along with juvenile hacking programs have led to higher reproduction rates and juvenile survival.

Lewis' Woodpecker

Historic Condition – Historical use by Lewis' Woodpecker in the watershed is not known. This species is closely associated with open forests, often at lower elevations. The species needs large dead or dying trees for breeding. Habitat would have most likely occurred after a large-scale fire, as this species has been characterized as a "burn specialist" because of its preference for nesting within burned pine forests (Saab and Vierling 2001).

Current Condition - No sightings have been recorded within the watershed. Current acreage of potential suitable habitat totals approximately 3,400 acres (Bridge Creek Fire area), although many of the large snags were removed when the fire was logged. Where large diameter ponderosa pine still exists at lower elevations, fire suppression has led to understory intrusions by various tree species that essentially creates unsuitable conditions

for Lewis' woodpeckers. At the same time, many areas are at risk to catastrophic fire, which would in turn help create additional habitat.

Trends – There is no trend specific to this watershed, but this species was recently listed as sensitive in Region 6. It is thought to be declining throughout its range, possibly due to loss of suitable habitat, prospects for nest and food storage trees, and competition for nest holes. Many areas within the watershed are at high risk for catastrophic fire, which could create additional habitat for this species.

White-Headed Woodpecker

Historic Condition - Documented provincial declines in numbers indicate historical populations to be greater than under the current condition. Historically, LOS ponderosa pine habitat (suitable for this species) had a wide distribution and high acre totals (19,600 acres) prior to timber harvest activities in the 1940's.

Current Condition - No sightings have been recorded within the watershed. Current acreage of suitable habitat totals approximately 2,040 acres. Where large diameter ponderosa pine still exists at lower elevations, fire suppression has led to understory intrusions by various tree species that essentially create unsuitable conditions for white-headed woodpeckers.

Trends-The dramatic decrease in LOS pine has greatly reduced areas of habitat suitable for this species. Unless large areas are allowed to return to late and old character, the future of this species within the watershed is uncertain.

California Wolverine

Historic Condition - Although historic population densities are unknown, wolverine were probably more abundant prior to European settlement. Historic distributions in the three Pacific western states extended from Canada, south throughout the forested portions of Washington, from central Oregon west to the coast, and throughout central and northern California. Heavy trappings in the early 1900's reduced or extirpated local populations. The essential component of wolverine habitat may be isolation and the total absence of disturbance by humans.

Current Condition - The wolverine is a shy, secretive species that requires large tracks of undisturbed sub-alpine communities where human presence is minimal. Recent sightings around Broken Top, Tam McArthur Rim, Benchmark Butte, Crane Prairie, and Cultus Lake indicate a moderate to high probability that wolverine inhabit the watershed, at least in a transitory fashion. Helicopter surveys for dens sites were conducted during the winter of 1998 by the Oregon Department of Fish and Wildlife within and adjacent to the watershed (within the wilderness). These surveys did not result in any sightings.

Trends - Wolverine populations were drastically reduced by trappings during the first half of this century, and may have been extirpated from much of its former range. The

species is believed to still occur in the Central Oregon Cascades, with populations believed to be stable. Increased recreation use within the watershed and surrounding areas, especially winter recreation, pose a threat to wolverine movement and distribution. The greatest impact on the potential of the land to support wolverine in the Pacific Northwest Mountains is forestry, settlement, and access (USDA 1994).

Pacific Fisher

Historic Condition - The Pacific fisher primarily uses mature, closed-canopy coniferous forests with some deciduous component, frequently along riparian corridors (Csuti et al. 2001). In Ruggiero et. al (1994), it is suggested fishers prefer closed-canopy (>60% canopy closure), late-successional forests with large physical structures (live trees, snags, and logs), especially if associated with riparian areas. With this in mind, suitable habitat most likely consisted of LOS stands in the mixed conifer wet and mountain hemlock wet and dry PAGs. Analysis of HRV shows about 5,800 acres of habitat historically.

Current Condition - Fur trappings during the early 1900 have decimated populations within Oregon and Washington. Extirpation from some areas is likely, while in others population densities have yet to recover and may not recover without substantial reintroduction efforts. There has been one known sighting within the watershed, which occurred in 2003.

Current suitable habitat is estimated at 3,900 acres, a decrease over historical conditions. Reasons for the decrease include catastrophic fire, past timber harvest, and insects and disease. High road densities also have a negative impact on fisher habitat. Although not as wilderness dependant as wolverine, fishers are usually characterized as species that avoids humans (Douglas and Strickland 1987).

Trends - Fishers generally avoid areas of high human disturbance either from road density or recreational developments. Increased recreation and human disturbance will have a negative effect on this species. Retention of roadless areas will aid in maintaining some viable habitat. Areas of current suitable habitat are at risk to loss by catastrophic fire, which would have a negative effect on this species as well.

Western Big-Eared Bat

Historic Condition - Historic condition of big-eared bat habitat and distribution was probably similar to current conditions.

Current Condition-There is no known caves within the watershed. Western big-eared bats have been known to utilize dwellings for hibernation and/or roosting. Potential habitat does exist in the Skyliner lodge, although there have been no reports of this species there.

Trends- No trends within this watershed are identified for this species.

Crater Lake Tightcoil

Historic Condition - This snail can be found in suitable wet habitat on the undersides of woody debris, among wet mosses, rushes and other low vegetation at the edges of wetlands, springs, seeps and streams and in perennially damp forest floor litter, especially where it has accumulated at the bases of shrubs and against logs (Duncan et al 2003). Habitat likely occurred adjacent to most creeks and springs within the watershed. Historical levels and population distribution are unknown.

Current Condition – Current habitat conditions have changed from historic conditions. The Bridge Creek Fire, harvest activities, and recreation have all changed some of the habitat conditions required for this species. The fire and harvest treatments have removed log debris that would have remained within close proximity to the creeks and springs that occur in the area. Recreation has trampled vegetation in many areas adjacent to the streams, creating unsuitable habitat. Although there has been some change, this species is known to occur along the Tumalo Creek drainage and springs that flow into it.

Trends- No trends within this watershed are identified for this species.

Silver-Bordered Fritillary

Historic Condition – This species **i**nhabits wet meadows, bogs, and marshes. Historic habitat conditions may be less than current conditions. Historically, approximately 154 acres of wet meadow habitat conditions occurred.

Current Condition –Current estimates show that there is approximately 254 acres of wet meadow type habitat within the watershed, greater than historic levels. The Bridge Creek Fire may have increased areas of meadow habitat. Surveys have not been conducted for this species within the watershed and it is unknown if it occurs.

Trends- There is the potential for reduction of habitat as conifers continue to encroach on some of the wet meadow habitats.

Johnson's Hairstreak

Historic Condition - This butterfly species can be found in coniferous forests, especially old growth. The caterpillar host is the pine dwarf mistletoe (*Arceuthoblum campylopodum*) that grows on conifers. Historically, there were approximately 28,743 acres of potential suitable habitat for this butterfly species. Although there was a larger percentage of old grow habitat, historically, mistletoe may have occurred less frequently due to more frequent fires.

Current Condition – Currently, there are approximately 2,743 acres of potential suitable habitat. The mistletoe parasite has increased in distribution and abundance over historical levels as a result of fire suppression and selective harvest practices over the past

several decades, increasing potential habitat across this smaller acreage of potential habitat.

Trends- No trends within this watershed are identified for this species.

MANAGEMENT INDICATOR SPECIES

Management indicator species (MIS) are those species that are selected because its welfare is presumed to be an indicator of the welfare of other species in the habitat. It is also a species whose condition can be used to assess the impacts of management actions on a particular area.

Great Blue Heron

Historic Condition -This species breeds along estuaries, streams, marshes, and lakes throughout Oregon (Marshall et al. 2003). Historical use within the watershed is not known, but it is suspected that this species occasionally used some of the stream systems for foraging.

Current Condition – Current conditions are probably similar to those historically. There are no known sightings within the watershed, but it is suspected that they occasionally utilize the area for foraging.

Trends – There is no trend specific to this watershed. Regional populations appear to be stable.

Raptors

Golden Eagle

Historical Condition - Preferred habitat consisting of open forest and desert shrub conditions was probably lacking, with the exception of the occasional large-scale fire that would have created openings suitable for foraging. Most historic use likely occurred at the eastern fringe where ponderosa pine stands mingle with juniper and desert shrub.

Current Condition-A lack of large diameter pine along the eastern fringe of the watershed has reduced nesting habitat suitability in that area. Active nesting has been reported along the cliffs within the Bridge Creek Fire Area. It is not known whether these birds are using this area for foraging or venture out to the desert for food.

Trends- Habitat trends for the golden eagle within the watershed are uncertain and can only be clarified after identifying locations of forage areas. If the birds are foraging primarily within the Bridge Creek Fire Area, stand succession will soon reduce foraging effectiveness.

Red-Tailed Hawk

Historical Condition - This species is suspected to have occurred mainly in areas after large fires or in areas of more open ponderosa pine LOS stands. Habitat types that provide suitable perches and are open enough to permit the detection of ground-dwelling prey will typically support Red-tailed Hawks.

Current Conditions – There are currently no known nesting red-tailed hawks within the project area. Most available habitat is in the lower elevations in the Lower Tumalo Creek Sub-watershed. Red-tailed hawks have an extremely wide tolerance for habitat variation, and commonly occur in areas close to human habitation. It is believed that this species is probably more common in the watershed currently than it was historically.

Trends - There is no trend specific to this watershed.

Northern Goshawk

Historical Condition - Historically, the abundance and quality of suitable habitat for northern goshawks was higher than currently exists. An estimated 25,600 acres of habitat was available in the ponderosa pine wet and dry PAGs, and mixed conifer dry PAG under historic conditions.

Current Conditions - Surveys were conducted in the general area in 2007 and 2008 with one detection and nest discovered. Additionally, goshawk sightings have been reported within the Bridge Creek Fire Area and just south of the watershed along Road 4615. Habitat distribution has diminished, mainly due to the timber harvest and road building at mid and lower elevations. Suitable nesting habitat for example now totals only 2,000 acres in comparison to the 25,600-acre estimate given for historic conditions.

Trends - Loss of habitat within the ponderosa pine and mixed conifer PAGs has restricted habitat available to goshawks. Areas now considered suitable are at high risk to stand replacement events due to the dense nature of these stands.

Cooper's Hawk/ Sharp-Shinned Hawk

Historical Condition - Historically, the abundance and quality of suitable habitat for Cooper's and sharp-shinned hawks was fairly similar to current conditions. An estimated 8,000 acres of habitat may have been available in the ponderosa pine wet/dry PAGs and the mixed conifer wet/dry PAGs.

Current Conditions - Surveys were conducted in the general area in 2007 and 2008 with a detection of a sharp-shinned hawk pair. Previous surveys in the past have revealed several Cooper's hawk pairs. Suitable habitat within the watershed is approximately 7,300 acres, close to that historically.

Trends – Much of the habitat that these accipiter species can be found in is at risk to loss by catastrophic fire. Many of these stands are dense and have high amounts of mistletoe and insects and disease. The loss of this habitat by these factors and timber harvest (commercial and pre-commercial thinning) would most likely reduce the amount of available habitat within the watershed.

Osprey

Historical Condition – It is unknown if this species ever used this watershed for nesting. It is possible, as historically there would have been more instream wood and beaver dams to slow the streams and create pools for fish. Large live trees and large snags that osprey would have used for nesting structures was most likely common.

Current Conditions – Osprey have rarely been seen within the Tumalo Creek Watershed. In 2008, an osprey was observed perched in a snag near Tumalo Creek on two occasions during the breeding season. It is unknown if there is a nest nearby or if the bird was just foraging in the area. With osprey populations increasing, these birds may be looking for additional areas for nesting and foraging. With the numerous habitat enhancement projects that have taken place within Tumalo Creek, there is more pool habitat that would provide ample opportunity for foraging for osprey.

Trends - There is no trend specific to this watershed. As osprey populations continue to increase, they will continue to look for additional areas for nesting and foraging, which could include areas within this watershed.

Great Gray Owl

Historic Condition - It is questionable whether the watershed ever supported breeding pairs of great gray owls since the prefer habitat (wet and dry meadows interspersed with lodgepole pine) was probably very limited in scope and distribution.

Current Condition - Fire suppression has most likely led to a conversion of open meadow has most likely led to a conversion of open meadow to pine stand in some areas, further restricting the habitat and potential for breeding pairs. No sightings have been reported.

Trends - Meadow forage habitat is decreasing due to lodgepole pine encroachment. Other forest openings are lacking in otherwise suitable areas because of fire suppression.

Cavity nesters

Approximately 39 species of cavity nesting bird species occur or are expected to occur within the Tumalo Creek Watershed. Snag, down log, and green tree replacement numbers are not currently known. Due to past management treatments, insect and disease outbreaks, and wildfire, gaps exist in both the distribution of available dead wood habitat and future snag and down log replacement trees. The following species will be discussed

below in the "Landbird Focal Species" section: black-backed woodpecker, red-naped sapsucker, and Williamson's sapsucker.

Pileated Woodpecker

Historic Condition - Suitable habitat for pileated woodpeckers, which is composed mainly of LOS mixed conifer wet stands and mountain hemlock, is estimated at 5,800 acres. Historical habitat suitability within mixed conifer dry vegetation types was probably lower because more frequent, low intensity fires tended to remove more down logs and understory canopy.

Current Condition – Pileated woodpeckers have been sighted within the watershed, along with abundant foraging signs within the mixed conifer wet and dry PAGs. Current habitat is available in LOS stands within the mountain hemlock and mixed conifer wet/dry PAGs and totals 4,700 acres. While some habitat has been lost to timber harvest and the Bridge Creek Fire, habitat for this species within the watershed has probably increased in suitability since fire suppression has allowed accumulations of down logs as well as understory intrusions of white fir within some stands historically lacking any significant understory vegetation.

Trends - Fire suppression in combination with retaining Wilderness and unroaded areas has probably increased overall suitable habitat within the watershed. Along with fire suppression and increased insect and disease within the watershed, many of these areas are at high risk to loss by catastrophic fire.

Northern Flicker

Historic Condition – Northern flickers are perhaps the most common woodpecker resident in Oregon. They can be found in a range of terrestrial habitat but are generally abundant in open forests and forest edges adjacent to open country (Marshall et al 2003). They require large snags or large trees with decay in order to build their nests. This type of habitat would have been more common historically, considering there may have been over 28,000 acres.

Current Condition – Although current availability of suitable habitat is less than it was historically (over 2,700 acres), this species is still one of the more common woodpecker species that occurs within the watershed. The actual number of acres is probably greater than this as this species does tolerate a variety of habitat conditions, as long as there are those larger trees suitable for nesting.

Trends – Although there has been a large reduction of LOS stands within the watershed, this species has managed to tolerate and even thrive in habitats created by human-induced change. This bird locally and regionally remains secure.

Hairy Woodpecker

Historic Condition – This woodpecker species, as with the northern flicker, can utilize a variety of habitats and snag sizes. Historically, it was most likely common, utilizing habitats within a variety of age classes in the ponderosa pine and mixed conifer PAGs.

Current Condition – Current conditions for this species are most likely similar to those found historically. This species is commonly seen within the watershed.

Trends - There is no trend specific to this watershed. Locally and regionally this species is considered secure.

Downy Woodpecker

Historic Condition - Often associated with deciduous and mixed deciduous-coniferous forests or riparian areas (Marshall et al. 2003, Csuti et al. 2001). Habitat for this species would have occurred adjacent to Tumalo Creek, as it does currently. The number of total acres is unknown, but likely greater than currently because of the amount of suitable habitat that burned within the Bridge Creek Fire.

Current Condition – This species has been observed within the watershed in an area that included lodgepole pine, fir, spruce, aspen, and willow. This habitat is not as abundant as it was prior to the Bridge Creek Fire.

Trends - There is no trend specific to this watershed. Locally and regionally this species is considered secure.

Black-backed Woodpecker/Northern Three-Toed Woodpecker

Historic Condition - Although habitat suitability indices were not conducted, numbers and distributions of these birds were probably greater historically, mainly due to the existence of more snags across the landscape including snags unharvested from stands replacing events. Also, suitable habitat is estimated to be greater historically. Acres of LOS Lodgepole pine were estimated to be over 2,000 acres

Current Conditions - Suitable habitat is currently estimated to be 1,800 acres fairly similar to historic conditions. In areas where salvage logging of standing dead trees has not occurred, populations of black-backed woodpeckers may be increasing. Lodgepole pine stands allowed to cycle naturally would continue to provide prime habitat for these species. Three-toed woodpeckers were sighted within the Bridge Creek Fire area 2 to 3 years post-fire. No sightings of black-backed woodpeckers have been reported within the watershed.

Trends – The increase in insect and disease within the watershed is providing increased foraging and nesting habitat for this species. Lodgepole pine stands allowed to cycle naturally will continue to provide habitat. The threat of risk to catastrophic fire increases the potential for future available habitat for this species.

Red-Naped Sapsucker

Historic Condition – This species inhabits a variety of coniferous forest communities within which there are stands of quaking aspen. In mountains, it also uses riparian woodlands of willow and other deciduous trees (Csuti et al. 2001). Habitat for this species would have occurred adjacent to Tumalo Creek, as it does currently. The number of total acres is unknown, but likely greater than currently because of the amount of suitable habitat that burned within the Bridge Creek Fire.
Current Condition – This species has not been observed within the watershed. The acres of suitable habitat are most likely less than historically. The habitat that occurs within the Bridge Creek fire is young and fairly stable, but other areas where aspen occurs within forested areas are at risk to loss by fire suppression and encroachment of conifers.

Trends – Without active management, aspen stands within the watershed continue to be at risk to loss by conifer encroachment and catastrophic fire. Locally and regionally this species is considered secure.

Williamson's Sapsucker

Historic Condition - Suitable habitat for Williamson's sapsucker, which is composed mainly of LOS mixed conifer PAGs and LOS ponderosa pine PAGs with large snags, would have covered approximately 28,000 acres historically. The amount and distribution of large snags would have been much greater than that of today, with this species probably more prevalent historically.

Current Condition – Williamson's sapsuckers have not been sighted within this watershed, but their foraging sign has been seen within the mixed conifer PAGs. Current habitat is available in LOS stands of ponderosa pine and mixed conifer and totals approximately 2,600 acres. While some habitat has been lost to timber harvest and the Bridge Creek Fire, snag habitat for this species is increasing within the watershed due to increased stand densities and stress on larger trees.

Trends - Fire suppression in combination with retaining Wilderness and unroaded areas has recently increased large tree snag habitat from trees becoming stressed by increased stand densities. With increased stand densities and insects and disease, many of these areas are at high risk to loss by catastrophic fire.

Mammals

Big Game

Historical Condition - John C. Fremont described deer populations across the East Cascades as low or nonexistent during his journey through this country in 1826 and 1827. Between 1926 and 1933, mule deer population of Oregon was estimated at 39,000 to

75,000 animals (Baily 1936). Populations increased in the 1930's to the 1940's before peeking in the late 1950's and early 1960's. Much of the increase in deer numbers is attributed to conversion of grassland to more palatable brush species through heavy grazing and fire suppression, creating more forage habitat by logging and extensive predator control (Gruel 1986).

Since the mid 1960's, mule deer populations in Oregon and across the Intermountain West began to decline as clear cuts converted back to forest, shrub stands became decadent, grazing pressure decreased, and traditional wintering areas were overcome by urban development.

Anecdotal information suggests that deer populations within the watershed were historically low, and probably never underwent the radical boom and bust observed for herds at lower elevations. Over the last 100 years, aside from intensive logging on private ground, the habitat has remained fairly static. While human access has increased in the middle and lower portions of the watershed, much of the higher ground is relatively inaccessible for most of the public.

Elk densities within the watershed were also historically very low to nonexistent. State biologists did not notice elk presence in the area with any regularity until the 1970's and significant increases in the herd were not seen until early 1990's.

Current Condition - Deer populations for the Upper Deschutes Herd Management Unit have undergone dramatic change in the 1990's. For example in 1991, the summer herd was estimated at 8,033 animals. Heavy and prolonged snow accumulations in 1992 caused massive winter mortality and the summer herd was estimate in 1993 at 5,694 animals. Since then, herd numbers have been fluctuating. The 2005 summer herd was estimated to be at 4,993 deer (information for 2006-2008 population estimates have not yet been received from the Oregon Department of Fish and Wildlife).

Summer herd elk numbers for the Upper Deschutes Unit are currently estimated at about 500 with the total number increasing annually.

Seasonal big game ranges within the Tumalo Creek Watershed include summer, transition, and winter range (See Table 15). The Deschutes National Forest Land and Resource Management Plan (1990) designates approximately 3,200 acres within the watershed for management as Deer Winter Ranger (M-7). Winter range for most of the Upper Deschutes herd that summer in the Tumalo Creek Watershed is centered on private land in and around Bull Springs, which is north of the Tumalo Creek Watershed. Seasonal movements for deer occur in an east-west direct (generally following the elevation gradient). Elk exhibit several movement patterns. A portion of the herd may winter east of the Cascade crest, while the remainder moves down above Bull Springs or head south to winter near the Inn of the Seventh Mountain.

Table 15. Deer Seasonal Ranges

Sub-watershed	Summer Range Acres	Transition Range Acres	Winter Range Acres	MA-7 Designated Acres
Upper Tumalo Creek	9,832	0	0	0
Lower Tumalo Creek	4,571	469 (private) 1,758 (FS)	5,120 (private) 3,200 (FS)	4,400
Watershed Totals	14,403	2,227	8,077	4,400

Deer cover/forage ratios were analyzed for the watershed (see Table 16). Each sub-watershed shows a ratio skewed toward cover, and well outside the 60/40 ratio recommended by Thomas (1979). Since timber harvest activities on private land cannot be assessed, cover forage values were analyzed for Forest Service lands only.

Table 16. Deer Cover/Forage Ratios

Sub-watershed	Cover Acres	Forage Acres	Cover/Forage Ratio
Upper Tumalo Creek	12,365	4,125	75/25
Lower Tumalo Creek	6,481	1,766	78/22
Watershed Totals	18,846	5,891	76/24

Road densities in some areas exceeded the desired condition for habitat security in some areas of the watershed, particularly Lower Tumalo Creek Sub-watershed, and a small potion of the Upper Tumalo Creek Sub-watershed (see Table 17). Overall road densities exceed 3.0 miles per square mile for the watershed. Roads 370 and 4601/ 4602 provide the bulk of hunter access into road-less and wilderness areas.

Table 17. Open Road Density

Sub-watershed (6^{th} Field HUC)	Road Miles	Sub-watershed Square Miles	Road Densities (Miles/square mile)
Upper Tumalo	40.81	32.43	1.26
Lower Tumalo	139.29	26.52	5.25
Watershed Totals	180.1	58.95	3.06

Trends - For deer, the trend is probably a slow, small increase in herd numbers residing within the watershed. The habitat's carrying capacity is low due to a lack of openings good forage habitat. This is mainly on Forest service Lands. As the Bridge Creek Fire area matures into more dense stands or second growth forage acres will be reduced even further.

Elk numbers continue to increase throughout the Upper Deschutes Management Unit, but growth is expected to slow as the herd nears carrying capacity. Although the notion is not supported in the literature, increases in elk populations can have a negative effect on deer numbers on the same range.

Marten

Historic Condition - Suitable habitat consists of late structure lodgepole pine and mixed conifer wet stands and to some degree mid-structure lodgepole. Habitat is estimated to have totaled about 8,600 acres historically. Historic levels of habitat fragmentation, which reduces habitat suitability for marten, most likely varied for any given century, but would have been more prone to isolated large acre events in lodgepole pine, and less so within mixed conifer wet plant associations.

Current Condition - Marten sightings have been reported within the Tumalo Creek Watershed, although formal surveys have not yet been conducted. Sightings have also been reported immediately north and south, indicating a high probability of marten presence within the watershed.

