Watershed Restoration Action Plan [Draft Nov. 1st 2012]

Elk Creek _th Field Subwatershed
HUC _______________

Pacific Northwest Region
Umpqua National Forest
Tiller Ranger District

November, 2012

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- South Umpqua Rural Community Partnership (SURCP)
- Partnership for the Umpqua Rivers
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Executive Summary

The Elk Creek Watershed Action Plan (ECWRAP) identifies historic, current, and desired watershed terrestrial vegetation, aquatic, and anthropogenic area conditions; proposes strategies and techniques to meet desired conditions and objectives, and outlines specific projects planned or currently underway within the watershed. This plan also describes terrestrial and aquatic vegetation and wildlife trends, and suggests directions and actions to pursue to alleviate undesired declining trends of wildlife and vegetation populations. This plan is part of a national framework developed by the US Forest Service to address watershed health, endangered species water quality, forest health, fire management, and forest resilience concerns using locally developed solutions. The key points listed below are discussed in further detail within the ECWRAP.

- Forest structure and composition has changed within the Elk Creek watershed in many locations causing declines in watershed health, habitat quality and forest resilience

- Past and present forest management practices continue to cause habitat and environmental degradation necessitating widespread forest and wildland ecological restoration

- Oak and dry pine habitat, of critical importance to numerous wildlife species, is degraded and continues to decline in many areas of the watershed

- Elk Creek provides critical habitat (as part of the South Umpqua Watershed) to several endangered, threatened and sensitive anadromous species including coho salmon

- Key aquatic environmental problems include lack of adequate habitat structures for spawning and rearing of fish, excessive roads, aquatic habitat fragmentation, aquatic habitat simplification, and high stream temperature.

- Beavers are a keystone species endemic to Elk Creek that have declined greatly in numbers since early fur trapping in the Pacific Northwest and with continued reintroduction, improved protection and management will likely provide unparalleled benefits to fish habitat and populations

- Human persistence and sustainable use of resources within the watershed is desired, and local organizations, citizens, producers, and practitioners must collaborate and be afforded opportunity to involvement in watershed restoration and sustainable management

- Specific projects currently underway or planned for the immediate future include: _____ list

Introduction

The Elk Creek Watershed Action Plan has been drafted to bring watershed concerns, issues, and interests expressed by members of the local community, organizations, and agencies forward and apply strategy in an action-based framework for watershed management. Through guidance and direction of this action plan, it is hoped that improved watershed health, sustainable resource management, and successful ecological restoration will be achieved.

Elk Creek flows in a south to north direction in the Tiller Ranger District of southern Oregon. Elk Creek is a tributary of the South Umpqua River, the longest undammed river in the western United States (214.8 miles) with unimpeded access to the Pacific Ocean. [more on basics of Elk Creek].