Acres of suitable marten habitat (4,200 acres) are less than historic conditions. The largest decrease in habitat has occurred in LOS mixed conifer wet stands. Optimal habitat in the form of LOS lodgepole pine has decreased also, being replaced by mid-structure lodgepole pine and mountain hemlock. The Bridge Creek Fire area (over 3,400 acres) most likely caused the greatest reduction of historic habitat within the mixed conifer association.

The areas that currently provide suitable habitat for marten are areas of lodgepole pine stands that would normally be set back in structural stage by agents of stochasticity that have been allowed to reach maturity. Also, snags and down logs in mixed conifer stands are also accumulating, further increasing habitat suitability in stands that may have been of marginal suitability historically.

Along with total current acres of suitable marten habitat less than historic levels, high densities of open road have eroded habitat suitability within many areas where stand conditions are favorable for marten, especially in the Lower Tumalo Creek Sub-watershed (see Table 18). This not only creates a disturbance factor, but also increases the likelihood of dead wood removal in the form of public firewood cutting.

Trends - Retention of road less character within the mixed conifer wet and lodgepole pine PAGs (within the Upper Tumalo Sub-watershed) has allowed stands to cycle naturally, providing large areas suitable for marten. Fire suppression within lodgepole pine, however, has led abnormally high fuel accumulations that create a high risk to large-scale stand replacement fire.

LANDBIRD FOCAL SPECIES/BIRDS OF CONSERVATION CONCERN

Neotropical migratory birds have become species of interest recently, due to the downward trend of landbirds in the western United States. The declines of these populations are a result of many complex issues, but factors believed to be responsible include habitat loss, fragmentation, and alteration of historic vegetation communities. Other probable causes to the decline include predation from feral species, nest parasitism, and use of pesticides associated with agriculture areas.

There is currently an Executive Order (13186) that provides for enhanced cooperation between the Forest Service and USFWS in regards to addressing impacts to neotropical migratory birds in conjunction with the Migratory Bird Treaty Act. Specific activities are identified where cooperation between the parties will substantially contribute to conservation and management of migratory birds, their habitat, and associated values, and thereby advances many of the purposes of the Executive Order.

In response to this Executive Order and subsequent compliance with the Migratory Bird Treaty Act, the Deschutes National Forest is currently following guidelines from the "Conservation Strategy for Landbirds of the East-Slope of the Cascade Mountains in Oregon and Washington" (Altman 2000). This conservation strategy addresses key habitat types as well as biological objectives and conservation strategies for these habitat types found in the East Slope of the Cascades, and the focal species associated with these habitats. The conservation strategy lists priority habitats: 1) Ponderosa Pine 2) Mixed Conifer (Late Successional) 3) Oak-Pine Woodland 4) Unique Habitats (Lodgepole Pine, White Bark Pine, Meadows, Aspen, and Subalpine Fir). There is no Oak-Pine Woodland within the Tumalo Creek Watershed.

Another publication became available in 2002 from the U.S. Fish and Wildlife Service entitled "Birds of Conservation Concern 2002" (BCC) which identifies species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act (ESA) of 1973. While all of the bird species included in BCC 2002 are priorities for conservation action, the list makes no finding with regard to whether they warrant consideration for ESA listing. The goal is to prevent or remove the need for additional ESA bird listings by implementing proactive management and conservations actions (USFWS 2002).

Priority habitat features and their associated landbird focal species that will be addressed are included in Table 18. Other focal bird species or birds of conservation concern discussed earlier in detail that also have sensitive species or MIS status include the American peregrine falcon, Lewis' woodpecker, white-headed woodpecker, golden eagle, black-backed woodpecker, red-naped sapsucker, and Williamson's sapsucker.

Some of the species listed below are late structure PAG habitat specialists while others require more general late structure PAG conditions. Historical and current conditions are based on habitat rather than species by species.

Table 18. Priority Habitat Features and their Associated Focal Species for Conservation.

Habitat	Habitat Feature /Conservation Focus	Focal Species
Ponderosa Pine	Large patches of old forest with large snags	White-headed woodpecker
	Large trees	Pygmy nuthatch
	Open understory with regenerating pines	Chipping sparrow
	Patches of burned old forest	Lewis' woodpecker
Mixed Conifer (Late Successional)	Large trees	Brown creeper
	Large snags	Williamson's sapsucker
	Interspersion grassy openings and dense thickets	Flammulated owl
	Multi-layered dense canopy	Hermit thrush
	Edges and opening created by wildfire	Olive-sided flycatcher
Unique Habitats		
Lodgepole pine	Old growth	Black-backed woodpecker
Whitebark pine	Old growth	Clark's nutcracker
Meadows	Wet/dry	Sandhill crane
Aspen	Large trees with regeneration	Red-naped sapsucker
Subalpine fir	Patchy presence	Blue grouse

Ponderosa Pine LOS

Ponderosa pine was chosen as a priority habitat because of extensive loss and degradation of forest characteristics. The result of degradation of Ponderosa pine forest from fire suppression and extensive timber harvest has been the change of large areas of late-seral ponderosa pine forest to mid-seral stands of Douglas-fir and grand/white fir (Altman 2000).

Historic Condition – Historic conditions included approximately 19,606 acres of late structure ponderosa pine. These areas underwent frequent fires, which kept the stands more open with park-like understory dominated by herbaceous cover with scattered shrub cover and pine regeneration. Larger tracts of old forests with large snags were common, with patches of forest that were heavily burned. Species including the white-headed woodpecker, pygmy nuthatch, chipping sparrow and Lewis' woodpecker were common and dominated these habitats.

Current Condition – Current acreage of late structure ponderosa pine totals approximately 1,280 acres, 7% of what historically existed. Where large diameter ponderosa pine still exists, fire suppression has led to understory intrusions by various tree species that essentially create unsuitable conditions for white-headed woodpeckers and chipping sparrows. A decrease in late structure habitat has essentially decreased the number of large live and dead ponderosa pine, important components in habitat for white-

headed woodpeckers, pygmy nuthatches and Lewis' woodpeckers. The focal species listed above in Table 18 are essentially less common than historically

Trends – By allowing areas of mid-seral ponderosa pine to develop into late structure ponderosa pine, acreages of this type of habitat is expected to increase over the years. Logging practices are retaining larger trees and snags, a benefit for all species listed above, and areas of late structure habitat are at risk for catastrophic fire, a potential benefit for Lewis' woodpecker. Although the potential for this habitat may increase, logging during the breeding season on the summer range has the potential to reduce local populations.

Mixed Conifer LOS

Mixed conifer (late-successional) forests were chosen as a priority habitat because of the substantial loss of the late-successional stage of this habitat type by common practice of clearcuts or shelterwood harvest cuts to reduce insect and disease and reduce the risk of catastrophic fire (Altman 2000).

Historic Conditions – Historic conditions include approximately 9,000 acres of late structure mixed conifer. These areas were a combination of late structure habitat conditions including multi-layered, dense canopy areas with large trees and snags interspersed with openings and dense thickets of conifers. Without fire suppression, there were edges and openings created by wildfire. Species including the brown creeper, Williamson's sapsucker, flammulated owl, hermit thrush, and olive-sided flycatcher were more abundant than currently.

Current Conditions – Currently, acres of late structure mixed conifer are approximately 1,460 acres, 16% of what existed historically. Most acres have been lost to timber harvest and the Bridge Creek Fire. Where this habitat exists, the associated focal bird species can still be found. With increased insect and disease activity within these stands throughout the watershed, the potential loss to catastrophic fire is high

Trends – Practices of clearcutting and shelterwoods are currently not a common method of treating mixed conifer stands. When stands are treated, it is to reduce the risk of fire and impacts from insects and disease. Although these methods would still retain large trees and snags, it would reduce stand densities and multi-layered stands. Thus, most likely species such as the brown creeper, flammulated owl, and hermit thrush would not benefit from these treatments. Until these areas are treated, they also remain at risk to catastrophic fire, which in turn would benefit the olive-sided flycatcher. Logging during the breeding season on the summer range also has the potential to reduce local populations.

Unique Habitats

Unique habitats are priority because of the importance of the associated habitat features that are at risk (Altman 2000).

Historic Conditions – Late structure lodgepole pine was approximately 2,000 acres historically. Historic acreages and conditions of whitebark pine, meadows, aspen, and subalpine fir are generally unknown, but amount of habitat was probably greater and in a healthier condition than currently because of the occurrence of wildfire.

Current Conditions – Late structure lodgepole pine is approximately 1,800 acres, 90% of what historically existed. Most of these stands have been or are currently being impacted by mountain pine beetle. Whitebark pines are currently under stress from the blister rust (introduced) that has been affecting this species for many years. Fire suppression has decreased this species from reseeding, which occurs in part from seed caches from Clark's nutcracker. Currently, the meadows that occupy the Tumalo Creek Watershed are not the type to support sandhill cranes. They are at risk, though, to conifer encroachment from natural processes and fire suppression. Aspen are probably not as abundant as historically. Colonies are recovering after the Bridge Creek Fire, but other areas where older aspen colonies occur in forested conditions are at risk to encroachment by conifers and loss to wildfire. A forest-wide aspen survey in 2001-2004 determined that most aspen stands on the Bend/Ft. Rock Ranger District were located in the Tumalo Creek area near the falls. Most of these aspen stands were recommended for treatment of encroaching conifers and brush in the report associated with the survey. Due to past management activities and pockets of insects and disease in the upper watershed, patches of subalpine fir occur in scattered patches.

Trends – Trends for unique habitats is similar to that of other habitats. Lack of fire has created conditions in each of these unique habitats that are out of balance of what would happen naturally. Until active management or a catastrophic wildfire occurs, this trend is expected to continue.

HABITAT IMPACTS FROM INSECTS AND DISEASE

The insect and disease (I &D) infestation has affected the Old Growth Management Area (OGMA) and Late or Old Stage (LOS) areas. I&D have affected 100% of OGMA and 81% of LOS in the watershed (see Table 19).

Table 19. Acres Affected by Insect and Disease

Subwatershed	Watershed Acres	OGMA Acres/ % affected I&D	NRF Acres/ % affected I&D	LOS Acres/ % affected I &D	Total Acres I&D	% of Watershed affected by I&D
Upper Tumalo	20,745	448/100	2314/81	--	9391	45
Lower Tumalo	16,968	0	245/52	--	2902	21
Totals	37,713#	448/0	2559/80	476/81*	12,293	36

= Calculated for 5th field only. Acres unaffected include 81acres SS6 and 9 acres SS7.
= total watershed is 37,713 acres but portion within FS boundary is 34,536. Calculations based on what is within FS boundary.

Table 20 displays the percentage of insect infestation by PAG. A majority of the I&D infestations have occurred within the Upper Tumalo Sub-watershed. The PAGs affected the most have been the mixed conifer dry and the lodgepole pine wet/dry. An obvious cause for the higher percentage of insect and disease activity in Upper Tumalo Creek is that fewer management activities have occurred in this higher elevation less inaccessible area. Much of the Upper Tumalo Creek sub-watershed is wilderness or un-roaded area. With the increased stress on the trees caused by drier conditions in the past decade, these denser, older structural stage stands in Upper Tumalo Creek are also more susceptible to insect and disease caused mortality. In Lower Tumalo Creek, all PAGS are at continued risk of insect and disease caused mortality, with the greatest mortality in the mixed conifer wet lodgepole pine wet/dry PAGs.

Table 20. Insect and Disease Infestation by PAG

Subwatershed	Major PAG	Total Acres	I&D	% Infested
Upper	PPD/W	36	17	47
	MCD	2596	1654	64
	MCW	4157	1803	43
	LPD/W	3075	2603	85
	MHD	8114	2950	36
	MDW/RIP	314	127	41
	ROCK/ALP	775	41	5
Lower	PPD/W	9134	1074	12
	MCD	1978	341	17
	MCW	1822	798	44
	LPD/W	703	659	94
	MHD	0	0	0
	MDW/RIP	7	7	100
	ROVK/ALP	10	0	0

I&D have variable effects depending upon the type of organism and the degree of effect. Rarely does it result in 100% tree mortality, but the loss of large trees and/or significant numbers of trees will affect habitat capability for some species (i.e. bad for some and good for others). LOS dependent species such as northern spotted owls would be adversely affected in most cases.

FIRE/FUELS

HISTORIC CONDITION

Prehistoric Fire

Evidence since the cessation of volcanic activity in the area suggests significant interactions between climate, vegetation, and fire which continued into present times. Pollen analyses conducted in the western Cascades (Leopold et al. 1982), revealed regional vegetation patterns during the Holocene Period. They imply a very dynamic relationship between vegetation and fire due to a much warmer and drier climate. This indicates that the range of dry meadows and shrub/grass plant associations were much more extensive and large range fires were very frequent.

Aboriginal Burning

There are historical accounts of aboriginal peoples using fire in the Deschutes River Basin for hunting to improve seed and berry crops, and as a weapon of war (Stewart 1936). Paiute and Tenino tribes resided in the valley. Klamath and Modoc were frequent visitors and used fire for the same reasons.

Early Settlement

The first people of European descent to appear were trappers about 1825. In the early 1840's immigrants passed through attempting to find shorter routes to the Willamette Valley and by the 1880's began to establish residence there (Bork, 1984). Settlers often used fire to clear land for livestock and crops (Pyne, 1982. Shinn, 1978). Evidence from fire atlas show several large human caused fires in the upper valley in 1908, 1910, and 1914. There were increasingly dry years and these fires may be due to ignorance and culture. A letter from a District Ranger on the Klamath National Forest written in 1918 to his supervisor attributed this increase in fires to prospectors, hunters, "renegade whites and Indians" and "pure cussedness" class of people in which he suggested shooting as a prevention tool (Harley 1918).

CURRENT CONDITION

Present Day Fires

Today in the Tumalo Creek Watershed, there are a variety of vegetation types and fire regimes representing the effects of the historically repetitious fire with variable spread rates and intensities. A modern day sampling of fire occurrence data from from1980 to 2007 revealed 68 fire starts, roughly equivalent to 3 fires starts annually. Most of these fires were ignited by natural causes. The last fire was in 2002. The area could still be

accurately described as a “fire environment” with an increasing human component. The Greater Bend Community Wildfire Protection Plan (CWPP) was developed in response to the fire environment concerns.

Fire Ecology

Mountain hemlock/alpine zones: Large fires are relatively in frequent in these high elevations sites but lightning patterns and frequency show that ignitions are common. Fire intensity is dependent upon weather and development of fuel complexes capable of supporting crown fire. These heavy fuel complexes take a long time to develop and are usually small. Therefore, high intensity fires are infrequent and usually less than 50 acres. Low intensity fires are frequently ignited but rarely exceed 100 acres.

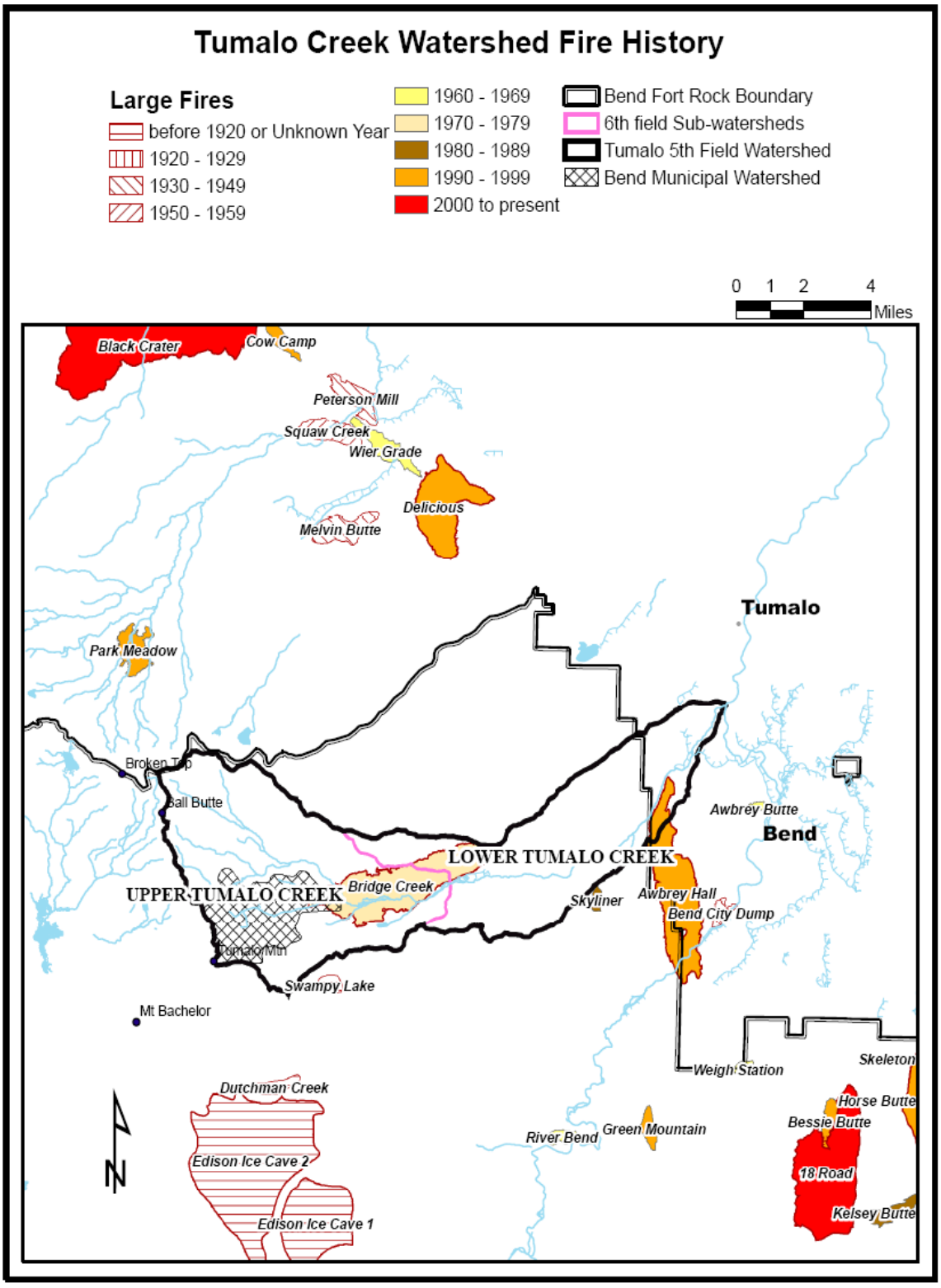
Mixed conifer zones: Fire frequency on these sites ranges from about 10 to 50 years. *Abies concolor* forests in Crate Lake national Park were found to have a return frequency of 9 to 42 years by McNeil and Zobel (1980). This would certainly indicate fire of low intensity due to the frequency. The extent of these fires was not great. At Crater Lake, McNeil and Zobel found few fires that burned their entire study areas of 7.5 square kilometers. According to Bork (1984), there are no existing trees scarred by fire across a 125 hectare area at Pringle Falls.

Moist lodgepole pine zones: Fire in these stands characteristically burned with low to moderate intensities occasionally torching out in crowns. The fire behavior is dependent upon stand condition and climate. Patchy fuel continuity prevented disturbance at a landscape scale (Hopkins, 1994).

Dry lodgepole pine zones: These stands are visited by fire every 40 to 60 years with low to high intensity. The magnitude of natural fires could range from slow burning, smoldering duff and litter across the forest floor, to an occasional crown fire. Crown fires are the most common due to low natural fuel loads. However, most any fire in a stand will be fatal due to the fire intolerant nature of the *Pinus contorta var. latifolia.* Fire studied in Crater lake National Park and at Wickiup Springs on the Fremont National Forest showed extensive low intensity fires and even large fire events adjacent to these stands that did not enter or affect the stands, suggesting these could have acted as a natural barrier except under unusual fire weather (Agee, 1993).

An important related disturbance is mountain pine beetle (*Dendroctonus ponderosae*) attacks. In stagnant or low vigor stands, these attacks can be significant and set the stage for stand destruction by creating heavy loads of down and dead material intermixed with developing regeneration. In the absence of fire, this insect may provide the disturbance that seems to be a natural part of stand development over time.

Exhibit 11. Tumalo Creek Watershed Fire History



Ponderosa pine zones:

Fire Regime Condition Class

Historical Fire Regimes, Natural Range of Variability and Fire Regime Condition Class (FRCC) Mapping Methodology**.**

Upper Deschutes Basin Fire Learning Network Technical Team: Amy Waltz, Jeff Campbell, Mike Simpson, Dave Owens, Jen O'Reilly, Glen Ardt, Gregg Riegel, Chris Zanger

Introduction

Fire Regime Condition Class is an ecological index that measures the departure of current stand structure, fire return intervals and fire severity from historic stand structure, fire return intervals and fire severity. Changes in forest structure have occurred since Euro-American settlement due to multiple factors, including fire exclusion, grazing and timber management. In many cases, the changes in forest structure have led to changes in fire behavior resulting in increased fire risk to communities, as well as a decline in or loss of fire-adapted plant and animal species.

This analysis was conducted by the Upper Deschutes Basin Fire Learning Network, a collaborative group of federal and state agencies, local government and community groups and conservation organizations. The mapping and computer analyses were contracted out to Jeff Campbell, of Spatial Solutions. Input data (as described in the document), was assimilated or generated by the UDB FLN technical team (above).

The technical team used the FRCC Mapping Tool, an Arc Extension that was developed by National Interagency Fuels Technology Team (NIFTT), part of the National Interagency Fuels Coordination Group (NIFC). For more information regarding this team and their products go to www.landfire.gov.

FRCC RESULTS for Tumalo Watershed

Biophysical Settings are potential vegetation classes with disturbance, and may represent historical vegetation distribution (Exhibit 12). The Tumalo watershed map is dominated by three Biophysical Settings: ponderosa pine, dry mixed conifer and wet mixed conifer – lodgepole pine.

Table 21 lists the historical and current successional stage distributions for the three most abundant vegetation types in Tumalo Watershed. Changes consistent among these three vegetation types include a significant reduction in the proportion of late-successional classes within each Biophysical Setting and a corresponding increase in mid-successional classes. Within the ponderosa pine Biophysical Setting, there is a significant increase in mid-successional classes with closed canopies (greater than 40% canopy cover).

Table 21. Successional stages

Vegetation Type	Successional Stage	Historic Distribution (%)	Current Distribution (%)
Ponderosa Pine	ES	25	18
	MSC	5	29
	MSO	25	38
	LSO	40	6
	LSC	5	9
Mixed Conifer (dry)	ES	15	9
	MSC	1	17
	MSO	30	54
	LSO	40	11
	LSC	14	8
Mixed Conifer (wet) &Lodgepole pine (wet)	ES	10	20
	MSC	10	17
	MSO	35	49
	LSO	40	7
	LSC	5	7

ES = early successional, MSC = mid-successional closed canopy, MSO = mid-successional open canopy, LSO = late-successional open canopy, LSC = late-successional closed canopy.

Table 22 lists stand FRCC (by successional stage) and watershed FRCC (also shown in Exhibit 13) for each Biophysical Setting. Stand departure is the percent departure of the current stands from the historic stands. For example, there is 84% less (-84) late-successional open stand ponderosa pine habitat in the Tumalo Watershed today as compared to modeled historic distributions. (Also see Table 8 – numbers vary depending on methods arriving at data). There are two components of Fire Regime Condition Class: the Vegetation Class Departure and the Fire Frequency and Severity Departure. These data are based solely on the vegetation class departure and does not include data on missed fire cycles or changes in fire severity. Missed fire cycles are not considered in this calculation due to the uncertainty of fire interval and pattern in the mixed severity fire regime that typifies mixed conifer Biophysical Settings (mixed conifer is considered to be in Fire Regime III, where fires of mixed severity, and often irregular patterns, occur every 35 to 100+ years). Should missed fire cycles be factored in, it can be assumed the FRCC for each of the Biophysical Settings would increase by one class, i.e. FRCC 2 to FRCC 3.

Stand departure is summarized into a stand level FRCC in the following manner:

-100 to 33 departure = stand FRCC 1

33 to 66 departure = stand FRCC 2

66+ departure = stand FRCC 3

Successional stages that are in less abundance today (like late-successional open stands) are summarized as FRCC 1 or similar by FRCC standards. This appears counter-intuitive, as this represents an "out-of-wack" system. These stands should be more appropriated labeled as "conserve" and, this analysis can highlight these stands as

important to conserve because of their scarcity on the landscape. Successional Stage Relative Abundance describes the current amount of a vegetation type relative to its historical condition, i.e. abundant, over represented, trace, similar, or under represented (Exhibit 14).

Table 22. Fire Regime Condition Class

Vegetation Type	Successional Stage	Hist. Dist. (%)	Cur. Dist. (%)	Stand Departure	Stand FRCC	Watershed FRCC (Departure Index)	FRCC
Ponderosa Pine	ES	25	18	-28.09	1	41	2
	MSC	5	29	82.88	3		
	MSO	25	38	34.12	2		
	LSO	40	6	-84.88	1		
	LSC	5	9	43.3	2		
Mixed Conifer (dry)	ES	15	9	-37.23	1	40	2
	MSC	1	17	94.13	3		
	MSO	30	54	44.81	2		
	LSO	40	11	-73.12	1		
	LSC	14	8	-39.75	1		
Mixed Conifer (wet) &Lodgepole pine (wet)	ES	10	20	50.92	2	32.5	1
	MSC	10	17	39.93	2		
	MSO	35	49	27.98	1		
	LSO	40	7	-81.44	1		
	LSC	5	7	28.08	1		

Exhibit 12. Tumalo Creek Watershed Potential Vegetation

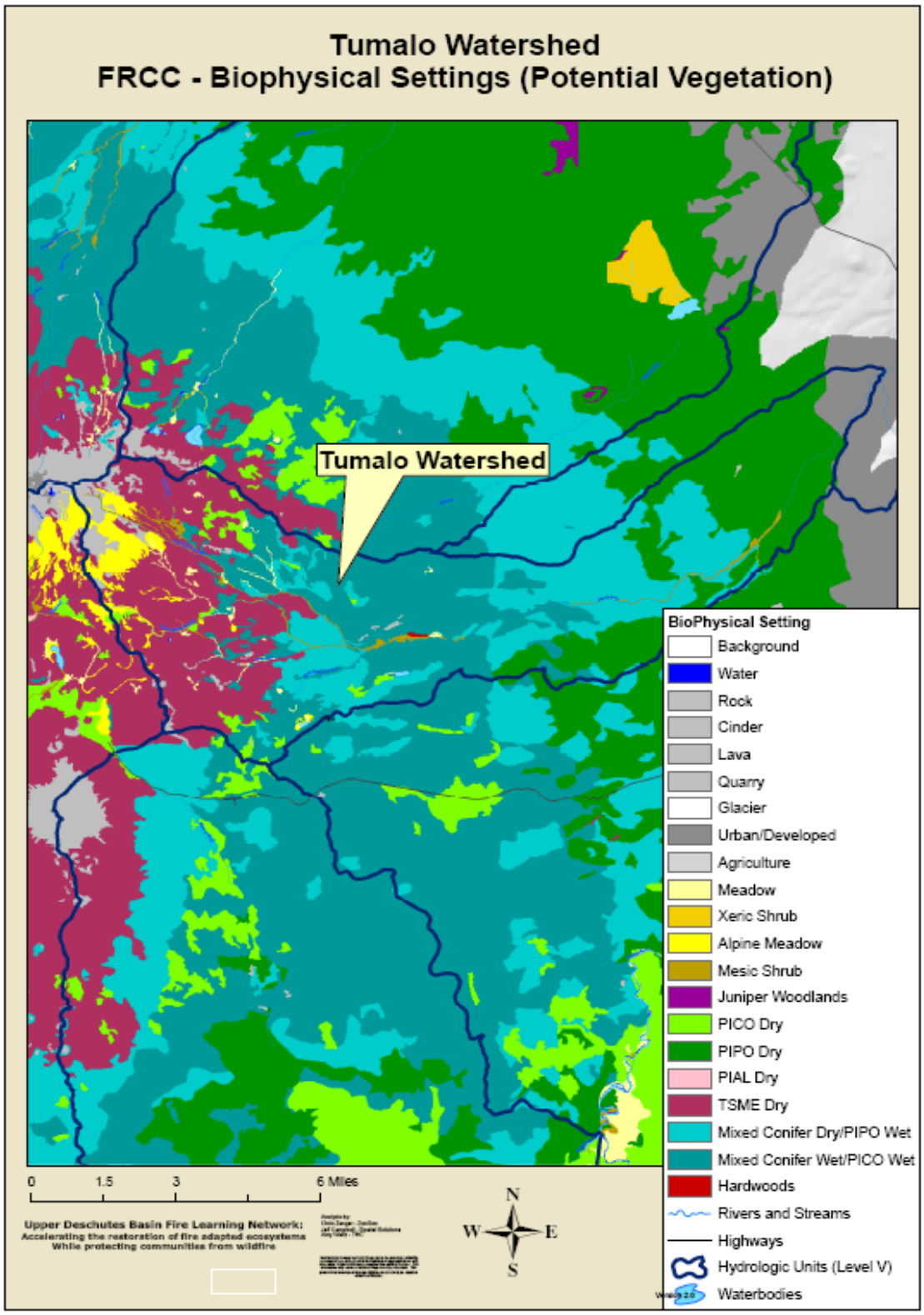


Exhibit 13. Tumalo Creek Watershed FRCC Biophysical Settings (Potential Vegetation)

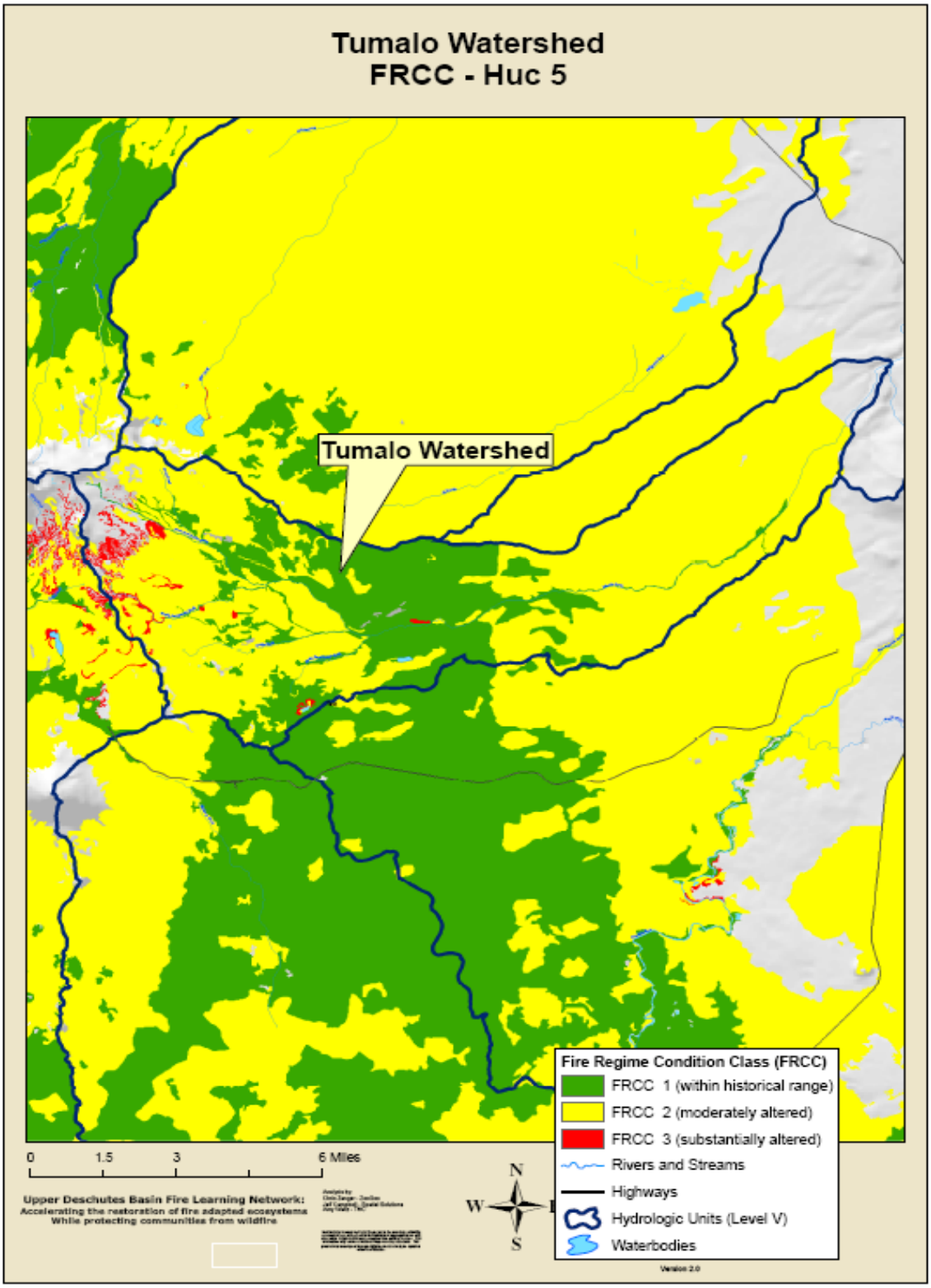
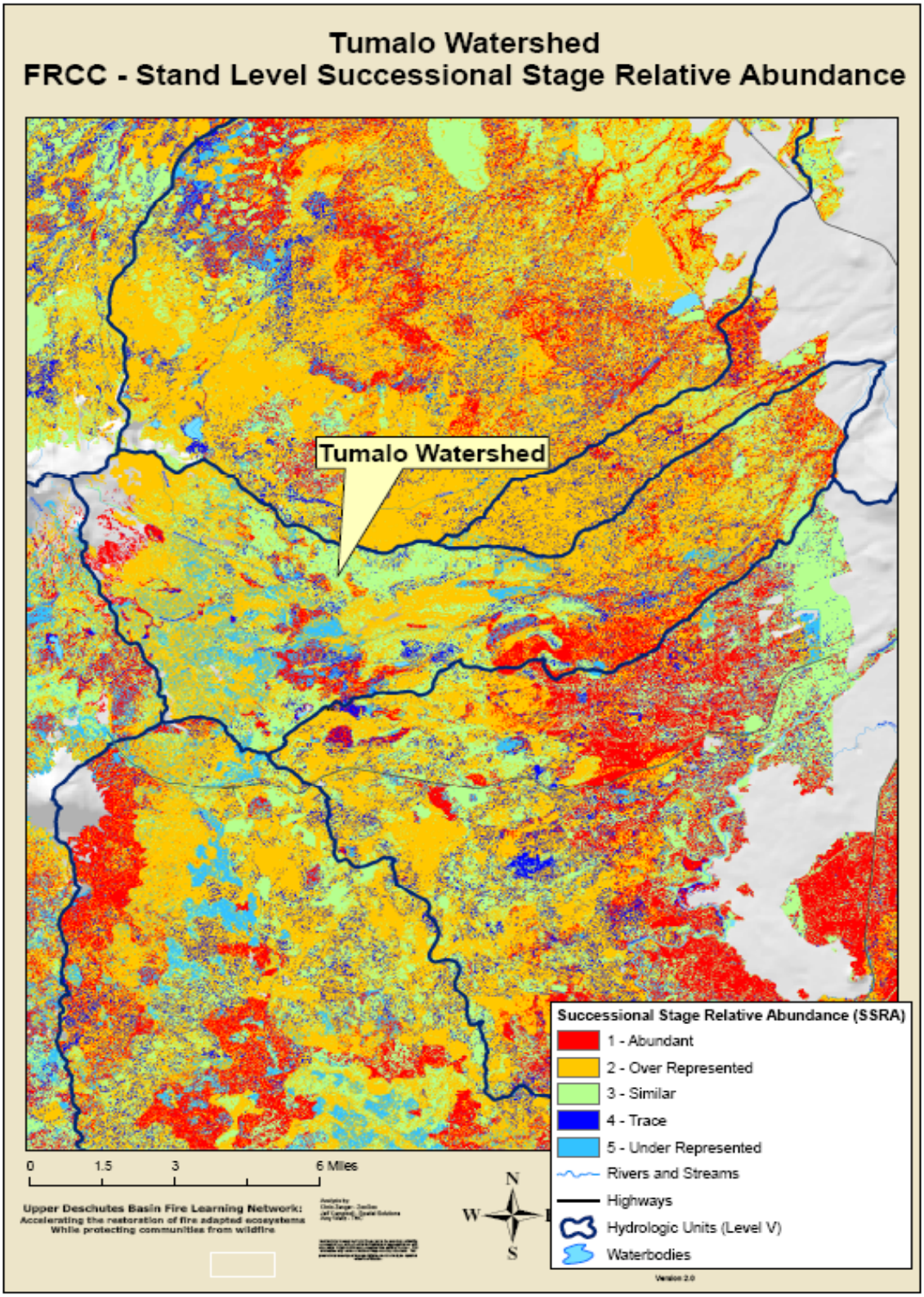


Exhibit 14. Tumalo Creek Watershed FRCC Successional Stage



The expansive stands of ponderosa pine that once dominated much of the area were a result of low to moderate intensity fires visiting the stands every 7 to 30 years (Bork, 1984). Stand replacement events were rare but occurred in 80 to 300 year intervals, leaving paths of replacement regeneration. These patches varied in size from 10 to 100 acres (Hopkins, 1994).

The Bridge Creek Fire

The 1979 Bridge Creek Fire was a human caused event which burned most of the vegetation within its boundaries. This fire has minimal mosaic patches which are scattered only along a small portion of the fire boundaries. The intensity of the fire may have contributed to the short-term hydrophobic character of the pumice soil in some areas. Structures were placed on slopes following the fire to reduce downhill flow velocities and sedimentation rates into Tumalo and Bridge Creeks. Although some of the south aspect slopes have been vegetated enough to be considered relatively stable.

In recent history, this is the only large fire ever to occur within the Tumalo Creek Watershed. A potential risk exists for a similar event given the right combination of weather patterns and fuel conditions. Although the probability is low due to the right conditions occurring only on 6 days throughout the summer, these identified conditions would still require monitoring during the entire year.

Fire Management Action Plan for the Bridge Creek/Tumalo Creek Watershed (Revised 1998)

Purpose: The purpose of this plan is to define the joint responsibilities of the Deschutes National Forest and the City of Bend in fire prevention and suppression of fires in the Bridge Creek/Tumalo Creek Watershed.

Present Management Situation: The legal Bridge Creek/Tumalo Creek comprises an area approximately 7,000 acres, more or less of which 4,510 acres are currently contributing to the City of Bend domestic water supply. Within the contributing watershed, 88 acres are the City of Bend domestic water supply. Within the contributing water 88 acres are noncommercial forest lands, 32 acres are riparian, and 4,223 acres are Forest Service Lands. The Deschutes National Forest Service Land Management Plan preferred alternative allocated 4,200 acres to the Domestic Watershed 1 Option. The Northwest Forest Plan allocated this area as Administratively Withdrawn.

Fuel Hazard and Potential Fire Behavior

This report describes the analysis conducted to address potential fire behavior and hazardous fuel conditions within the Tumalo Creek Watershed. Data used to characterize the landscape were developed for the Deschutes National Forest based on 2004 satellite imagery.

Conditions were modeled for a "problem fire", defined here for the Tumalo watershed as a fire driven by a westerly wind, moving down-canyon, and threatening the Bend Municipal Watershed and the wildland-urban interface. For modeling purposes, problem fire conditions are:

Wind direction: 270 degrees
Wind Speed: 25 mph (20 foot wind)
Fuel Moistures (97% percentile): 1 hr: 2%, 10 hr: 3%, 100 hr: 6%,
Live Woody: 55%, Live Herbaceous: 30%, Foliage: 100%

A west wind (270 degrees) at speeds of 25 mph would be a relatively rare event; however it represents the conditions which are the greatest threat to values at risk.

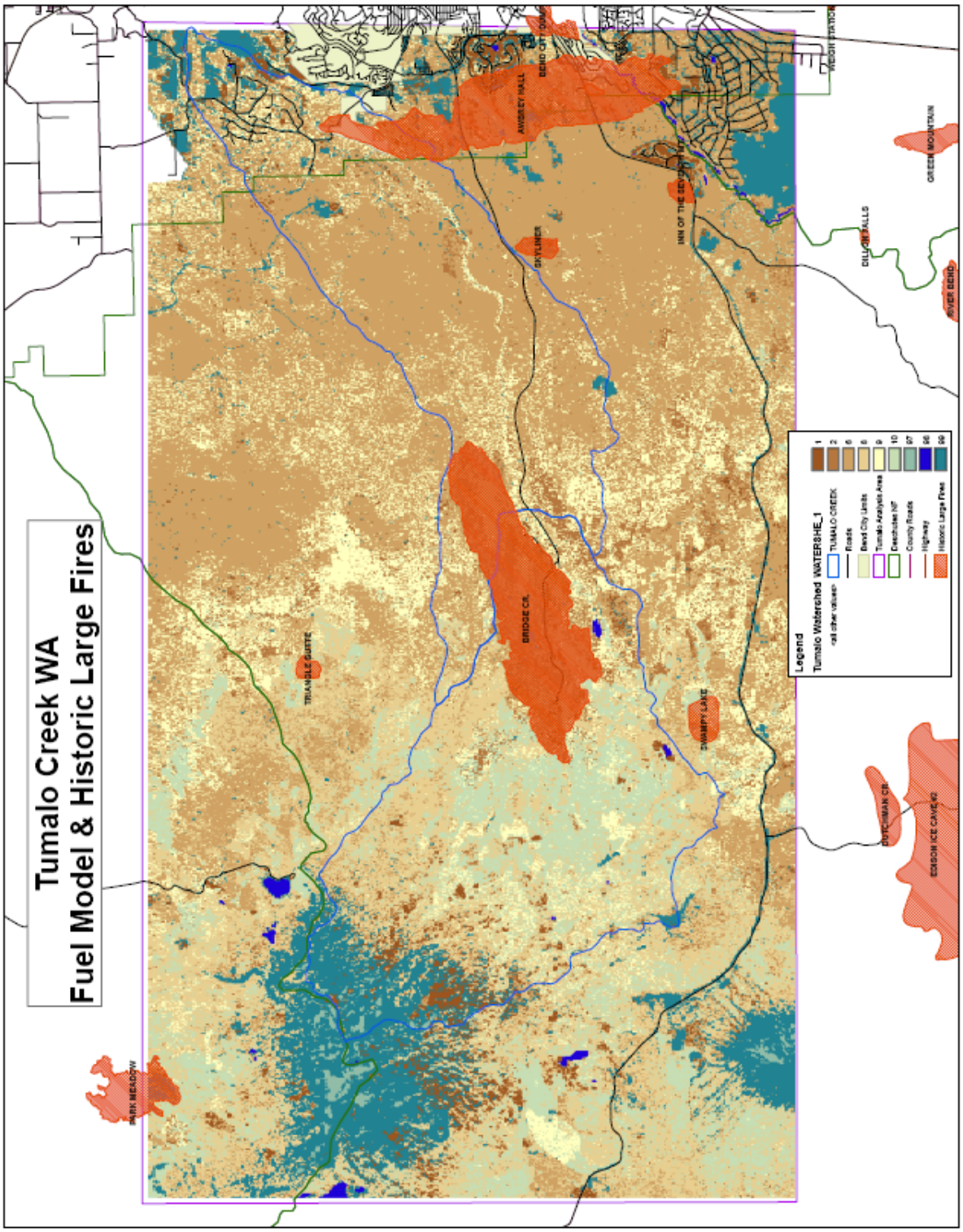
The FlamMap analysis area is significantly larger than the Tumalo Creek Watershed. A large rectangle was selected for the analysis so that adjacent areas are included and edge effects are captured. Where possible, descriptive outputs are reported for the watershed.

Table 23 displays acres by fuel model for the Tumalo Watershed. Fuel models and historic large fires are shown in Exhibit 15.

Table 23. Fuel models

Fuel Model	Acres	Percent of Watershed
1 - Grass	1,210	3
2 – Grass, shrub, litter	2,688	7
6 - Shrub	14,204	38
8 – Short-needle litter	7,249	20
9 – Long-needle litter	4,714	13
10 – Heavy dead & down	4,487	12
97 – bare ground	102	0
98 - water	32	0
99 – bare ground	2,346	6
Total	37,032	99

Exhibit 15. Tumalo Creek Watershed Fuel Models/Historic Large Fires



The first output from FlamMap is displayed in Exhibit 16. Burn probability is displayed. Burn probability is an output grid from the minimum travel time fire growth model.

This feature produces a single output map that contains the fraction of the number of fires that encountered each node (0.0 to 1.0). The burn probability for the Tumalo Creek Watershed is derived from a random distribution of 3000 fires, with duration of 8 hours.

High burn probabilities are related to the sizes of fires that occur on a given landscape -- for the same conditions, large fires produce higher probabilities than small fires (each burn a larger fraction of the landscape). Since fire size is a function of the gross spread rate and duration of the fire, treatments or conditions that reduce the spread rate will lower the burn probability.

Table 24. Burn Probability, Tumalo Creek Watershed

Burn Probability - Description	Acres	% of Watershed
Very Low	16,585	44
Low	4,890	13
Moderate	3,872	10
High	7,905	21
Very High	3,782	10

The description terms (very low, low etc) are assigned based on a classification of the range of burn probability values into 5 classes. They are relative values, not absolute.

Potential fire behavior was calculated and two values are displayed here: flame length and crown fire. Flame length potential is displayed in Exhibit 17 and crown fire in Exhibit 18.

Table 25. Flame Length Potential

Flame Length (feet)	Acres	% of Watershed
<2	13,342	35
2-4	537	1
4-8	3,657	10
8-11	2,348	6
11+	14,660	39

Table 26. Crown Fire Potential

Fire Type	Acres	% of Watershed
0 – Non-burnable	2,210	6
1 – Surface fire	16,454	44
2 – Torching (Passive Crown Fire)	12,365	33
3 – Active Crown Fire	3,515	9

The table below displays the acres and percent for flame length potential and burn probability outputs from the FlamMap model for the Tumalo Watershed. The two outputs are combined as shown in the table. Exhibit 19 shows the two combined output.

Table 27. Flame length potential and burn probability

Burn Probability	**Flame Length (feet)**					
	0	**2**	**4**	**8**	**11**	**20**
Very Low	na	4,181 (12)	100 (<1)	930 (3)	337 (1)	6,081 (18)
Low	na	934 (3)	201 (<1)	844 (2)	661 (2)	2,523 (7)
Moderate	na	1,075 (3)	165 (<1)	1,588 (5)	908 (3)	4,174 (12)
High	na	220 (1)	71 (<1)	296 (1)	442 (1)	1,812 (5)
Total	6,933 (20)	6,409 (19)	536 (1)	3,657 (11)	2,348 (7)	14,660 (42)

Burn probability is a relative index for the likelihood of a piece of ground burning given the conditions run in the model (97th %-tile weather and fuels, with 20' wind (270 degrees, 25 mph). Burn probability ranges from 0.00 to 0.10156. The range was divided into 4 equal divisions. Categories for burn probability are:

0 – 0.02539 = Very Low
0.02539 – 0.05078 = Low
0.05078 – 0.07617 = Moderate
0.07617 – 0.10156 = High

Flame length potential was divided into categories roughly based on the Hauling Chart. Categories for flame length:

0 – **0**, Non Burnable
.1 – 2: **2**
2.1 – 4: **4**
4.1 – 8: **8**
8.1 – 11: **11**
11.1 +: **20**

Exhibit 16. Tumalo Creek Watershed Burn Probability

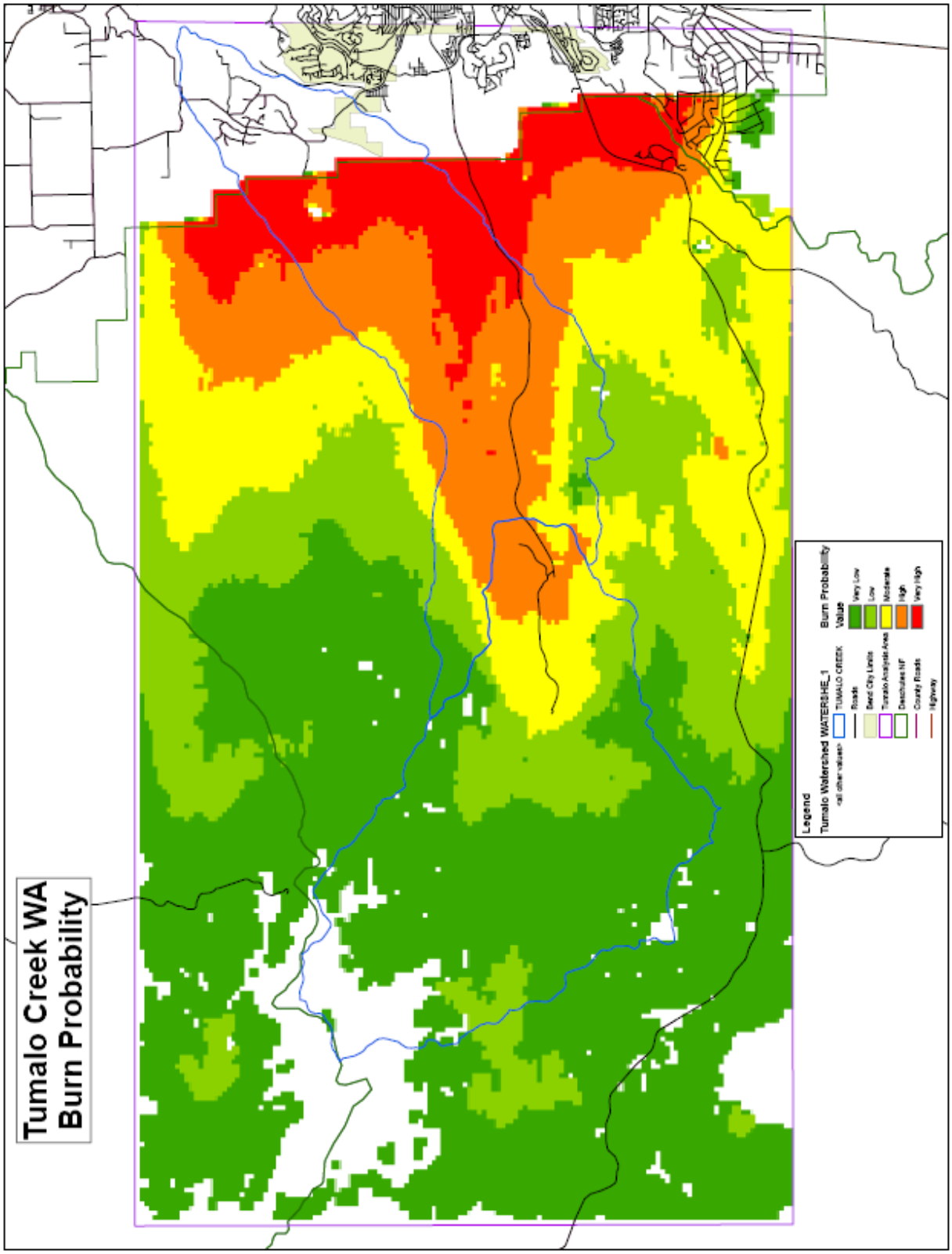


Exhibit 17. Tumalo Creek Watershed Flame Length Potential

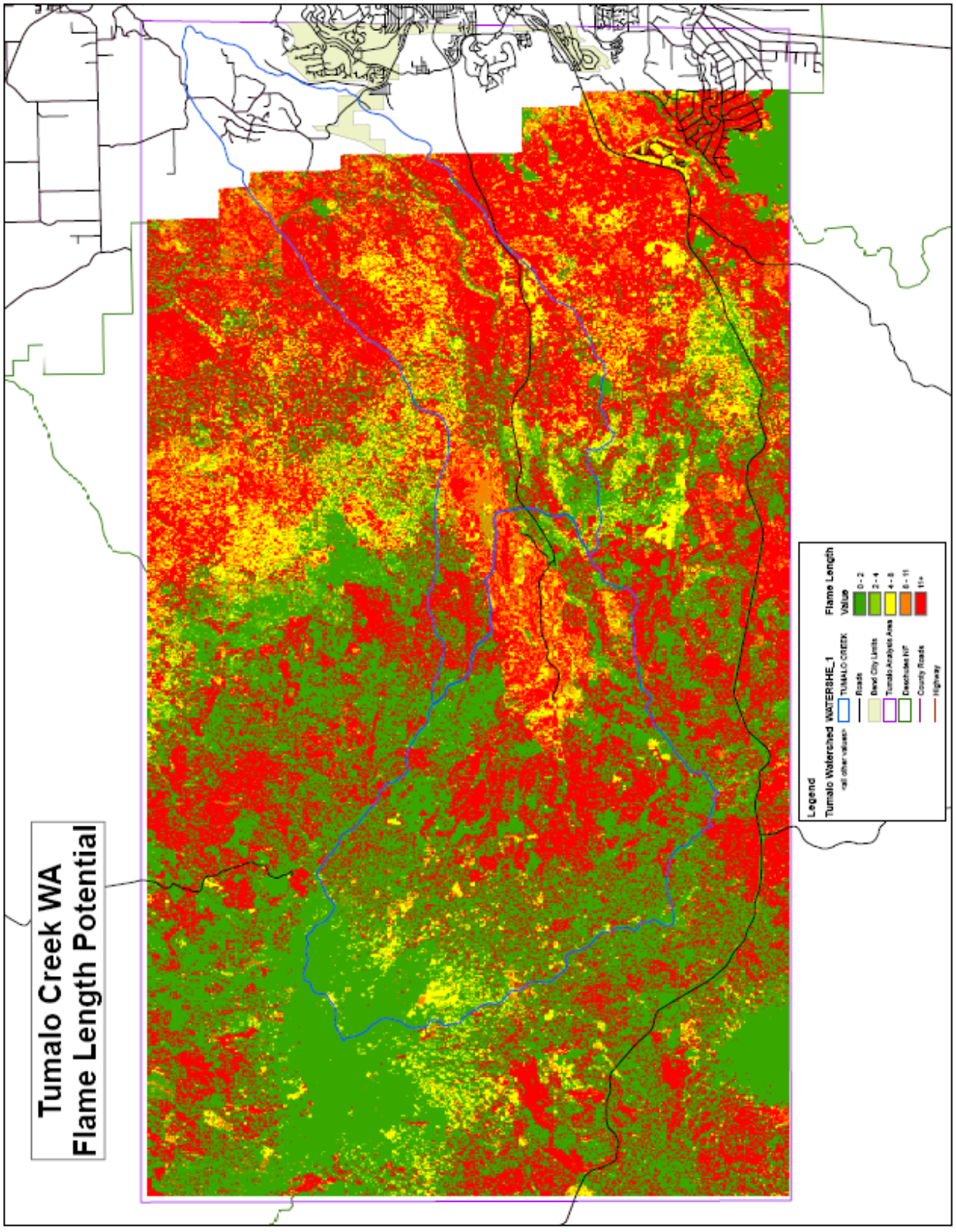


Exhibit 18. Tumalo Creek Watershed Crown Fire Potential

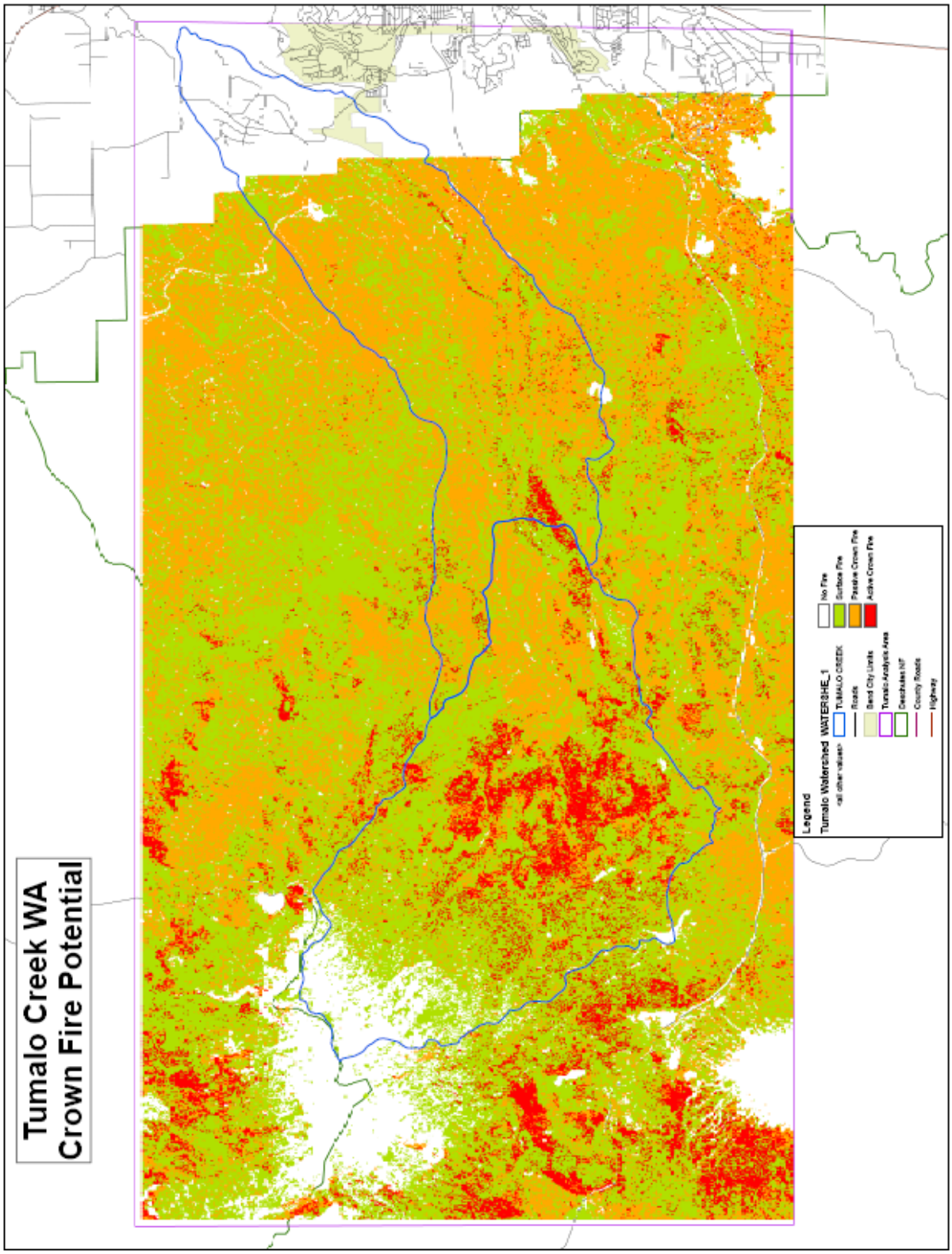
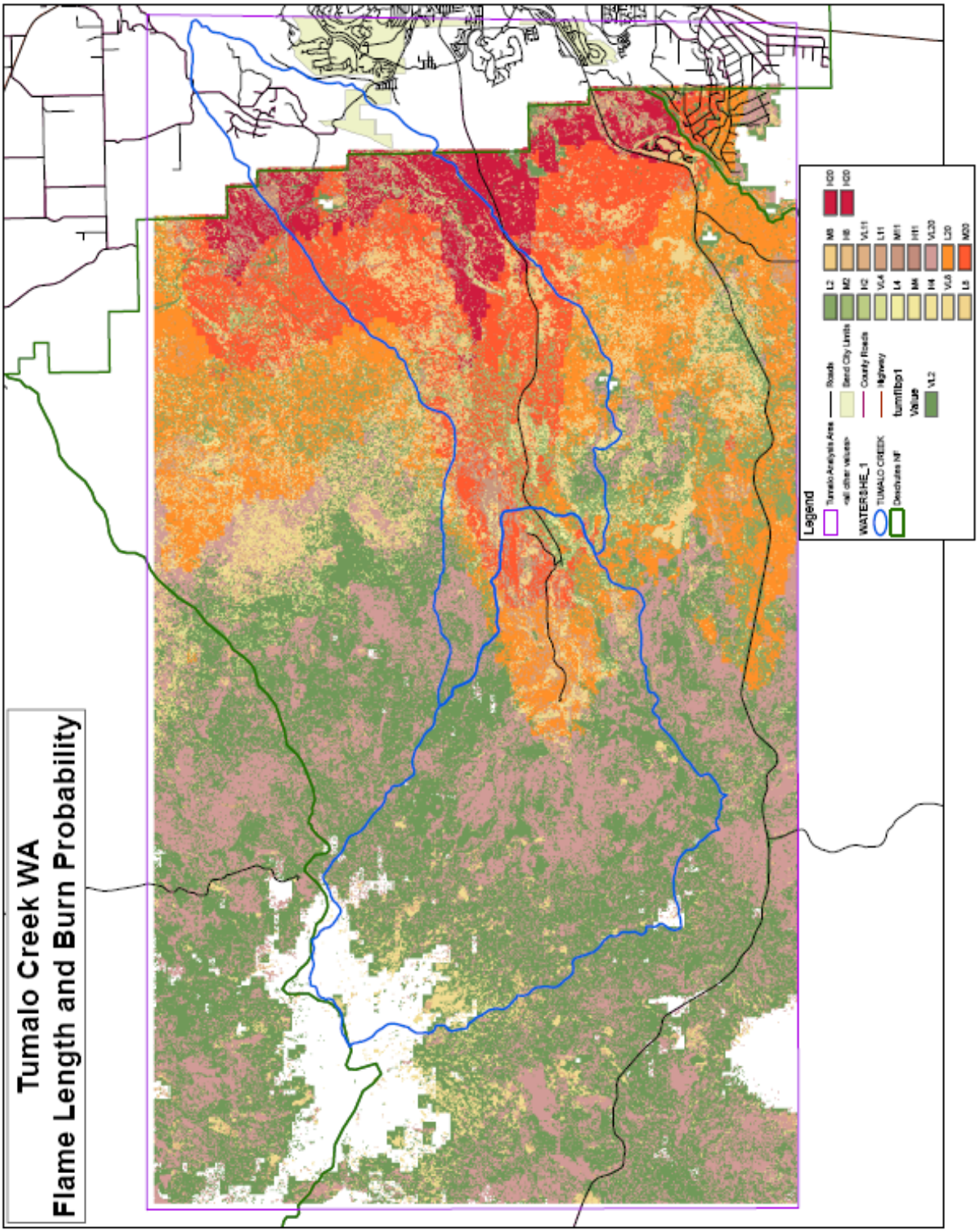


Exhibit 19. Tumalo Creek Watershed Flame Length and Burn Probability



An agreement between the City of Bend and the U.S. Forest Service was made in 1926 describing the major use of the watershed as production of potable water. This agreement stipulated that the Forest Service has the primary responsibility for fire suppression and joint responsibility for prevention.

Within the legal watershed, 365 acres were either partially or totally consumed by the Bridge Creek Fire and 5.1 mm board feet of timber were removed in a salver sale after the fire. All of the slash from this operation has been treated. Fuel loading in this area is now less than 10 tons per acre.

A primary suppression disadvantage is the layout of existing roads in the watershed. Road 4603 ends at the City of Bend Water Intake on Bridge Creek. Road 370 goes through the headwater at the northern end of the watershed. Road 4601 and Roads 700 and 800 border the north rim of Tumalo creek. Trail 23 traverses the watershed from north to south by starting at Happy Valley and crossing Tumalo Creek, it then follows Spring creek for approximately a mile before turning south and crossing Bridge Creek. After passing Swampy Lakes Shelter, the trail ends at Road 80 off Road 4615. It's the most heavily used trail. Trail 24 traverses the east-west axis of the watershed starting at the Bend City Water Intake, following Bridge Creek west and ending on Road 370. According to the Land management Plan's preferred alternative, there are no immediate plans for new roads in the watershed. Detection is also a problem because there are no lookout stations within the watershed. The nearest lookout with visibility into the area is Lava Butte which is located 14 miles to the southeast of the watershed.

The key resource values within the watershed are water, wildlife and dispersed recreation. To date, management activities have been limited primarily to City water improvements, fire protection, and primitive trail development and dispersed recreation.

Communication: Fires in the Tumalo Watershed should be reported to Central Oregon Interagency Dispatch at 416-6800.

Action Plan in Case of Fire: Due to the inaccessibility of the watershed, an observation plane and smoke jumpers from Redmond Air Center will be put on stand-by and dispatched at the request of the Duty Officer, after receiving a "fire report". The District Ranger will notified that an initial attach is underway. If the jump plane and/or smokejumpers are not available, Prineville BLM Helitack will be dispatched. Ground forces will also be dispatched to the nearest trailhead and will start walking to the fire or be flown to the fire via helicopter from Tumalo Falls. The number of air and ground forces depends upon the Action Class of the day, as specified in the Forest Mobilization Plan. Fire retardant use must be approved by the Duty Officer.

There are areas within the watershed where mechanized equipment can be used advantageously, but such use in some areas could create unacceptable environmental impacts. Permission must be granted by the District Ranger for any heavy equipment use in the domestic watershed. In case of a large fire or one with large fire potential, a Resource Advisor or the District Ranger, if available will be ordered. The Resource

Advisor will ensure that the fire suppression action does not create unacceptable environmental impact upon the watershed. The Resource Advisor will ensure that the fire suppression action does not create unacceptable environmental impact upon the watershed. The Resource Advisor will also coordinate if needed a Burned Area Rehabilitation Team which will be assembled to provide expertise for analyzing damage and recommending rehabilitation procedures.

Responsibilities: The U.S. Forest Service has the primary responsibility for suppressing fire in the watershed. They will train the city fire guard with local U.S. Forest Service fire courses that pertain to his/her duties. They will provide aerial detection on high hazard days, and after lightning storms, and will initiate and enforce fire closures. The City of Bend will provide a fire guard to patrol the watershed by foot 5 days a week. This seasonal employee will hike the trails and survey areas in the watershed where people are frequently found.

References: FSM 2500-Watershed Management, 2509.12-FSH Burned Area Emergency Rehabilitation Handbook, 2523-Emergency Rehabilitation of Watersheds Following Wildlife 5106.14-Fire Control/Watershed Management. Greater Bend Community Wildfire Protection Plan, 2006, and Interagency Fire Regime Condition Class Guidebook, 2005, version 1.2.

RECREATION

HISTORIC CONDITION

Wilderness Landscape Area

Recreation use in the Three Sisters Wilderness dates back to the turn of the century. During this era, thousands of sheep and cattle grazed the meadows and openings on both sides of the Cascade Crest. Establishment of the National Forest in 1905 initiated the move toward reduction of livestock numbers and establishment of grazing seasons consistent with the resource capability. Administration was largely custodial in nature from the time the area was included in the National Forest System until the termination of World War II. Trails and administrative facilities suitable for the fire prevention and suppression activities were constructed and maintained during this time.

The Three Sisters Primitive Area was established by the Chief of the Forest Service in 1937 under the authority of Regulation L-20. It consisted of about 191,000 acres of rough, primitive country along the backbone of the Central Oregon Cascades. In 1939 Regulation L-20 was revoked and Regulations U-1 and U-2 were adopted to provide for establishment and management of Wilderness Areas. The Secretary of Agriculture directed that areas established under Regulation L-20 be reclassified under Regulations U-1 and U-2. The Three Sisters Wilderness was established on February 6, 1957. With the passage of the Wilderness Act on September 3, 1964, the area became a part of the National Wilderness Preservation System. The Oregon Wilderness Bill of 1984 expanded

the Sisters Ranger District portion of the Three Sisters Wilderness Area to include some Roadless areas in the vicinity of Snow Creek and Black Crater Lake.

The need to educate users in good Wilderness practices resulted in assignment of the first Wilderness Ranger to the northern portion in 1964. Additional rangers were added over time. Their duties were to furnish information, collect data, clean up campsites and maintain trails. The first of several Forest discussions on coordination and management between the Deschutes and Willamette National Forests occurred during the 1970s. This was also the time when research began to address solutions to management problems. One of the outcomes was the development of the Limits of Acceptable Change (LAC) Process. This gave managers a way to measure and monitors the physical and social impacts of recreation use. Current management direction is provided primarily by the Wilderness Strategies Project EA which was completed and signed in 1990 by a team from the Willamette and Deschutes National Forests.

Most of the current trail system evolved from earlier sheep driveways, firemen way trails, packer routes, and fishermen trails, all of which were refined over time. The trailheads evolved with the road systems as roads were developed closer to the Wilderness boundary. Some of the early trail building and maintenance was done by the Civilian Conservation Corps (CCC). More recently, money for improvements has been provided through the Capital Investment Process which allows all Forest to compete for a pot of money managed at a regional level. Current regional policy is to avoid building new trails. Although changes in the system can be made, there should be no net gain in the miles of trail within in the Wilderness.

Cold Forest/Unroaded Landscape Area

Recreational use within this landscape area was primarily centered around access for wilderness grazing and seasonal hunting. Horse trails that were formed in these areas were most likely converted to roads at some point during the last 50 years. Trail systems that are present include the Swampy Lakes and Virginia Meissner areas, both of which evolved around the designation of old roads/horse trails for Nordic skiing and more recently, mountain bike use. Skyliner Lodge and ski area were also used during the mid 1900's for winter recreation. Development of houses along Tumalo Creek began in the 1950's and continues to a limited extent today.

Bridge Creek Watershed Landscape Area

Located within this Landscape Area is the Bend Municipal Watershed which provides approximately 50 percent of the city water supply. Although trail development within the watershed has been relatively minimal, access and use within the watershed was not limited until after the Bridge Creek Fire in 1979. Trails include the Bridge Creek hikers trail and the winter snowmobile trail #6. Specific recreation restrictions went into effect in 1990.

Front Country/Transition Landscape Area

Recreation within the Cold Forest/Unroaded Landscape Area was historically similar to the Wilderness Landscape Area, with early use centered around access for sheep and cattle grazing. A ranger station present in Happy Valley in the early 1900's provided horse supported supervision of grazing and trail use in the area. Trail development evolved around horse access to the high country lakes. During the early 1960's Road 370 was developed as a highway project between Cascade Lakes and Sisters, although the project was never completed.

Private/ Dry Forest Landscape Area

Recreation use of this area was most likely limited to seasonal hunting and access to higher country areas. Ownership by Cascade Timberlands allows public access and use of roads, although overnight use is prohibited.

Dry Forest Landscape Area

Recreational use of this area primarily centered around access for wilderness grazing and seasonal hunting. The development of mountain biking trails within this landscape area began in the 1980s and now includes an extensive number of trail miles.

CURRENT CONDITION

Wilderness Landscape Area

Recreation within the Wilderness area remains within the designated encounter limits set under Forest Plan Standards and Guidelines for the Wilderness Management Area, although maintaining standards for physical impacts and social encounters may be difficult as use increases. Overall, within the Three Sisters Wilderness, overnight use is down (Hall and Shelby 1992) but day-use increased from 42 percent in 1982 to 76 percent in 1995. The average group size for day use is 2.6 people per party and the average for overnight is 3 per party. Use within the Wilderness has doubled from 1982 to 1991 and has continued to increase at a rate of about 4 percent per years. The portion of the Wilderness within the Tumalo Creek Watershed is used at low to moderate rates, primarily due to the lack of surface water features and developed trails. Use within the Wilderness doubled from 1992 to 2002, and the trend continues to be upward, especially for day use.

Wilderness regulations require that all users carry a self-issue permit. These permits are found at the trailhead bulletin boards along with other pertinent information. Human use includes hiking, horseback riding, hunting, skiing, mountain climbing, nature study, photography and the study and use of Wilderness skills. Wilderness outfitter guides are available for those people who need their services. There is currently a moratorium on allowing additional outfitter guides in wilderness.

Fire has been one of the natural forces that created and maintained ecosystems of the Crest Wildernesses. In 1996, a team from the Deschutes and Willamette National Forest wrote a Prescribed Natural Fire Program Plan for the Mt. Jefferson, Mt. Washington and

Three Sisters Wildernesses. This plan paves the way for the reintroduction of natural fire in the Wilderness. However, a "risk assessment" and "management ignited supplement" must be done before the plan can be implemented. The assessments have not been done although interest has been revitalized with the recent Sisters District fires.

Cold Forest/Un-roaded Landscape Area

Recreation use within this Landscape Area has increased steadily in the past 5 years as trail systems have developed to accommodate uses displaced from the Municipal Watershed and the popularity of the area has increased. Multiple uses of trails in this area are occurring even though some trail segments have been constructed for a specific use. Mountain biking occurs on most trails and conflicts between mountain biking and other uses have the potential to become safety or recreational experience problems. Management may need to restrict trails to specific designated uses if resource related impacts or the safety of users are compromised. Tumalo Creek (North Fork) trail is now restricted to uphill only for bikes. Managing trails for the purpose of preventing overuse or inappropriate types of uses should be determined by monitoring resource conditions and user experiences. As anticipated increase in recreation use could result in decreased water quality and hydrologic function. In general, effects to stream channels from recreation use would be due to road, trail, and dispersed camping use. Lack of maintenance is considered a significant problem because it would allow increasing amounts of sediment to be deposited into streams within this and the Front Country/Transition Landscape Area.

Bridge Watershed Landscape Area

Access and use of the watershed area was severely limited by the City of Bend in response to pressures from the Oregon Health Division which enforces EPA regulations. Municipal water supplies obtained from this watershed are currently not filtered and Oregon Health Division required the implementation of limited use in order to allow this non-practice to continue. Mountain bike use and overnight camping were eliminated in 1995. Use of existing trails is currently limited to day-use hiking only. In the last 6 years, drainage has been improved.

A snowmobile trail that travels through the watershed continues to be open for winter use. There is limited use of winter snowmobile trails in the summer since these trails utilize meadows and other openings and are considered inappropriate and not intended for summer use. Resource damage often occurs when OHV users ignore posted signs restricting OHV use from these trails.

Front Country/Transition Landscape Area

This Landscape Area includes the developed recreation sites at Tumalo Falls Trailhead and Skyliner Lodge. The Tumalo Falls Trailhead, including the parking lot, was reconstructed and a new toilet was installed in the late 1990's, which eliminated the previous issues of erosion from the poorly drained parking lot and leaks from the vault

toilet. The City of Bend Municipal Watershed facilities including a steward's house and intake building are located adjacent to the trailhead parking area.

Skyliner Lodge is a CCC era structure built in the 1930's. Over 70 years old, it is in fair condition and has been improved and well maintained in the mid 1990's. The barrier-free entry was completed and funded by a grant from the Regional Forester's Challenge Cost-Share Program. The Oregon Museum of Science and Industry operates a Cascade Science School here providing outdoor education for young people and has been responsible for several changes on the site, including the addition of yurts as sleeping shelters.

Road 4603 accessing the Tumalo Falls Trailhead is in moderate conditions and presents several safety issues, including a lack of good sight distance and the loss of the original surfacing material. There conditions usually occur where the road is either two-lanes or in some cases, only one-lane. Overgrown brush on either side of road also hinders sight distance. The Skyliner Bridge was replaced in 2003 but the bridge near the Tumalo Falls day use area remains in marginal condition and needs to be either replaced or reconstructed.

The Swampy Lakes Trail system continues to receive winter Nordic use and summertime hiking and mountain biking use. The addition of the Swede Ridge access trail has completed a loop opportunity for users accessing this system from the Tumalo Falls or Skyliner Lodge trailheads.

Dispersed camping is popular along Roads 370, 4601, and 4602, Typical impacts from dispersed car camping includes the denuding the trampling of vegetation, soil compaction, and related erosion, and the removal of vegetation either dead or alive for firewood. Current access to the road systems is somewhat limited by gates. Road 370 is usually under snow until early August and gates control traffic use until the road is dry enough to support vehicular traffic. Normal use season is August through October. Road 370 and Road 4601 are in particularly poor condition due to heavy use and minimal levels of road maintenance. The trend is for a gradual decline of the road's condition. Reconstruction would be required to bring it to an acceptable standard.

Private/Dry Forest Landscape Area

Recreation use within this landscape area continues to occur under accepted Cascade Timberlands conditions of day-use only. Horseback riding trails near Tumalo Reservoir and a mountain bike trail from Shevlin Park to the Bridge Creek Fire area are used and maintained by the public. The Road 4606 system is primarily located on Cascade Timberlands and overnight use is prohibited there.

Dry Forest

Recreation use for this landscape area is primarily tied to the mountain bike trail system emanating from the Phil's Trail Trailhead. Other activities include road driving and dispersed camping.

Trail Conditions

The Metolius-Windigo horse trail to the Three Creeks Lake area was done in 2003 which moved the trail off of Road 370. In general trails within the watershed are in good condition since approximately 40 percent of the summer trails have been constructed in the last 7 years. Pre-existing trails are also in good condition. In most cases, trails are located in upland vegetation areas away from riparian areas. Trails following Bridge Creek and Tumalo Creek are low in gradient and in good condition due to the many drainage structures built. Some of the water bars on the Bridge Creek Trail need to be replaced and the drainage structures built. Some of the water bars on the Bridge Creek Trail need to be replaced and the drainage structures on all of the trails need annual cleaning. Typically, user trails developing over time lead to viewpoints or goes the water's edge and has the potential for erosion and sediment contribution to perennial streams. Both Bridge and Tumalo Creek are in good condition relative to user trail development.

Erosion Processes

The existing trail conditions do not contribute to the sediment directly into the streams. There are portions of the trails, especially on steeper pitches where water may run down trails and off of the trail periodically. The typical situation is to have the water exit the trail and deposit the sediment within 10 feet of the trail's edge. For both Bridge and Tumalo Creek trails, although the trails parallel the streams closely, sedimentation going directly into the streams rarely occurs.

Increasing use on the trails has increased soil disturbance within the trail tread, creating further fishing or trenching of many trails. At some point, the trenching will increase beyond the point where a water bar or drain dip can effectively divert the water off the trail. As volume and velocity of the water increases, the potential for an increase in sediments reaching water courses also increases. Normally, this could take 30 years or more to occur if the trail was well designed and constructed to specifications, although this could occur in less time due to the trend of increased use and types of uses. Implementing mitigation measures could slow down the anticipated negative impacts. There are concerns for the area just above Tumalo Falls for ¼ mile where high use and bank erosion have occurred on the trail. A change in the course of the creek has added to the problem

The access roads in the area are already in a condition that would require repair, heavy maintenance or reconstruction. Specifically, Road 370 and its tributaries and Road 4601 on the east and steeper slopes are already eroding at an accelerated rate and additional traffic would continue this trend. The majority of erosion that is occurring does not cause direct damages to any streams, although Road 370 crosses the North Fork of Tumalo Creek without any bridge structures. Other roads within the area are less steep and in better condition. Significant increase in OHV use has occurred on and off roads in the area. Illegal OHV use occurring on trails, primarily off the 370 road.

Human Impacts

The trend of increased recreation use in the watershed area has been established over the last few years as the population in central Oregon increases and its popularity as a destination resort and recreation area has grown. Most of the day-use activities are hiking, mountain biking, and horseback riding. Restrictions prevent domestic animals, bikes, overnight camping, and campfires in the City of Bend Municipal Watershed Area. These restrictions will remain unless the status of the watershed as a surface water system changes in the future. The two fastest growing recreation utilizations of the watershed are mountain biking and horseback riding. The increase in horseback riding can be attributed to the development of Todd Creek Horse Camp. The population of Central Oregon is continuing to grow, and due to the easy access from the city of Bend an increased interest in hiking is expected.

Although hunting has decreased throughout the watershed, dispersed camping still occurs. Off-trail use is high during hunting season but fairly low during the summer season. Most of the off-trail use occurs in the winter due to snowmobilers having more access. Most of the trail use occurs in the winter due to the snowmobilers having more access. Most of the trail users are Nordic skiers with backcountry skies going off-trail to avoid snowmobilers. Daily use counts have increased approximately 5 to 10 percent per year over the last several years over most of the area.

Resource Concerns

Additional resource concerns related to trail use and recreational experiences include trails that go through wet meadow areas; trail short-cutting resulting in erosion; camping adjacent to lakes or streams; the proliferation of user created trails on certain routs including peak climbing; the depletion of dead and down woody component resulting from the use of campfires; and camping in or on the edge of the meadows.

THREATENED, ENDANGERED, AND SENSITIVE PLANTS, SURVEY AND MANAGE PLANTS, and INVASIVE PLANTS

Existing Distribution

No Threatened or Endangered plant species, or their habitats, are known to occur within the Tumalo Creek Watershed. There are five Regional Forester's Sensitive plant species within the watershed, described in this document.

A relatively small portion of the Tumalo Creek Watershed has been surveyed for Threatened, Endangered, and Sensitive plants (TES Plants). Past surveys for these plants have covered about 25% of the watershed, including the Tumalo Creek floodplain. In January 2008, an additional 23 species were added to the Regional Forester's Sensitive plant list. Surveys conducted prior to this time did not focus on these species or their habitats. Potential habitat appears to be present for some of these new species, and as

more surveys are conducted, it is possible that TES species populations may occur within this watershed.

The following Sensitive species are known within the watershed boundary:

Newberry Gentian (*Gentiana newberryi)*

The Tumalo Creek watershed contains excellent habitat for this species; thirteen populations have been found in the western half of the watershed.

Habitat is found in moist meadows or adjacent to streams and rivers above 4,700 feet. It is likely that more sites are present but have not yet been found, due to the fragmented nature of surveys in the area.

Capitate Sedge (*Carex capitata*)

Habitat for this species is generally in open, wet places, but is sometimes found in drier sites at high elevations**.** In the Pacific Northwest, it is often found on sandy, acidic soils. This species is known from six sites on the Deschutes National Forest. Sisters Ranger District has two sites in the Three Creeks Lakes area, Crescent has a site near Odell Lake and another near Crescent Lake, and Bend has one site near Little Cultus Lake and one site within the Tumalo Watershed. This site is on an unnamed side tributary to Tumalo Creek in the western part of the watershed.

Lesser Bladderwort (*Utricularia minor*)

This submerged insectivorous plant is found in shallow, standing or slow-moving water that has poor nutrient quality. It has been documented on the Deschutes National Forest on both the Sisters and the Bend Ranger Districts. In 2008 it was located in a fen in the northwestern portion of the Tumalo watershed.

M**oss (*Tomentypnum nitens*)**

Habitat for this moss is slightly raised hummocks, logs, or stumps in medium to rich montane fens in elevations ranging from 5,000 to 6,000 ft. A constant source of low-volume moisture appears to be a critical habitat component for this moss. Several populations of this moss have been located on all three Ranger Districts of the Deschutes National Forest. It has been located at two separate sites, both small fens, within the Tumalo Creek drainage. How much habitat for this species exists in the area is not known as it is a recent addition to the Regional Forester's sensitive plant species list and historic surveys did not focus on this species or the micro-habitats where this species is found.

Liverwort (*Tritomaria exsectiformis*)

The typical habitat for this species is open to shaded coniferous forests at elevation (3,200 – 5,200 feet). In Oregon, this liverwort is usually associated with low volume, perennial water flow from spring-fed hydrologic systems in low gradient areas. It is known from all three ranger districts of the Deschutes National Forest.

POTENTIAL HABITAT

Potential habitat exists for the following Sensitive plant species, although to date there are no known sites for them within the watershed with the exception of the species mentioned above:

Tall Agoseris (*Agoseris elata*)

Nonforest and openings in ponderosa pine and, rarely, lodgepole pine. Dry edges of moist ecotones adjacent to moist meadows, lakes, stream courses, riverbanks. Nearest known occurrences are on the Sisters Ranger District. Low probability.

Shasta Arnica (*Arnica viscosa*)

Its habitat is alpine or subalpine rocky sites, relatively steep screen and talus slopes above or at treeline, elevation 6,500 feet to 9,200 feet. There are isolated areas of potential habitat in the western quarter of the watershed area.

A population containing several hundred plants exists several miles to the west of the watershed. It is the only known population of this sensitive species, although few surveys have been conducted with the intent of locating more.

Its range extends from Central Oregon to northern California, where it is considered uncommon. Moderate probability.

Peck's Milkvetch (*Astragalus peckii*)

Most commonly found in shrub-steppe plant associations, but has also been reported from common juniper woodlands, ponderosa pine forest edge and lodgepole pine forest openings. It grows in loose, deep pumice, loamy sand, or sandy soils with flat to gentle slopes. It has often been found in or along dry watercourses, old lakebeds (basins), pumice flats and other natural openings. Most of its preferred habitat lies just outside the watershed, to the northeast. Low probability.

Pumice Grape-fern (*Botrychium pumicola*)

This Central Oregon endemic is known from alpine and montane habitats. It occurs in the pumice soils of lodgepole pine openings and frost pockets, and also at elevations as high as 9,100 feet.

Potential habitat is present in the western fringe of the analysis area but extensive surveys have not been conducted; known sites lie less than a mile to the west. Within the lower-elevation, montane site type, there may be more sites that

remain to be found, although in this elevation band there is little habitat present. Low probability.

Brewer's Reedgrass (*Calamagrostis breweri*)

Moist-dry alpine and subalpine meadows, open slopes, stream banks, and lake margins between 4,600 feet and 6,000 feet. Has not been found on the Deschutes National Forest; nearest sites are west of the Cascade Mountains. Low probability.

Abrupt-beaked Sedge (*Carex abrupta*)

Moist meadows and streambanks at moderate to high elevations in the mountains. Closest known population is on the Willamette National Forest. Has not been found on the Deschutes National Forest. Moderate probability.

Lesser Panicled Sedge (*Carex diandra*)

Swampy, marshy, or boggy areas, especially wet meadows, fens, muskegs, floating mats and peaty shores of lakes and ponds. Often is found in shallow sometimes brackish water. In the mountains. Known from Lake and Lane Counties. Has not been found on the Deschutes National Forest. Moderate probability.

Slender Sedge (*Carex lasiocarpa* var. *americana*)

Found in fens, bogs, lakeshores, and wet meadows, in deep, organic, acidic soils with low to moderate nutrient levels. At mid elevations. Known from sites elsewhere on the Bend/Ft. Rock Ranger District, and also from Big Marsh on the Crescent Ranger District. Low probability.

Pale Sedge (*Carex livida*)

Open bogs and fens with water tables above ground level for the majority of the growing season, peat lands. Known sites are between 2,000 feet and 8,000 feet. Closest recorded population is in Lane County. Has not been found on the Deschutes National Forest. Moderate probability.

Green-tinged Paintbrush (*Castilleja chlorotica*)

Many sites for this Central Oregon endemic have been discovered on the Bend/Ft. Rock Ranger District, the closest being about one mile south of the watershed. Typical habitat includes open areas and forested openings in ponderosa pine, lodgepole pine, and mixed conifers, in rocky soils, often with sagebrush or bitterbrush. It has been found at elevations between 4,200 feet and 8,200 feet, although locally the majority of populations have been limited to an elevation band of 4,200 feet to 4,800 feet, in association with bitterbrush. The exceptions locally are two small sites that have been found at elevations of 5,300 and 5,900 feet. Low probability.

Fee's Lip-fern (*Cheilanthes feei*)

Located in crevices on cliffs, especially of basalt origin. Known in Oregon from Wallowa County. Not known from the Deschutes National Forest or Central Oregon. Low probability.

Lichen (*Dermatocarpon meiophyllizum*)

Found on the rocks of stream channels and lake shores within the splash zone, but can be found submerged and up to 2 meters above the water surface. It has also been found in seeps and on both basic and acidic rocks. Only known from exposed or partially exposed sites. Elevations range between 200 - 7500 ft., but is generally considered to be high elevational. Closest known site is on the Umpqua NF. Low probability.

Gorman's Aster (*Eucephalus gormannii,* formerly *Aster gormannii*)

Endemic to Oregon, in nonforest and forest openings, subalpine and alpine, dry exposures, and open rocky slopes. Known from the west side and crest of the Cascade Mountains between 4,000 feet and 6,500 feet. Low probability.

Moss (*Helodium blandowii*)

Found in montane fens where it can form small hummocks or mats. Can be associated with sedges and shrubs bordering fens or along the small streams with fens. Elevations between 5000 – 6000 feet. Associated with true firs and lodgepole pine. Known from two sites on the Bend/Ft. Rock Ranger District west of the Cascade Lakes Highway.

Skin Lichen (*Leptogium cyanescens*)

On trees in humid forests; widely scattered. On mossy trees and rocks or directly on rock when near water. Considered riparian through 2001. Recently documented in upland settings on vine maple, big leaf maple, and in moss on white oak. Associated with Western Hemlock and Pacific Silver Fir Zones in mixed conifer stands, mature big leaf maple and Douglas-fir stands, maple and willow thickets. Not known from the Central Oregon. Low probability.

Aristulate lipocarpha (*Lipocarpha aristulata*)

On sandy soils in wet bottomlands, sand bars, emergent shorelines, ditches, and ponds, at elevations from 0 – 4900 feet. Not known from Central Oregon. Low probability.

Water Lobelia (*Lobelia dortmanna*)

In shallow water, up to a depth of 2 meters, at the margins of lakes and ponds. Known mainly from low elevations, but found on the Sisters Ranger District at an elevation of 3,500 feet, which is the only known site in Oregon. Low probability.

Inundated Club-moss (*Lycopodiella inundata*)

Deflation areas in coastal back-dunes; montane bogs, including sphagnum bogs; less often, wet meadows. Known on Deschutes National Forest from the Crescent

Ranger District. There may be habitat present at small, high-elevation sites. Moderate probability.

Ground Cedar (*Lycopodium complanatum)*

There are no known sites of this species within the watershed, although a similar species in this genus exists in a meadow near Highway 46. It has not been found elsewhere on the Deschutes National Forest.

Potential habitat occurs at the edges of wet meadows within coniferous forest; it has also been found on dry, forested mid-slopes with low canopy cover. Within the watershed, it may occur elsewhere but its narrow habitat preference may be limiting. Moderate probability.

Annual dropseed (*Muhlenbergia minutissima*)

Sandy riverbanks, moist meadows, open rocky slopes, and receding banks of reservoirs. Not known from Central Oregon. Low probability.

Adders-tongue (*Ophioglossum pusillum*)

Moist to wet meadows among low shrubs, sedges, and grape-ferns. Found at elevations between 5 feet and 5,000 feet. This species has not been found on the Deschutes National Forest. Low probability.

Fungus (*Ramaria amyloidea*)

Coral-like fungus on moist humus or wood, or under duff. May favor hemlock. Fall species. Associated with *Abies spp., Pseudotsuga menziesii* and *Tsuga heterophylla*. There is a known site on the Crescent Ranger District. Moderate probability.

***Rhizomnium nudum* (Moss)**

Its habitat is coniferous forests that include silver fir, western hemlock, mountain hemlock, western red cedar and Engelmann spruce; on the Deschutes National Forest sites (three sites near the Cascade Lakes highway corridor zone), lodgepole pine, Engelmann spruce, mountain hemlock, and western white pine are the primary forest trees. It occurs on humus or mineral soil in seepages, vernally wet depressions or intermittently wet, low-gradient channels on a substrate that is continuously wet. Exposure varies from full sun to full shade. Though not known from this watershed, it is likely that sites may yet be found. Moderate probability.

Scheuchzeria (*Scheuchzeria palustris* ssp. *americana*)

Potential habitat is open-canopied bogs, fens, and other wetlands where it is often in shallow water. It is primarily known from west of the Cascade Mountains. This species is known on the Deschutes National Forest from a fen near Little Cultus Lake. Moderate probability.

Luminous Moss (***Schistostega pennata)***

On mineral soil in damp caves and crevices and on the soil-bearing root masses of fallen trees. Often near streams or other wet areas. Requires humid, heavily shaded micro-sites. Most commonly found within silver fir plant series but also common in western hemlock and mountain hemlock series. Also in lodgepole pine stands near water. Stands are typically late seral or old growth. Known sites on the Crescent Ranger District. Moderate probability.

Water Clubrush (*Schoenoplectus subterminalis* formerly *Scirpus subterminalis*)

Generally submerged to emergent in quiet water 2-8 decimeters deep, in peat-lands, sedge fens, creeks, ditches, ponds and lakes. Known from the Crescent Ranger District in Big Marsh. Low probability.

Marginate Splashzone Moss (*Scouleria marginata*)

Often forming dark mats on exposed to shaded rocks in streams; seasonally submerged or emergent. Moderate probability.

Alpova alexsmithii.

Fungus. Occurs principally on soil in Pacific Silver Fir (44%) and Mountain Hemlock (44%) series at elevations of 2742-5764 feet. A mycorhizal associate of *Tsuga*. Associated species include Pacific silver fir, lodgepole pine, Engelmann spruce and mountain hemlock. Other woody associates include *Vaccinium membranaceum* and *Vaccinium scoparium*. Fruits August-December. Documented from the Mt. Jefferson Wilderness on the Deschutes National Forest.

Gastroboletus vividus.

Fungus. Found in association with the roots of *Abies magnifica* and *Tsuga mertensiana* above 5,000'. Fruits July-September. A known site at Crater Lake National Park. No known sites on the Deschutes National Forest.

Ramaria amyloidea.

Fungus. Coral-like fungi on moist humus or wood, or under duff. May favor hemlock. Fall species. Associated with *Abies* spp., *Pseudotsuga menziesii* and *Tsuga heterophylla.*

Hygrophorus caeruleus.

Fungus. Associated with roots of Pinaceae; may be restricted to *Abies*. Typically fruits in mid-elevation to montane conifer forests in the spring near melting snowbanks. Fruits May-July. Documented on the Deschutes National Forest.

Helvella crassitunicata.

Fungus. Occurs in montane forests containing *Abies* spp., from old growth and younger age groups, from low to high elevation in the fall and winter, occasionally on trails, or other moderately disturbed areas. Documented on the Sisters district of the Deschutes National Forest.

THREATS TO SENSITIVE PLANT HABITAT QUALITY

The following factors have affected or may affect sensitive plant habitat quality in the watershed:

Driving over it/digging: One of the Newberry's Gentian sites within the watershed lies in a site within the wilderness where someone has been driving into the meadow and digging up small lodgepole trees, presumably for resale to nurseries. This illegal activity is imperiling the plants at this site.

Foot, horse, or bike traffic, or dispersed camping: Elsewhere in the watershed, where as-yet un-surveyed habitat may exist, these activities could be negatively impacting habitat quality for Newberry's Gentian. These same types of activities could also impact the habitat quality for the known Peck's Milkvetch population.

Invasive Plant Species Encroachment: No noxious weeds are known to be in close association with sensitive plant populations in the watershed at this time. However, noxious weeds are present in the watershed and more are found there every year. This trend could eventually threaten sensitive plant habitat and sites, and especially, overall native plant species diversity.

Fire Suppression: Over time, since the era of fire suppression began, the size and number of forest openings has been reduced in the lower portions of the watershed. Openings create important islands for plant diversity and habitat for sensitive species as well. Encroachment of meadows by lodgepole pine is an example of this situation, whereby competition and shading from trees reduce opportunities for native and sensitive plants to flourish.

INVASIVE PLANTS

By far, the majority of invasive plants within the watershed occur within the Tumalo Creek floodplain. Of special concern is the proliferation of spotted knapweed (*Centaurea maculosa***)**, but Canada thistle (*Circium arvense*) occurs there also. The conduit is Skyliner Road, which leads from Bend, where the knapweed populations are legion. There are sites within the riparian zone throughout the length of the floodplain, as well as along the roadside there. There are also sites higher, adjacent to Bridge Creek at the outflow building and near the caretaker's residence. The sites along the road that occur more than 100' from the creek through Tumalo floodplain are being treated with herbicides, and the remainder are being hand-pulled. Biological control agents (insects that are a plant species' natural enemies) have been released on two Canada thistle sites within the floodplain. The sites along Skyliner are being controlled with herbicides, where they lie adjacent to Forest Service land; there are sites on Skyliner that remain untreated because they occur adjacent to private land.

There are many other invasive plant species that could invade the watershed, such as diffuse knapweed (*Centaurea diffusa*) and yellow star thistle (*Centaurea solstitialis*). Increased weed infestations in the watershed can be expected with increasing recreational use and existing disturbed sites.

Table 28.Deschutes National Forest Sensitive Plant Species List

Fifty-nine plants are currently on the Regional Forester's Sensitive Species List (FSM 2670.44, Jan.2008) for the Deschutes National Forest, as follows (BFR = Bend/Fort Rock District, CRE = Crescent District, SIS = Sisters District):

Scientific Name	Common Name	LISTING STATUS	District		
			BFR	CRE	SIS
Agoseris elata	Tall agoseris	ONHP List 2	S	S	D
Arabis suffrutescens var. *horizontalis*	Crater Lake rockcress	Sp. Of Concern ONHP List 1	---	S	---
Arnica viscosa	Shasta arnica	ONHP List 2	D	S	S
Astragalus peckii	Peck's milk-vetch	ONHP List 1	D	D	S
Barbilophozia lycopodioides (LIVERWORT)		ONHP List 2	S	S	S
Botrychium pumicola	Pumice grape-fern	ONHP List 1	D	D	---
Brachydontium olympicum (MOSS)		ONHP List 2	S	S	S
Calamagrostis breweri	Brewer's reedgrass	ONHP List 2	S	S	S
Carex abrupta	Abrupt-beaked sedge	ONHP List 2	S	S	S
Carex capitata	Capitate sedge	ONHP List 2	D	D	D
Carex diandra	Lesser panicled sedge	ONHP List 2	S	S	S
Carex lasiocarpa var. *americana*	Slender sedge	ONHP List 2	D	S	S
Carex livida	Pale sedge	ONHP List 2	S	S	S
Carex retrorsa	Retrorse sedge	ONHP List 2	S	S	S
Carex vernacula	Native sedge	ONHP List 2	S	S	S
Castelleja chlorotica	Green-tinged paintbrush	ONHP List 1	D	S	S
Cheilanthes feei	Fee's lip-fern	ONHP List 2	S	S	S
Chiloscyphus gemmiparus (LIVERWORT)		ONHP List 1	S	S	S
Cicuta bulbifera	Bulb-bearing water-hemlock	ONHP List 2ex	S	S	S
Collomia mazama	Mt. Mazama collomia	ONHP List 1	S	S	S
Conostomum tetragonum (MOSS)		ONHP List 2	S	S	S
Cyperus acuminatus	Short-pointed cyperus	ONHP List 2	D	D	S
Cyperus lupulinus ssp. lupulinus	Cyperus	ONHP List 2	S	S	S
Dermatocarpon meiophyllizum (LICHEN)		ONHP List 3	S	S	S
Elatine brachysperma	Short-seeded waterwort	ONHP List 2	S	S	S
Eucephalus gormanii	Gorman's aster	ONHP List 1	S	S	S
Gentiana newberryi var. *newberryi*	Newberry's gentian	ONHP List 2	D	S	D
Helodium blandowii (MOSS)		ONHP List 2	D	S	S
Heliotropium curassavicum	Salt heliotrope	ONHP List 2	S	S	S

Leptogium cyanescens (LICHEN)		ONHP List 3	S	S	S
Lipocarpha aristulata	Aristulate lipocarpha	ONHP List 2	S	S	S
Lobelia dortmanna	Water lobelia	ONHP List 2	S	S	D
Lycopodiella inundata	Bog club-moss	ONHP List 2	S	D	S
Lycopodium complanatum	Ground cedar	ONHP List 2	S	S	S
Muhlenbergia minutissima	Annual dropseed	ONHP List 2	S	S	S
Ophioglossum pusillum	Adder's-tongue	ONHP List 2	S	S	S
Penstemon peckii	Peck's penstemon	Sp. Of Concern ONHP List 1	S	S	D
Pilularia americana	American pillwort	ONHP List 2	S	S	---
Polytrichum sphaerothecium (MOSS)		ONHP List 2	S	S	S
Potamogeton diversifolius	Rafinesque's pondweed	ONHP List 2	S	S	S
Pseudocalliergon trifarium (MOSS)		ONHP List 2	S	S	S
Rhizomnium nudum (MOSS)		Dropped—"too common"	D	D	D
Rorippa columbiae	Columbia cress	ONHP List 1	S	D	S
Rotala ramosior	Lowland toothcup	ONHP List 2	S	S	S
Scheuchzeria palustris ssp. *americana*	Scheuchzeria	ONHP List 2	D	S	S
Schistostega pennata (MOSS)		ONHP List 2	S	D	S
Schoenoplectus subterminalis	Water clubrush	ONHP List 2	S	D	S
Scouleria marginata (MOSS)		ONHP List 3	S	S	S
Splachnum ampullaceum (MOSS)		ONHP List 2	S	S	S
Texosporium sancti-jacobi (LICHEN)		Sp. of Concern ONHP List 2	S	S	S
Tomentypnum nitens (MOSS)		ONHP List 2	D	D	D
Trematodon boasii (MOSS)		ONHP List 1	S	S	S
Tritomaria exsectiformis (LIVERWORT)		ONHP List 2	D	D	D
Utricularia minor	Lesser bladderwort	ONHP List 2	D	S	D
FUNGI (detection issues)					
Alpova alexsmithii		ONHP List 1	S	S	D
Gastroboletus vividus		ONHP List 1	S	S	S
Helvella crassitunicata		ONHP List 2	D on DES	D on DES	D on DES
Hygrophorus caeruleus		ONHP List 2	S	S	D
Ramaria amyloidea		ONHP List 2	S	D	S

CODES:
--- = Not documented or suspected
D = Documented
S = Suspected

Species of Concern = Federal Designation; neither Endangered or Threatened

ONHP List 1 = Oregon Natural Heritage Program List: Contains species which are endangered or threatened throughout their range or which are presumed extinct.

ONHP List 2 = Oregon Natural Heritage Program List: Contains species which are threatened, endangered or possibly extirpated from Oregon, but more common or stable elsewhere.
ONHP List 2-ex = Extirpated in Oregon.

ONHP List 3 = Oregon Natural Heritage Program List: Contains species for which more information is needed before status can be determined, but which may be threatened or endangered in Oregon or throughout their range.

ONHP List 4 = Oregon Natural Heritage Program List: Contains species of concern which are not currently threatened or endangered.

Chapter V - Trends and Interpretation

TREND RATINGS

The team identified trends occurring within each landscape area that relate to the watershed's primary issues and key questions. A trend rating system was developed which measures the short-term risk to the ecosystems by describing the source of the problem of occurrence and the resources affected. The trends are rated as high, moderate, or low based upon the amount of expected change from current and historic conditions. The ecological integrity of each landscape area was also given a rating based upon how much of a departure was evident from historic regimes. Further support is from the description of the conditions affecting the ecosystem. Both the trend ratings and ecological integrity ratings were then used to develop the management recommendations in Chapter VI.

Wilderness Landscape Area

Trend #1: More old forest currently exists than under native disturbance regimes.
Cause: Lack of disturbance, including fire suppression efforts.

Resources Affected: All resources are affected to some extent, most notably vegetation as forest structures continue to advance to age (Ever increasing risk of stand replacement event) and wildlife habitat (lack of early forest structure, as openings become filled with trees). Stand conditions will eventually become less stable, a result of insect, disease, and other disturbance agents. In addition, fire risks over time will build as fuel loadings increase and these increased risks include the spread of fire from the Wilderness into the Front Country/Transition Landscape Area directly to the east.

Trend #1: More old forest currently exists than under native disturbance regimes.

Cause: Lack of disturbance, including fire suppression efforts.

Trend Rating: Moderate

Rationale for Rating: Although the late and old forest structure continues to increase proportionately on the landscape, these conditions have not departed greatly from the native forest conditions prior to fire suppression. Increasing forest biomass will eventually result in higher intensity fires and great consumption of fuels, yielding more difficult control efforts. However, for the near future, this area will remain a high priority for fire suppression efforts in order to protect surrounding resource area values.

Trends #2: Increased recreation use is resulting in more trail impacts which include loss of trail tread integrity from heavy traffic and horse use.

Cause: Increasing population numbers and marking of the area development of new trails, trailheads, and horse camps making the area more accessible to the public.
Resources Affected: Vegetation, Soils, Water Quality, Wildlife, Recreation Experience

Trend Rating: Low-Moderate

Rationale for Rating: Use will continue to increase in the area at a moderate rate and will be affected primarily by access from Road 370. The development of Todd Creek Horse Camp may increase recreation use of this area by those accessing the Wilderness by horse.

Trends #3: The extent of fire, including frequency of occurrence and amount of acreage, has decreased within the plant associations located in the Wilderness area.

Cause: Fire suppression efforts.

Resources Affected: All resources are affected to some extent, most notably vegetation (Increased risk of stand replacement events), water quality (increased overland flows), and wildlife (habitat changes, lack of structural diversity). The risk of fire movement from here to the Front Country/Transition Landscape Area to the east is increasing.

Trend Rating: Moderate

Rational for Rating: Although the frequency and extent of fires is decreasing, the majority of forest conditions remain within the normal fire return interval of the mountain hemlock plant association. Increased little and duff levels raise the risk of higher intensity and longer duration burns at the soil surface as forest conditions approach the upper end of this return interval. Fire suppression efforts are likely to remain a priority for this area due to the high fuel load condition of the Front Country/Transition Landscape Area located to the east and close proximity to Bend and to the Bend Municipal Watershed.

Cold Forest/Un-roaded Landscape Area

Trend #1: More old forest exists currently than probably existed under native disturbance regimes.

Cause: Lack of disturbance including fire suppression efforts.

Resources Affected: All resources are affected to some extent, most notably vegetation as forest structures continue to advance in age (ever increasing risk of stand replacement event) and wildlife habitat (lack of early forest structure, as openings become filled with trees). Stand conditions will eventually become less stable, a result of insect, disease, and other disturbance agents. In addition, fire risks over time will build as fuel loadings increase and these increased risks include the spread of fire from the un-roaded areas into the Front Country/Transition Landscape Area directly to the east.

Trend Rating: Moderate

Rational for Rating: Although the late and old forest structure continues to increase proportionately on the landscape, these conditions have not yet departed greatly from the native forest conditions prior to fire suppression. Increasing forest biomass will eventually result in higher intensity and greater consumption of fuels, yielding more difficult control efforts. However, for the near future, this area will remain a high priority of fire suppression efforts in order to protect surrounding resource area values.

Trends #2: Recreation use is increasing.

Cause: Trail development and user-created trails, demand from the mountain biking community for more single track trails, increased marketing of the area, and an increased population base. There is also an increase in winter recreation use of back country and off-trail use for both motorized and non-motorized activities.

Resources Affected: Recreation Experience

Rating: Low-Moderate

Rational for Rating: As trail access and opportunities have increased, so have the number of users. The largest increase has come from mountain bike users. Horse use has also increased with the development of Todd Creek Horse Camp and the adjacent Metolius-Windigo Trail.

Trend #3: The road surface and stream crossings of Road 370 are gradually deteriorating over time. . The road surface of road 370 has had some improvements made since 1998, including small culvert crossings of some intermittent channels and spot surface improvements. The ford of the middle fork of Tumalo creek remains a seasonal source of sediment.

Cause: Automobile use during wet weather conditions and low levels of road maintenance.

Resources Affected: Soils, Hydrology, and Water Quality

Trend Rating: High

Rational for Rating: Existing gates on each of Road 370 limit use to August through October, although breaches of the gates and on the road surface occur on a regular basis. While limiting the season of use is generally beneficial, weather and drainage condition during the open months can quickly deteriorate. The road has a natural surface which is susceptible to sediment movement from overland flows and rutting from vehicular traffic. Low maintenance levels have allowed rutting and gullying to persist. The road fords a perennial and 2 ephemeral streams, raising the occurrence of fine sediment contributions to these streams.

Bridge Watershed Landscape Area

Trend # 1: EPA drinking water quality standards and state Oregon Drinking Water Program turbidity levels are being met.

Cause: The Bridge Watershed Landscape Area is well vegetated and comprised of soils with a high rate of infiltration of precipitation. As a result, the majority of instream water is from springs that provide water of exceptional biological and chemical, as well as very low turbidity. Recreational use is regulated and there is a general lack of development and disturbance within the watershed. However, new federal drinking water requirements will necessitate construction of a filtering plant in the near future.

Resources Affected: Hydrology

Trend Rating: Low

Rational for Rating: The Safe Drinking Water Act of 1986 requires 90 percent of fecal coliform samples to meet Environmental Policy Act standards. Since testing began in 1988, over 99 percent of the samples have met or exceeded the standard. While the state DEQ requires that municipal water supplies can only be delivered unfiltered when nephelometric turbidity units (NTU) are less than 5, the City of Bend tries usually not to exceed 2.5 NTU as a matter of policy. The City water supply has exceeded this level approximately 20 days annually between 1988 and 1998 and does not draw water from Bridge Creek when this occurs.

Trend #2: More old forest exists currently than probably existed under native disturbance regimes.

Cause: Lack of disturbance, including fire suppression efforts.

Resources Affected: All resources are affected to some extent, most notably vegetation, as forest structures continue to advance in age (ever increasing risk of stand replacement event) and wildlife habitat (lack of early forest structure, as openings become filled with trees). Stand conditions will eventually become less stable, a result of insect, disease, and other disturbance agents. In addition, fire risks over time will build as fuel loadings increase and these increased risks include the spread of fire from this watershed into neighboring area.

Trend Rating: Moderate

Rationale for Rating: Although the late and old forest structure continues to increase proportionately on the landscape, these conditions have not departed greatly from the native forest conditions prior to fire suppression. Increasing forest biomass will eventually result in higher intensity fires and greater consumption of fuels, yielding more difficult control efforts. However, in order to protect resource area values directly related to the City of Bend Municipal Watershed as well as resource values of the surrounding area.

Trend #3: Recreation use is continuing to change in terms of type and number of users.

Cause: Increasing popularity of mountain biking on existing trails since the 1980's.

Resources Affected: Soils, Vegetation, Wildlife Habitat, Water Quality, Recreation Experience

Trend Rating: Moderate

Rating Rationale: Hiking and minimal livestock uses were the traditional uses in the past in the Bridge Creek Watershed. With the increasing popularity of mountain since the 1980's the City of Bend Municipal Watershed decided to regulate the this type of use and prohibited both mountain biking and domestic animals from the area under its management. Hiking is the only permitted recreational use allowed there.

Front Country/Transition Landscape Area

Trend #1. Recreation use is increasing in the Skyliner Lodge area. Trail construction, re-routes and use restrictions within this landscape area have addressed soils and hydrology resource concerns associated with tread erosion, concentrated water flow and sediment contribution to streams.

Cause: Developed trail system and associated facilities, proximity to Bend, and increased development in adjacent residential areas.

Trend Rating: Moderate-High

Rating Rationale: Historically, the Skyliner Lodge area was the major winter recreation destination prior to the development of Mt. Bachelor Ski Resort. The ski hill area has been used for sno-play and Skyliner Lodge has been occupied by the Oregon Museum and Science Industry. Increased growth in Bend, including the outlying residential areas along Skyliner Road, has added to the increased use in the area for both summer and winter.

Trend #2: More stands are overstocked to the point of instability.

Cause: Fire suppression, lack of vegetation management, and natural forest succession.

Resources Affected: All resources are affected to some extent, most notably vegetation; as forest structures continue to gain density in the absence of disturbance. Wildlife habitat is affected as the distribution and abundance of a variety of landscape conditions decrease, including the lack of early forest structure, as openings become filled with trees; and the loss of old forest structures due to insect attacks root pathogens, and stand-replacing fires. Stand conditions eventually become less stable with the increased stocking and the inter-tree competition that this brings, resulting in insect, disease, and possibly fire disturbance agents that work to rebalance the stands across the landscape.

As most stands become overstocked and unstable relative to the native disturbances that once punctuated this Landscape Area, more area is involved in more intense disturbance cycles when they do occur (e.g. the Bridge Creek Fire of 1979 which grew to 3,364 acres).

Trend Rating: High

Rationale for Rating: Although the late and old forest structures are not very dominant on the landscape, these conditions have not greatly departed from the fire climax forest conditions prior to fire suppression. Many lodgepole pine stands that once burned as they matured are not similarly killed by mountain pine beetles as they advance in age. In the absence of stand management activities, these types of forests stands are slowly replaced by late seral white fir and mountain hemlock stands and may eventually appear to have old growth characteristics. The greatest change, however, is with the increased stand densities throughout this landscape area, especially in the ponderosa pine communities. Fire suppression and selective harvesting have decreased the amount of large, old ponderosa pine structure and created many more small trees per acres. Many stands once dominated by ponderosa pine over stories and frequent light intensity fires now have fewer ponderosa pine and roughly 10 times the number of trees in the understory relative to the pre-fire exclusion era. This shift from essentially single-storied pine to fir dominated stands carrying great understory biomass has resulted in greater instability and higher intensity fires when they do occur.

Trend #3: Insect and disease pathogens will continue to operate on the landscape.

Cause: Fire suppression, lack of vegetation management and increasing stand densities.

Resources Affected: Forests continue to gain density in the absence of fire and vegetation manipulation disturbances. As these stands become older and denser, they provide ideal habitat for opportunistic insect and disease agents. Wildlife habitat is negatively affected when the distribution and abundance of landscape conditions decreases in variety such as the lack of early forest structure, loss of openings, and loss of old forest structure due to insect attack, root pathogens, and stand replacement fire. Stand conditions eventually become less stable with the increased stocking and inter-tree competition that this brings, resulting in insect, disease and possibly fire disturbance agents that work to rebalance the stands across the landscape.

Trend Rating: Moderately-High

Rationale for Rating: As the forests continue to gain density in the absence of management disturbances, insect and disease pathogens respond to new habitat conditions. In the maturing lodgepole pine stands, optimum host habitat to support mountain pine beetle outbreaks occurs when stands exceed 30 trees per acre of trees 9 inches in diameter. Root rot becomes more widespread when ponderosa pine dominated stands are harvested and replaced by dense stands of true fir species. Since these conditions are not greatly departed from the native disturbance regimes, a moderate

rating is given. Although there are more acres that carry magnitude of insect and disease agents is not greatly different than pre-settlement conditions.

Trend #4: There is a tree species shift from pine to fir and hemlock.

Cause: Fire suppression and forest succession from fire climax to climatic climax species.

Resources Affected: All resources are affected to some extent, most notably the vegetation condition across the landscape, as the subtle change in species occurs over the course of decades. Wildlife habitat is affected as ponderosa pine dominated stands become replaced by true fire stands and the species responds to this shift. Similarly lodgepole pine dominated stands are slowly being replaced by true fir and/or mountain hemlock.

Trend Rating: Moderate

Rationale for Rating: Although this is not necessarily desirable, the shift from early seral stands (ponderosa, lodgepole pine) to late seral forest types (white fir, mountain hemlock) results in a re-distribution of stand conditions and habitats. If these shifts result in the minimization or elimination of scarce habitat conditions, then the species that use these habitats become less abundant. While this is a long-term process, the shift in species should be recognized as a moderate trend rating as it results in not only changes in species composition, but also in habitat conditions, insect and disease agent activities, and ultimately differing disturbance patterns and processes. The shift from essentially single-storied pine stands to multi-storied pine and fir has led to greater natural fuel loadings resulting in higher fire intensities when fires do occur.

Trend #5: Road beds on Roads 370 and 4601 continue to deteriorate and erode.

Cause: Increased automobile use during wet weather conditions, low levels of maintenance and poor road grades or road locations.

Resources Affected: Water Quality (Roads 370 and 4601), Recreation Experience

Trend Rating: Moderate

Rationale for Rating: Existing gates on each end of Road 370 limit use to August through October. While limiting the season of use is generally beneficial, weather and drainage conditions during these months can quickly deteriorate. Road 370 is a natural surface road susceptible to sediment movement from overland flows and rutting from vehicular traffic. Some maintenance work, including drainage work, has been recently completed. Road 4601 has been surfaced with a variety of rock and cinders in some areas and remains a natural surface road in others. The primary area of deterioration is a

section that climbs directly uphill through the Bridge Creek Fire area at an estimated 10 percent grade. Sediment movement from this grade is capable of reaching Tumalo Creek.

Trend #6: Recreation use is increasing, including Off-Highway Vehicles (OHVs); some illegally on trails.

Cause: Proximity to Bend and development of trail systems.

Resources Affected: Wildlife, Fisheries, Soil, Water Quality, Vegetation, Recreation Experience

Trend Rating: Moderate

Rationale for Rating: Both the Tumalo Reservoir area and the area south of the Skyliner Road have numerous mountain biking trails. This low elevation area provides access to horses primarily in the Tumalo Reservoir area and to mountain bikes in the lower Skyliner area for about 8 months out of the year. Both are very close to and accessible to from Bend.

Trend #7. Tumalo Creek is included on the 2004-2006 Oregon Department of Environmental Quality 303(d) list of water quality impaired water bodies for the parameter of water temperature.

Cause: The stream was added to the 303(d) list despite relatively cold water temperatures. However, these temperatures do not meet bull trout requirements. Although no bull trout have ever been documented in Tumalo Creek, they are suspected to have once occupied the stream.

Resources Affected: Fisheries

Trend Rating: Low

Rationale for Rating: No bull trout occupy the stream. Nearest bull trout population is over 20 miles downriver and there are downriver migrational barriers, warm temperatures, and flow diversions to overcome for upstream migration into Tumalo Creek.

Private/Dry Forest Landscape Area

Private forest lands are expected to be managed for timber production into the foreseeable future. Wood production may be trending toward a sustained yield policy that would include maintaining some structure within treated stands. Rehabilitation of existing soil impacts are not expected to occur. Timber activity on lands acquired from the Forest Service is likely to increase from current levels under federal jurisdiction. Recreation access and day-use policies are not expected to change from existing Cascade Timberlands policies. Many vegetative and fire related trends are similar to those found in the Dry Forest Landscape Area.

Dry Forest Landscape Area

Trend #1: Tumalo Creek is included on the Oregon Department of Environmental Quality 303(d) list for water quality impaired streams with the parameter being water temperatures (See Trend #7 above).

Trend #2: Middle-aged shrubs and forest vegetation are continuing to advance in age.

Cause: Natural forest succession process.

Resources Affected: Wildlife, Vegetation, and Recreation Experience. As stands continue to recover from previous selection harvest, they will advance in age and size. Depending upon health, vigor, fire events, and future tree harvest activities, it is possible that these stands will eventually grow into large, old structural stage composition. Recreation and wildlife values that are connected to old forest conditions will be increased.

Trend Rating: Moderate

Rationale for Rating: The late and old forest structures that are associated with the pre-settlement ponderosa pine forest today are greatly lacking from this Landscape Area. Since most of this land was privately owned, many acres have been harvested during the 1930's and 40's and selectively harvested in the 1980's and 1990's. Structural conditions have greatly departed from the fire climax forest conditions prior to European settlement with the large, old ponderosa pine stands once dominating this landscape now covering only a small percentage of the area. There will, however, be a continual advancement in size, density, and structure of these middle-aged stands in the absence of stand replacement fire or insect or disease disturbances.

Trend #3 Urban interface areas are increasingly demanding fire protection

Cause: Increased fire risk as a result of homogeneous, mid-seral stand and shrub structures, the continued development of adjacent urban forest lands, and increased recreational use.

Resources Affected: Social Impacts, Fire Resources

Trend Rating: High

Rationale for Rating: Existing fire protection policies include inter-agency and multi-partnership agreements for the suppression of fire and the reduction of risks associated with fuel loadings and vegetation structures. The Greater Bend CWPP was completed in 2006 and the East and West Deschutes County CWPP was completed in 2007 in order to collaboratively address hazardous fuels and wildland fire threats in the wildland urban interface.

ECOLOGICAL INTERGRITY RATINGS

The ecological integrity of each landscape area was given a rating by the team bases upon how much of a departure is evident from historic regimes. These ratings are supported by a description of the conditions affecting the ecosystem and may relevant management policies.

Wilderness Landscape Area
Ecological Integrity Rating: High

Responsible Conditions:
Un-fragmented late structural forests; the majority of stands are currently within the upper parameters of historical fire regimes, although a stand placement event is likely. Disturbance agents are still within historic range of variability (HRV) parameters. Recreation is within the limits of the designation level with moderate to low levels of use. Minimal impacts such as soil erosion and compaction to roads and facilities are occurring.

Relevant Management Policies: Wilderness Area Policy

Cold Forest/Roadless Landscape Area
Ecological Integrity Rating: High

Responsible Conditions: Un-fragmented late structural forest. High use and impacts on Road 370. Recreation use is approaching the upper limits of a Semi-Primitive recreation experience with moderate to low levels of use.

Relevant Management Policies: Prescribed fire in a Non-Wilderness, Designated Roadless Area

Bridge Watershed Landscape Area
Ecological Integrity Rating: High

Responsible Conditions: Late structural forest. Municipal Watershed Area. Species are fairly intact except for early trappings. The area supports a pristine ecosystem-dependant species.

Relevant Management Policies: City of Bend Municipal Watershed, Designated Roadless Area

Front Country/Transition Landscape Area
Ecological Integrity Rating: Moderate

Responsible Conditions: Fragmentation is fairly minimal. LOS is still present but less than 50 percent of historic fire climax regimes. Most of the instability in the watershed is found primarily in the area which many stands have experienced species and structural

conversion and human access is relatively high. Despite these conditions there are no urgent or immediate forest problems. The northwest corner is Roadless with areas in other parts of the landscape area having high road density. Recreation use is approaching the limits of a Semi-Primitive recreation experience for those using trails from Tumalo and Swampy Lakes. Mountain pine beetle infestation has decreased forest health, added fuel loading, and has affected wildlife habitat in NRF, LOS, and OGMA.

Relevant Management Policies: Designated Roadless Area, Front Country Management Area

Private/Dry Forest Landscape Area

Ecological Integrity Rating: Low

Responsible Conditions: Heavily fragmented, high road density, lack of LOS structure, canals, high levels of soil disturbance including compaction, and loss of organics from past harvest operations.

Relevant Management Policies: Cascade Timberlands Land Management Policies

Dry Forest Landscape Area

Ecological Integrity Rating: Low

Responsible Conditions: High road density, past harvest impacts, limited structural variety, lack of LOS structure (Varying degrees of fragmentation), somewhat modified landscape as compared to the Private/Dry Forest Landscape Area (private lands have about 10 percent of late and old forest structure left intact and public lands have about 20 percent left).

Relevant Management Policies: Wildland/Urban Interface, General Forest, Deer Winter Range, and Scenic View Management Areas

ECOSYSTEM CONDITIONS

The team identified and described the current and desired conditions affecting the ecosystem of the watershed by landscape area. The social and ecological functions express the essence, use, and resource opportunities of each of these landscape areas.

Wilderness Landscape Area

Current Condition: There are limited water resources, no existing water quality problems, and no known fish populations. The ecosystem is relatively pristine with clear, cold water and extensive tracts of intact LOS structure that is minimally fragmented. Wolverine populations are suspected. There is very little early structural stage which presents a problem for those wildlife species needing dispersal openings. There is no

roading which allows for an intact system and high potential for maintaining good connectivity.

Late and old structure mountain hemlock stands are present in nearly double the amount expected under natural fire disturbance regimes. The landscape has a pre-dominantly high country natural that includes numerous alpine meadows between forested stringers. Fire starts are suppressed although a Prescribed Natural Fire Plan has partially been completed.

Desired Condition: Water quality is maintained for existing streams and surface waters. Wilderness experiences that are highly desired by recreation users are maintained. Wildlife habitat moves toward a condition where small openings needed by certain species and more heterogeneous opportunities are created. Fire continues to be suppressed, but a Prescribed Natural Fire Plan is in place in order to reintroduce fire under appropriate conditions. Dispersed day-use and unstructured hiking opportunities increase for both hikers and horse use.

Social and Ecological Function
*Potential wolverine habitat
*Refuge for wildlife
*LSR Connectivity between Sisters LSR and the Cultus Sheridan LSR
*Low density use in the Wilderness for hikers and horse recreationists

Trends (Short-term 0-10 years, long-term 10+ years)
*Late and old forest structures will increase due to lack of disturbance and increased stability.
*More LOS habitat with an inevitable natural disturbance and increased stability.
*A slight increase in more day use vs. overnight camping
*Frequent fire starts insignificant in size and duration
*Prescribed Natural Fire Plan and implementation

Cold Forest/Un-roaded Landscape Area

Current Condition: Conditions are similar to those in the Wilderness Landscape Area. The biggest differences are a greater abundance of surface water and changes to the natural hydrology. The amount of water in the Middle Fork of Tumalo Creek has increased with input from the Crater Creek ditch. Where Road 370 crosses the stream, drainage is poor and there is an increase of sediment in the streams. Springs that feed the Middle Fork of Tumalo Creek are diverted from into Bridge Creek. Increased turbidity has resulted in some areas as a result of these changes. Brook trout are found in the streams. Potential wildlife species include wolverine, fisher, marten and spotted owl.

This landscape area has the greatest amount of late structural forest with approximately 2 to 3 times more than historically expected under fire disturbance regimes. Bikes are allowed as a non-motorized use in the summer and snow-miles are allowed as a motorized use in the winter. More summer and winter use occurs here in the Wilderness

with mostly snowmobiling, skiing and increased snowshoeing activities. There is a moderate to high density level of summer and winter trails.

Desired Condition: Crater Ditch is eliminated in order to restore historic and natural water flows to Soda Creek and Sparks Lake. Improve ditch maintenance if water rights cannot be purchased. Natural stream stability of existing streams continues to be maintained. Non-motorized recreation use is emphasized as a day-use activity. Road 370 erosion problems are corrected and it is maintained as a primitive road with high clearance conditions. Road 370 remains open for the short-term and provides access to selected trailheads in the long-term. Appropriate use levels and restrictions for bike riding and winter snowmobile use are maintained in order to meet water quality standards. Forest vegetation encroachment upon natural openings is controlled.

Social and Ecological Function
*Provides high quality water for irrigation use in the Bend area
*Increase in day-use recreational activities.
*Significant summer range for big game.
* Serves as a refuge for LOS dependant species that are intolerant of fragmentation and high road densities.
*LSR connectivity similar to the Wilderness Landscape Area in terms of un-fragmented condition.
*A reservoir of pristine conditions.

Trends (Short-term 0-10 years, long-term 10+ years)
*Vegetation has a continued increase in late and old structural stands.
*Semi-Primitive Non-Motorized use occurs.
*Increased day-use, accessible by new trails and trailheads from the Cascade Lake Scenic Byway or Road 370.
*Snowmobile and mountain bike use are increasing at a faster rate than other recreation uses.
*Less hunting, dispersed camping and road hunting.
*Development of loop trail system completed.
*More winter motorized activities and fewer hunting activities in the long-term.

Bridge Watershed Landscape Area

Current Condition: Bridge Creek was originally a small stream but channel size has increased with the diversion of water since 1955. Erosion and increased turbidity increased after the fire but have not stabilized. Rainbow trout and non-native brook trout are found in the streams. Potential wildlife species include wolverine, fisher, marten, and spotted owl. Diversity of vegetative species, including more spruce is present. Recreation use is heavily regulated. This area includes the upper extent of the Bridge Creek Fire Area. Water quality is currently meeting standards for coliform and turbidity.

Desired Condition: Winter snowmobile use is limited. Forest vegetation encroachment upon natural openings is controlled. Recreation use is not heavily regulated due to water

quality requirements for the City of Bend Municipal Watershed. Future management actions taken by the City of Bend result in less of a need to regulate use in the watershed. Sedimentation and erosion problems in the canal are eliminated in order to protect water quality.

Social and Ecological Function
*Serves as a refuge for LOS dependent species that are intolerant of fragmentation and high road densities.
*Provides 50 to 60 percent of the drinking water to the city of Bend.
*Late-Successional Reserve connectivity
*Elk summer range
*Wilderness experience in a non-wilderness area close to Bend that is a hiker only, quality experience for solitude within the ecosystem similar to the west side of the Cascades in a setting that includes falls, creeks, and riparian vegetation.

Trends (Short-term 0-10 years, long-term 10+ years)
*Decreased regulation of recreation activities dependent upon future actions taken by the City of Bend Municipal Watershed concerning transport of water.
*Water quality is improved in the Bridge Creek Fire area as vegetation increases
*Water quality standards increase due to the demands for better quality water (currently meeting standards for coliform).
*Fire continues to have full suppression.

Front Country/Transition Landscape Area

Current Condition: Eastern brook trout and rainbow trout are found in the streams, particularly in Tumalo Creek. Tumalo Creek is on the DEQ 303(d) list of water quality impaired streams for year round elevated water temperature (non-spawning). The restored reach of Tumalo Creek is overall stable but still with localized areas of channel adjustment.

There is currently less of a departure in vegetative structure from historic vegetative structure from historic regimes than in other landscape areas. There is more early and mid-forest structure with some fragmentation and varying levels of open road densities. The Bridge Creek Fire of 1979 was a bigger fire than normally would occur but due to the fuels, it was much closer to naturally occurring conditions. Stands that have less resilience are mostly found in this landscape area. Plantations established within the Bridge Creek Fire Area continue to gain density as they mature. Lodgepole pine mortality is increasing because of mountain pine beetle infestation.

Motorized access and developed recreation sites such as the Tumalo Falls Lookout and Skyliner Lodge are more prevalent within this landscape area. Dispersed use is increasing with more overnight and motorized use in other areas, including OHV use.

Desired Condition: Tumalo Creek is removed from the 303 (d) list. Road densities are reduced. Understory density and fire risk are reduced within some mixed conifer stands and the newly established plantations in the Bridge Creek Fire area. Forest vegetation encroaching upon natural openings is removed. Resiliency is restored to some dense stands especially ponderosa pine once dominated by frequent fire cycles. Engelmann spruces are returned to the riparian zones.

Trail connections between urban and forest areas are improved including the existing Tumalo Trail system and to the Three Creeks area on the Sisters District. Existing informal winter recreation trail system improvements are made rather than constructing any new trails.

Social and Ecological Function
*Provides a portion of the linkage between the Three Creeks and Sheridan LSRs.
*Serves as a travel corridor for migrating big game.
*Transition zone from private lands that are fairly developed and heavily managed to Wilderness with a fair amount of roads, some trail systems, and large areas without trails or roads.
*Recreational driving on back roads in a Semi-Primitive wilderness to vista lookout points at Bearwallow Butte and Triangle Butte.
*Many opportunities exist to provide linkages and connections to others part of the watershed.
*Fairly central transition zone.
*Skyliner Road Subdivision and private parcels-growing residential populations.
*Outdoor educational center at Skyliner Lodge.

Trends (Short-term 0-10 years, long-term 10+ years)
*Increased recreation use at the Skyliner Lodge area with the addition of trail linkages.
*More development occurring in the residential areas along Skyliner Road.
*Increased use on Road 4601 for recreational driving, dispersed camping, day-use hiking and fishing activities due to the close proximity to the city of Bend.
*Skyliner Lodge becoming more of a focal point for recreation in the area.
*Stream flow becoming more "normal" to pre-fire flow conditions.
*Increasing stand densities with continued fire suppression.
*Increased mortality due to beetles, primarily in lodgepole but also occurring in ponderosa.

Private/Dry Forest Landscape Area

Current Condition: Ponderosa pine LOS is lacking. The area is heavily managed and roaded in order to provide commercial wood products and reduce fire risks. Soil disturbance areas are extensive. Deer winter range is in moderate condition. Access for recreation driving and hunting is provided by the road system which is closed in the winter. Cascade Timberlands lands have a policy of no shooting allowed, no overnight use, and fire closures. Eastern brook trout, rainbow trout, and possibly brown trout are found in Tumalo Creek. Topographical features are canyon formations above the streams.

There are extensive stands of middle-aged trees and high road densities with a lack of ponderosa pine LOS. The Columbia Southern Canal was removed from DEQ 303(d) list for flow modification but elevated water temperatures were added.

Desired Conditions: Forests are managed to provide more diverse conditions, including an increase in LOS conditions. Tumalo Creek is removed from the DEQ 303(d) list for elevated water temperatures. Vegetation management activities occur for economic gain, sustainable harvest, long-term sustained yield, fire risk, and to generate commercial value. A mosaic of shrub and forage conditions are interspersed with thermal cover where possible and road densities are reduced to levels below 1.5 to 2 miles/square mile.

Social and Ecological Function
*Deer and elk winter range.
*Public use allowed for day-use recreation, including mountain bike trail connection from Shevlin Park to the Skyliner area.
*Transitional zone between the city of Bend and primitive forest.

Trends:
*****Dependent upon stand growth rates, market conditions, and Cascade Timberland's long-term land management plans.

<u>Dry Forest Landscape Area</u>

Current Condition: Eastern brook trout and rainbow trout are found in Tumalo Creek with possibly brown trout in the downstream reaches of Tumalo Creek. Topographical features are canyon formations above the streams. There are extensive stands of middle-aged trees and high road densities with a lack of ponderosa pine LOS. A fair amount of trails exist.

Desired Conditions: Road density is reduced. Management towards LOS pine conditions and for a variety of tree shrub age classes. Use of the area as an urban interface dumping ground in reduced.

Social and Ecological Function
*Deer and elk winter range.
*Day-use for mountain bikes and horses.
*Shevlin Park/private land
*Pumice lands (mining, shooting range, urban land uses, dumping ground, on the fringe).
*Forest/urban interface boundary (fire risks).

Trends:
*****Middle-aged forests will continue to advance in age.
*Dense stands will be at risk to insects and fire.
*Private/public land interface.
*Fire awareness/urban interface.

CHAPTER VI – Management Recommendations, Data Gaps, Analysis Limitations, Monitoring, and Aquatic Conservation Strategy

MANAGEMENT RECOMMENDATIONS

Management recommendations are made by the watershed analysis team as a way to maintain and protect the critical elements and processes identified through the trend ratings and assessment of ecological conditions in Chapter V. Using the issues and the key questions, these recommendations reflect the most relevant and desirable conditions for the watershed which are the protection of water quality, enhancement of a quality recreation experience, and improvement of forest health and riparian function.

Wilderness Landscape Area

1**.** Manage natural ignitions for the benefit of natural resources (Wildland Fire Use) in accordance with the Cascade Crest Wildland Fire Use Guide (2008).

2. Determine appropriate level of use for this landscape area.

3. Maintain current maintenance level (Level 2) and seasonal closures on Road 370 to limit access, improve safety for users, and reduce impacts to resources due to road deterioration.

Cold Forest/Un-roaded Landscape Area

1.Reduce forest encroachment through manipulation of vegetation around meadows.

2.Maintain current maintenance level and seasonal closures on Road 370. Improve stream fords with additional armoring of bank areas that are currently a source of sediment input. Recent breaches of off-road restrictions and gated closures reflect the need to assess how to improve management and use of this road in a sensitive, high elevation location.

3.Re-introduce fire in this landscape area, especially meadow edge burns, by developing and implementing a Prescribed Natural Fire strategy.

4.Assess appropriate recreation use levels to limit social and resource impacts.

Bridge Watershed Landscape Area

1.Vegetative manipulation and thinning around meadows from forest encroachment.

2.Maintain appropriate recreation access to meet water quality standards.

Front Country/Transition Landscape Area

1. Promote wetland restoration along Tumalo Creek in the Bridge Creek Fire Area. Thin encroaching lodgepole and densely planted ponderosa pine to promote aspen and hardwood stands. Plant more Engelmann spruce for long term conversion to spruce bottomland.

2. Reduce stand densities and fuel loading where appropriate. Use CWPP's for design of projects to reduce hazardous fuels, especially in the wildland urban interface, and restore fire resilient stands.

3**.** Improve public safety through hazardous fuels reduction projects including along access routes.

4. Manage access to promote a semi-primitive non-motorized summer recreation experience.

5. Assess the grade and maintenance level of Road 4601 as it leaves Tumalo Creek drainage and relocate with the appropriate switch backs to reduce erosional loss from current levels.

6. Purchase the section of privately owned land that includes Tumalo Lake.

7. Thin and culture to develop late structure and prevent overstocking in the ponderosa pine and mixed conifer dry sites.

8. Salvage some of the standing and down dead in higher elevation lodgepole pine for fuel reduction to reduce fire risk while retaining overstory continuity.

9. Pre-commercial thin tree plantations within the Bridge Creek Fire area including along Road 4601, 4603 and Tumalo Creek to prevent overstocking and provide safer public egress and firefighter safety.

10. Spur road and skid trail restoration and obliteration on select areas within the Bridge Creek Fire area.

11. Assess need for Nordic hut-to-hut system.

Private/ Dry Forest Landscape Area

Cascade Timberlands

Dry Forest Landscape Area

1. Road density reduction through closure and obliteration.

2. Mowing and burning to treat shrub component.

3. Maintain existing recreation facilities.

4. Assess road to trail conversion opportunities and existing use trail tread design and restriction status of any trails acquired through the Crown Land Exchange.

5. Re-introduce fire in appropriate stands to address urban interface fire protection/awareness needs.

6. Soil restoration on acquired lands on the north side of Tumalo Creek. Activity areas identified as being in condition class C or D under the existing condition analysis are included in these recommendations.

7. Thin and culture in high density, late and old structural ponderosa pine and mixed conifer dry sites.

DATA GAPS AND ANALYSIS LIMITATIONS

In general, data gaps for the soil resource include a direct correlation of site productivity reductions resulting from soil disturbances such as compaction and the loss of natural horizon stratification. Detrimental disturbances totaling more than 20 percent of the aerial extent of an activity area are currently determined to be significant enough to reduce site productivity, although actual changes in long-term biomass production and general forest health are difficult to quantify. The assessment of existing conditions across the watersheds was done using activity databases and remote sensing and is generalized to some degree.

Soil movement and sediment contributions to streams resulting from roads and trails within the watershed have also not been quantified although observations on the ground have identified the occurrence of these mechanisms. The reduction of erosion and sedimentation is regarded as a priority within this watershed because of the municipal water supply.

MONITORING

Continued monitoring of trail conditions within the watershed is recommended. Current monitoring of the North Fork trail has revealed moderate stability of the trail tread under current hiker and mountain biker use. North Fork trail is uphill only for mountain bikes. Areas of hiker travel off of the trail to gain vantage points of the stream and falls continue to be impacted and should be monitored into the future. Informal monitoring of the Swede Ridge, South Fork, and Happy Valley trails has identified small sections of tread slough or excessive grades. Restoration work has been completed in recent years on the South Fork trail.

AQUATIC CONSERVATION STRATEGY

INTRODUCTION

The Northwest Forest Plan provides guidelines for developing an Aquatic Conservation Strategy for the purpose of protecting and restoring aquatic/riparian ecosystems on Forest

Service administered lands within the eastern extent of the range of the northern spotted owl. The main objectives are to ensure protection of aquatic systems, maintain connectivity, water quality, and water and sediment storage and transport regimes, and maintain and restore fish, wildlife, and plant populations and diversity. In order to meet the Aquatic Conversation Strategy objectives, a proposed project of management action must maintain the existing condition or move it within the range of natural variability of the important physical, social, and biological components of the watershed.

The key components of the Aquatic Conversation Strategy are Riparian Reserves, Key Watersheds, Watershed Analysis, and Watershed Restoration. Riparian Reserves are portions of watersheds where riparian-dependent resources receive primary emphasis and include water bodies such as lakes and ponds, wetlands, streams, stream processes, and fish habitats. Key watersheds are a system of large refugia that are crucial to at-risk species and stocks and provide high quality water. These refugia include areas of high quality as well as degraded habitat. The Upper Tumalo sub-watershed is identified as a Tier 2 Key watershed, in which there may be no at-risk fish stocks but serve as important sources of high quality water.

Watershed Analysis is the vehicle for achieving the Aquatic Conservation Strategy objectives. A basis for monitoring and restoration programs is provided through this process and Riparian Reserve widths and conditions are developed and recommended by the watershed analysis team specifically for the Tumalo Creek Watershed. Watershed Restoration is a long-term program designed to restore watershed health and aquatic ecosystems which include habitats supporting fish and other aquatic and riparian dependant organisms.

RESOURCE CONSIDERATIONS FOR SETTING RIPARIAN RESERVES

Ecological processes driving floodplain and channel dynamics are essential considerations in setting widths and conditions for Riparian Reserves. The width of the defined stream channel and floodplain, as well as the flow regime characteristics of the system, dictate the minimum tree size needed to provide effective instream wood. The presence of large woody material within a stream channel is a critical factor in maintaining the systems integrity, including the movement and storage of sediment in the channel. Providing additional sources of large wood and floodplain stabilization is a key component of a designated Riparian Reserve in which vegetative health and structure is promoted and diverse aquatic habitat types are created. Maintaining healthy floodplain vegetation is important in resisting erosive forces of flood events and to filter sediment and nutrients during the high flow events.

Riparian Reserves are a component of the Aquatic Conservation Strategy intended to provide habitat beneficial to fish and riparian-dependent and aquatic species other than fish, enhance habitat conservation for species dependent on the riparian transition zone, improve travel and dispersal corridors for terrestrial animals and plants, and serve as connectivity corridors between Late-Successional Reserves. These Riparian Reserves

ensure a moist zone for both amphibians and other wildlife species. Nearly 80 percent of the terrestrial wildlife species are either directly or indirectly dependent upon these areas for meeting their habitat needs. Ungulates use riparian areas disproportionately more than upland terrestrial areas for fawning and calving. Lactating females take advantage of the improved cover and succulent vegetation.

Within the Riparian Reserves, particularly in lodgepole pine and the wet mixed conifer plant association groups, maintaining healthy forest stands with high snag densities and green tree replacements over the long-term is highly desired for sustaining wildlife habitat needs and water quality. Higher management risks within these areas are often desirable in order to allow natural processes to occur unimpeded by unnecessary human intervention.

RIPARIAN RESERVE WIDTHS AND MANAGEMENT REQUIREMENTS

Riparian Reserves as described in the Northwest Forest Plan and Record of Decision (ROD) have been adopted (USDA, USDI 1994) for the Tumalo Creek Watershed. Considered to be special management areas, proposed projects and activities will be prohibited or regulated based upon the ROD Standards and Guidelines and the resource directions described below. The environmental assessments or environmental impact statements prepared for these projects and activities will be used to describe and to determine site specific conditions and mitigation needs.

A portion of the watershed within the Dry Forest Landscape Area lies east of the northern spotted owl line and therefore falls under the Inland Native Fish Strategy (INFISH) Environmental Assessment (1995). Rather than Riparian Reserves, INFISH defines riparian areas and associated lands as Riparian Habitat conservation areas (RHCA). As with riparian Reserves, riparian-dependent resources receive primary emphasis. With a few exceptions, the widths for RHCAs mimic those of Riparian Reserves from the NWFP. Within this document, RHCAs will be considered as Riparian Reserves.

Recommended Riparian Reserves widths along many of the watershed's streams have been increased slightly due to the presence of moist soil types reflective of riparian hydrology and vegetation. Riparian Reserves were established for lakes, ponds, intermittent and perennial streams, and wetland associated with soil resources mapped as land types 2, 5, and 8 in the 1979 Deschutes National Forest Soil Resource Inventory (See Exhibit 20).

Vegetation

Fire, salvage, and various thinnings are operational tools available to create small openings in riparian areas. Large trees within the distance equal to the height of 2 site-potential trees from the stream channel will often be retained since they have the potential for providing shade and woody material to the stream systems, and ground cover once they fall. Wildlife habitat considerations will dictate the remaining condition of the patches needing to be created. Fuel loading in Riparian Reserves is generally greater than

in surrounding uplands where active management has occurred, except within established facilities such as developed recreation sites, residential areas or wildland /urban interfaces.

Roads, Grazing and Minerals Management

As per ROD, site specific conditions and mitigation will be described and determined in the project environmental assessments or environmental impact statements. There will be no net increase in roads.

Lands, General Riparian Area Management, Watershed and Habitat Restoration, Fish and Wildlife Management and Research

As per ROD, site specific conditions and mitigation will be described and determined in project environmental assessments of environmental impact statements.

Recreation Management

Campgrounds or camping sites will not be developed within the distance equal to the height of 2 site potential trees of any water body. Existing camping sites that have fire rings or picnic tables closer than 50 feet to water will be reassessed and relocated if necessary based upon site review and comments from affected campers. Vegetative buffers will be used to prevent sediment from washing into adjacent waters and to focus foot traffic onto defined pathways. Circulation patterns and access will be redirected be realigning trails or relocating trailheads, using different surface materials such as wood boardwalks, wood viewing platforms or hard surfaces, trail borders or boundaries using natural elements such as the surrounding fallen woody material, semi-buried stones, or native shrubs or ground covers. Native plant species that are 12 to 18 inches minimum height are suggested as a way to deter foot traffic. Tree plantings should be of mixed sizes and varied spacing to appear natural. Native plant species are to be approved per site by the District or Forest Botanist.

Scenic views will be strongly considered when relocating camping sites, day-use picnic sites, trails and viewpoints. Openings views, providing more sun exposure and light, and replanting damaged riparian vegetation areas will improved both the overall scenic quality and the desired recreation experience close to water. Day-use picnic sites will be designated with picnic table locations away from areas where riparian vegetation is damaged or removed.

RECOMMENDED RIPARIAN RESERVE WIDTHS

The recommended Riparian Reserve widths for the Tumalo Creek Watershed will adhere to the following standards listed in the Record of Decision for the Northwest Forest Plan (pages C30-C31.)

For the Tumalo Creek Watershed, recommended Riparian Reserves on Forest Service land totals 5,415 acres, of which less than 10% are actually RHCAs within the Dry Forest Landscape Area. The Riparian Reserves are overlapped by other designated areas from the Northwest Forest Plan (Congressional Reserves, Late-Successional Reserves, Administratively Withdrawn), each with their own specific standards and guidelines. Riparian Reserve standards and guidelines apply in these other areas.

Fish Bearing Streams

Riparian Reserves consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to a distance equal to the height of 2 site-potential trees or 300 feet slope distance (600 feet total, including both sides of the stream channel) whichever is greatest. A site-potential tree height is the average maximum height of the tallest dominant trees (200 years or older) for a given site class. The greatest slope distance is 300 feet for most stream reaches with the Tumalo Creek Watershed. One notable exception is within the canyon area of Tumalo Creek, where the Riparian Reserve widths will extent to the top of the gorge, greater than 300 feet slope distance.

Permanently flowing non-fish bearing streams:

Riparian Reserves consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance (300 feet total, including both sides of the stream channel), whichever is greatest. The greatest slope distance is 150 feet for most stream reaches under this category within the Tumalo Creek Watershed.

Wetlands greater than one acre:
Riparian Reserves consist of wetlands and the area to the outer edges of the riparian vegetation or to the extent of seasonally saturated soil, or to the extent of unstable and potentially unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance from the edge of wetlands greater than 1 acres, whichever is greatest. Site specific analysis will be needed to determine the greatest slope distance for wetlands greater than one acre within the Tumalo Creek Watershed.

Lakes and natural ponds:

Riparian Reserves consist of the body of water and the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of unstable and potentially unstable areas, or to a distance equal to the height of 2 site-potential trees, or 300 feet slope distance, whichever is greatest. The greatest slope distance is 300 feet for lakes and ponds within the Tumalo Creek Watershed.

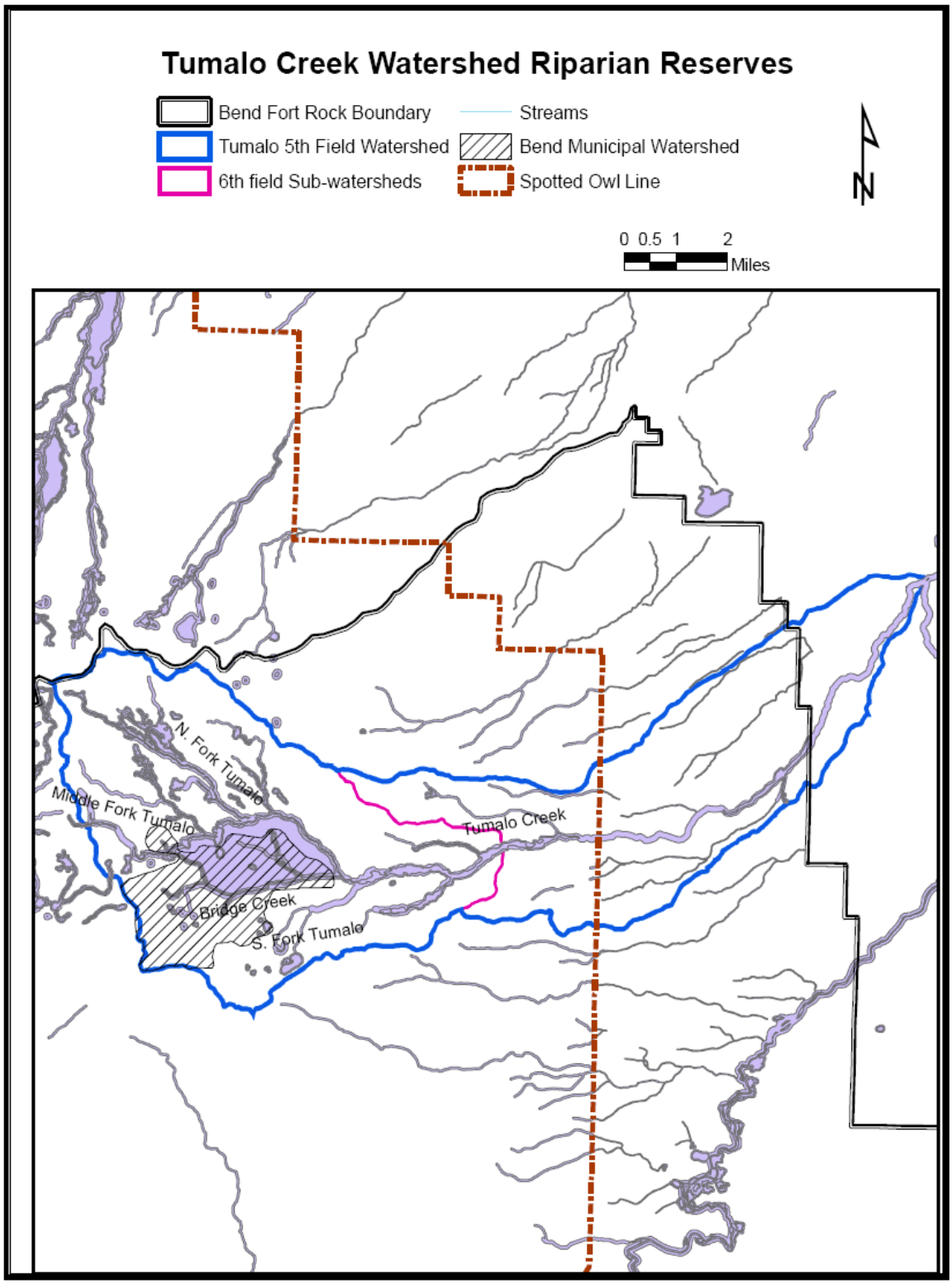
Seasonally flowing or intermittent streams, and wetlands less than one acre:

Intermittent streams are defined as any nonpermanent flowing drainage feature having a definable channel and evidence of annual scour or deposition.

This category applies to features with high variability in size and site specific characteristics. At a minimum, the Riparian Reserves must include the stream channel and extend to the top of the inner gorge, the stream channel or wetland and the area from the edges of the stream channel or wetland and the area from the edges of the stream channel or wetland to the outer edges of the riparian vegetation and extension from the edges of the stream channel to a distance equal to the height of one site-potential tree, or 100 feet slope distance, whichever is greatest. The greatest slope distance is 100 feet for streams and wetlands less than 1 acre within the Tumalo Creek Watershed.

Note: All recommended Riparian Reserve widths are subject to change under site-specific analysis conducted during a NEPA decision-making process.

Exhibit 20. Tumalo Creek Watershed Riparian Reserves/RHCAs



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Appendix

Tumalo Creek Bridge to Bridge Restoration Project
Monitoring Report
10/10/2008

Prepared by Tom Walker, Deschutes National Forest

Introduction: This report summarizes monitoring conducted on the Tumalo Creek Bridge to Bridge Restoration Project, implemented on the Deschutes National Forest, Bend/Ft. Rock Ranger District between 2004-2007. This report contains monitoring information on fish populations and planted vegetation.

I. Fish Populations: Electrofishing surveys were conducted within all three Phases of the Tumalo Creek Bridge to Bridge Restoration Project to determine the response of fish populations to stream restoration work. Each survey was conducted prior to and two or three years post-restoration. The stream is inhabited by the native redband trout and the non-native eastern brook trout. The three sites were approximately 100 meters in length and were in areas that underwent major reconstruction during the restoration.

Methodology: Multi-pass depletion surveys with block nets and battery-powered Smith-Root backpack electrofishers was the method employed for all pre-project surveys. Post project fish surveys were accomplished with mark-recapture, with the exception of the main channel of Phase I where a depletion survey was used. Caudal fin clips were used to mark fish in the mark-recapture surveys. In all surveys, all fish captured were measured for fork length and released. Some individuals were weighed to develop a Condition Factor.

Table 1. Fish Population Surveys

Phase	Pre-Project Survey Date	Method	Restoration Completion Date	Post-Project Survey Date	Method
I	8/18/2004	Depletion	10/2004	8/31/2006	Depletion/Mark-Recapture
II	8/18/2004	Depletion	9/2005	8/13/2007 8/14/2007	Mark-Recapture
III	7/29/2005	Depletion	8/2006	9/18/2008 9/19/2008	Mark-Recapture

Photograph 1. Electrofishing Survey

Table 2. Fish Population Survey Results

Station	Pre or post project	Date	Channel Location	Redband population estimate (95% CI)*	Redband / 100m	Brook population estimate (95% CI)	Brook/ 100m	Total fish population estimate	Total fish/100m
Phase I	Pre	8/18/04	main	30 (17-44)	25	60(50-69)	50	90	75
Phase I	Post	8/31/06	main	42 (23-60)	42	73 (67-78)	73	115	115
Phase I	Post	9/07/06	Side channel	65 (29-162)	65	522 (410-663)	522	587	587
Phase I	Post	8/31/06 and 9/07/06	Side and main channels	107	107	595	595	702	702
Phase II	Pre	8/18/04	main	29 (24-34)	35	63 (55-71)	75	92	110
Phase II	Post	8/13 and 8/14/07	main	28 (11-69)**	33	173 (82-398)	204	201	237
Phase III	Pre	8/31/01	main	11(7-16)	21	21 (0-45)	39	32	60
Phase III	Pre	10/10/02	main	16 (10-22)	15	50 (35-64)	46	66	61
Phase III	Pre	7/29/05	Main and side channel	31 (27-35)	28	160 (149-171)	144	191	172
Phase III	Post	9/18 and 9/19/08	Main and side channel	68 (34-148)	59	179 (124-269)	155	247	214

* 95%CI = 95% Confidence Intervals. The population is likely to fall within the range given 95% of the time.
** This population was biased because of the small number of fish recaptured.

Within the Phase I study area, the creation of the side channel and available habitat achieved during restoration increased the numbers of fish post-project. Fish population estimates increased from 75 per 100 meters channel length pre-project to 702 per 100 meters post-project, primarily due to the large numbers of fish inhabiting the newly created side channel. This survey was conducted within a reach that received more extensive restoration than the rest of the Phase I project area, and would be considered atypical of the entire phase. Project work throughout the remainder of this phase was primarily main channel restoration, with a minor component of side channel creation. The increase in fish populations observed within this study area is likely not as pronounced in other areas within Phase I.

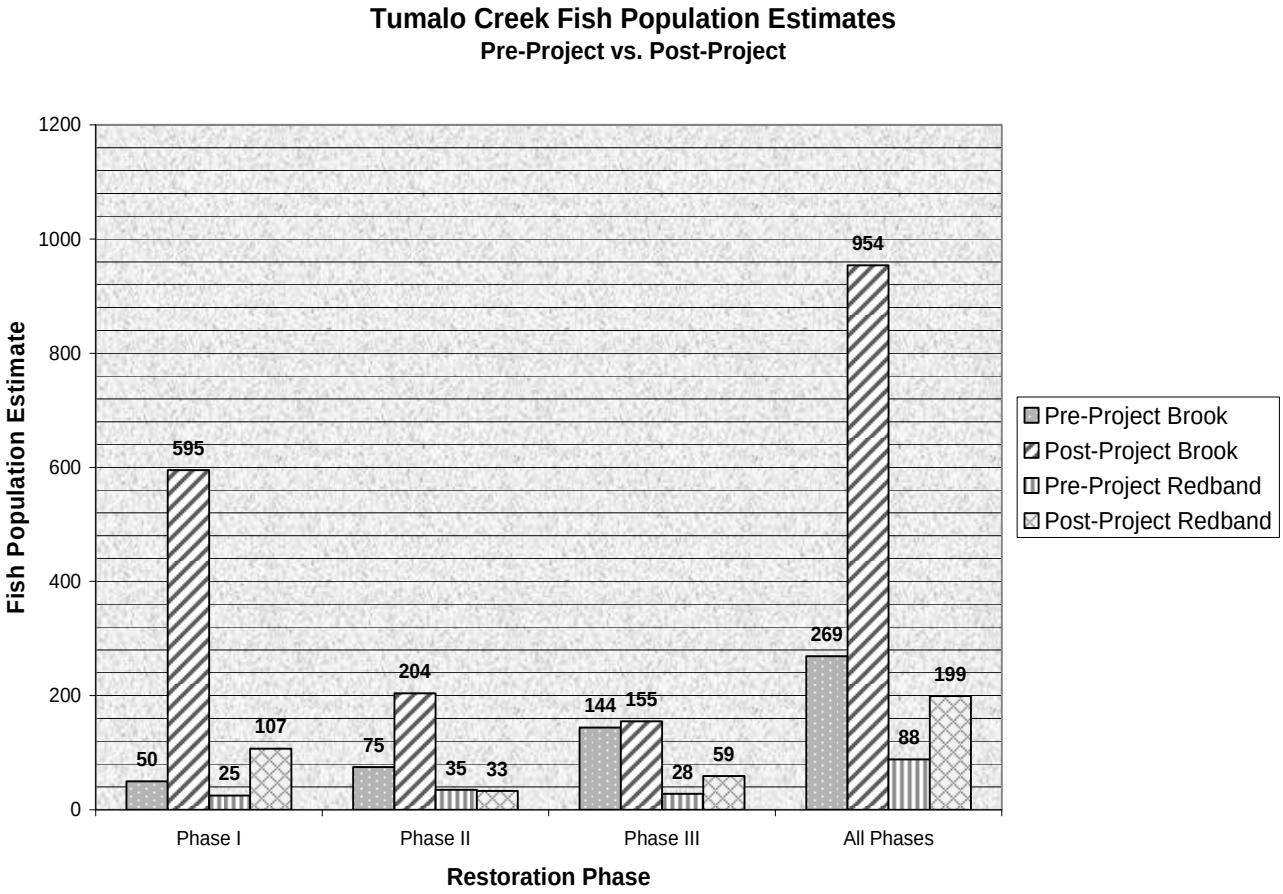
Within the Phase II study area, the fish population estimate increased from 110 fish per 100 meters to 237 fish per 100 meters due to an increase in the brook trout population. This study area did not include side channel creation.

The Phase III study area fish population estimate increased from 172 to 214 fish per 100 meters. The pre-project fish population was higher than the other study areas likely due to accumulations of large wood that had drifted down from above. These accumulations were temporary and unstable, likely to move out at the next high flow event. This area had also been assessed for fish populations prior to some prior restoration work in 2001 that had relocated a portion of the channel and placed boulder structures (8/31/2001 and 10/02/2002 data in table above). The fish population estimates were only 60 and 61 fish per 100 meters at that time. While both fish species exhibited significant increases, the brook trout population had the greatest increase, primarily due to large numbers found within the side channel habitat of the Phase I study area.

No control reach outside of the project area was surveyed. Channel types and habitat conditions upstream and downstream of the nearly 3 mile project area differed from within the project area, making a control area difficult to establish. In addition, due to velocities outside of the project area because of steeper channel gradients, placing block nets as part of the survey protocol was infeasible. However, when comparing pre-project data sets from multiple years, and other survey work done in Tumalo Creek in the recent past, the fish population was fairly consistent at a range of 60 to 75 fish per 100 meters channel length. This range may represent what would have been found within a control reach and that of un-restored areas. The restoration work has significantly increased the fish population above this range.

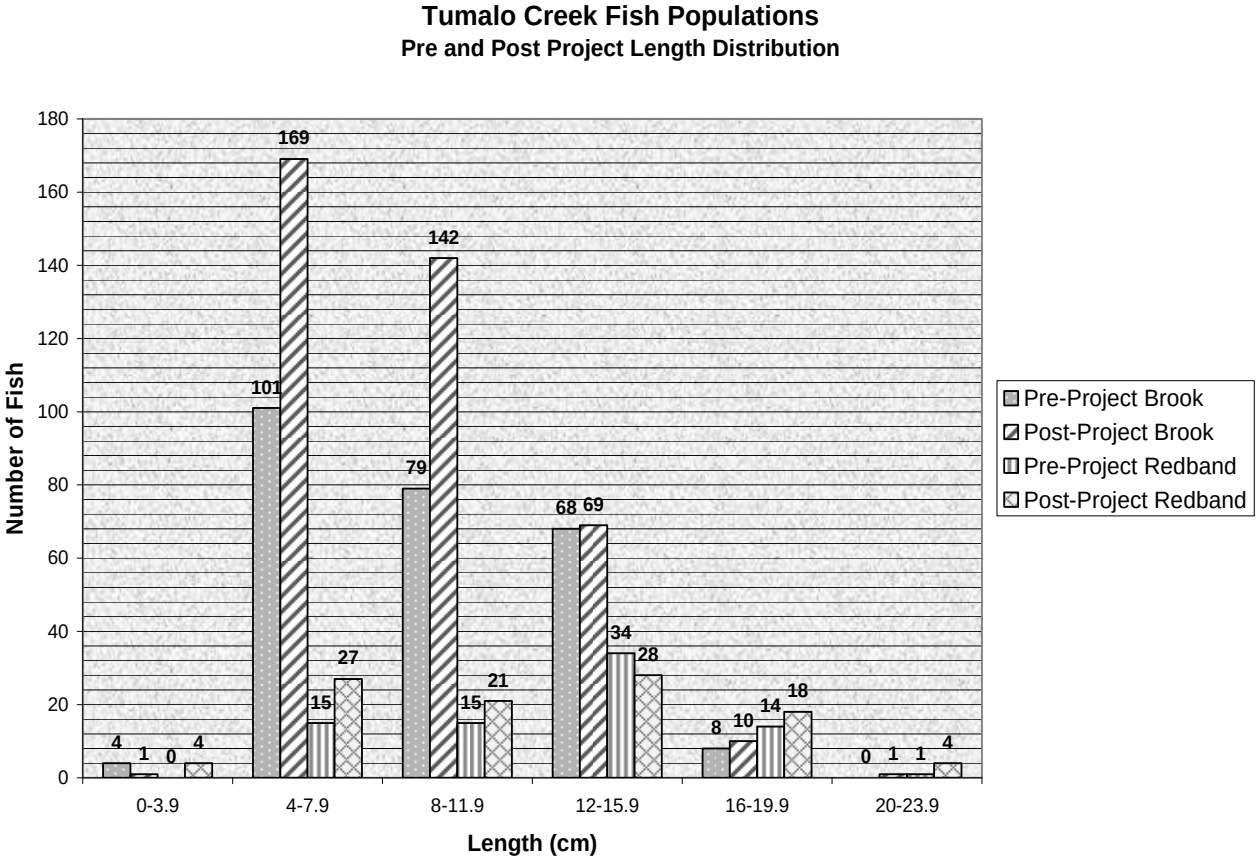
The graph below demonstrates the fish population estimates for both species in all three restoration phases.

Figure 1.



The graph below demonstrates the length frequencies of both fish species pre and post restoration for all phases. Demonstrated is the increase in brook trout, primarily smaller fish associated with side channels which serve as rearing habitat. There was also a slight increase in larger redband trout (>16 cm). The numbers represent what was actually captured and measured rather than the population estimates.

Figure 2.



Several individual fish were weighed when measured for length to derive condition, or well-being of the fish. A Fulton Condition Factor (K) was used to evaluate condition, where $K = (W/L^3) \times 100{,}000$ (metric units). The higher the number, the heavier the fish is for its length and in better condition. Brook trout pre-project K values ranged from 0.51 to 1.78 with an average of 1.14 (N=79), while post-project K values ranged from .85 to 1.3 with an average of 1.09 (N=43). Redband pre-project K values ranged from .84 to 1.66 with an average of 1.24 and post-project values ranged from 1.06 to 1.38 with an average of 1.17 (N=12). Post-project K values were slightly decreased from pre-project values. The small number of individuals measured post-project may have contributed to the difference.

II. Vegetation Monitoring

Restoration of Tumalo Creek included planting of over 71,000 native riparian shrubs and trees, primarily from rooted stock sourced from on-site or nearby locations. Plots were established within Phase I in the fall of 2004 to monitor plant growth, survival, and effectiveness of browse protection. Numbered metal tags were attached to plants within the plots. Willow and alders were the primary species planted for restoration and were the species monitored in the plots. Plants were measured for height at the time of planting and again 3 years later.

Table 3. Planted Vegetation Results

Plot #	Species	Number of plants measured	Ave. 2004 height (ft)	Ave. 2007 height (ft)	Ave. Increase (ft)	Ave. 2007 crown width (ft)
1 (Reach 12)	W	26	.67	1.36	.69	1.08
2 (Reach 11)	W	58	.91	3.18	2.27	2.84
Weighted Average	**W**		**.84**	**2.61**	**1.77**	**2.29**
1 (Reach 12)	A	23	.22	1.69	1.47	1.28
2 (Reach 11)	A	24	.32	3.08	2.76	1.95
Weighted Average	**A**		**.27**	**2.37**	**2.10**	**1.62**

An objective of the vegetation plots was to monitor plant survival. However, due to substantial loss of tags after high flow events and lateral channel migration, determining survival rates became impractical. Visual observation suggests survival rate was high, perhaps 80% or greater, but losses were experienced where the channel migrated laterally into the plots, washing plants away. Initially in 2004, several hundred plants were provided with vexar plastic browse protection. Monitoring revealed little animal browsing occurring in the first year, therefore browse protection was not used in subsequent years.

The table above includes crown width measurements. This parameter was not collected in previous years making a comparison over time impossible.

The photographs below, taken in October 2008, depict the plants in all three restoration phases. Plants were not measured for height in 2008, but individuals were near 7, 8, and 3 feet height for Phases I, II, and III, respectively. The rod in the photographs is 9.5 feet tall.

Photograph 2. Phase I Plants

Photograph 3. Phase III Plants

Photograph 4. Phase II Plants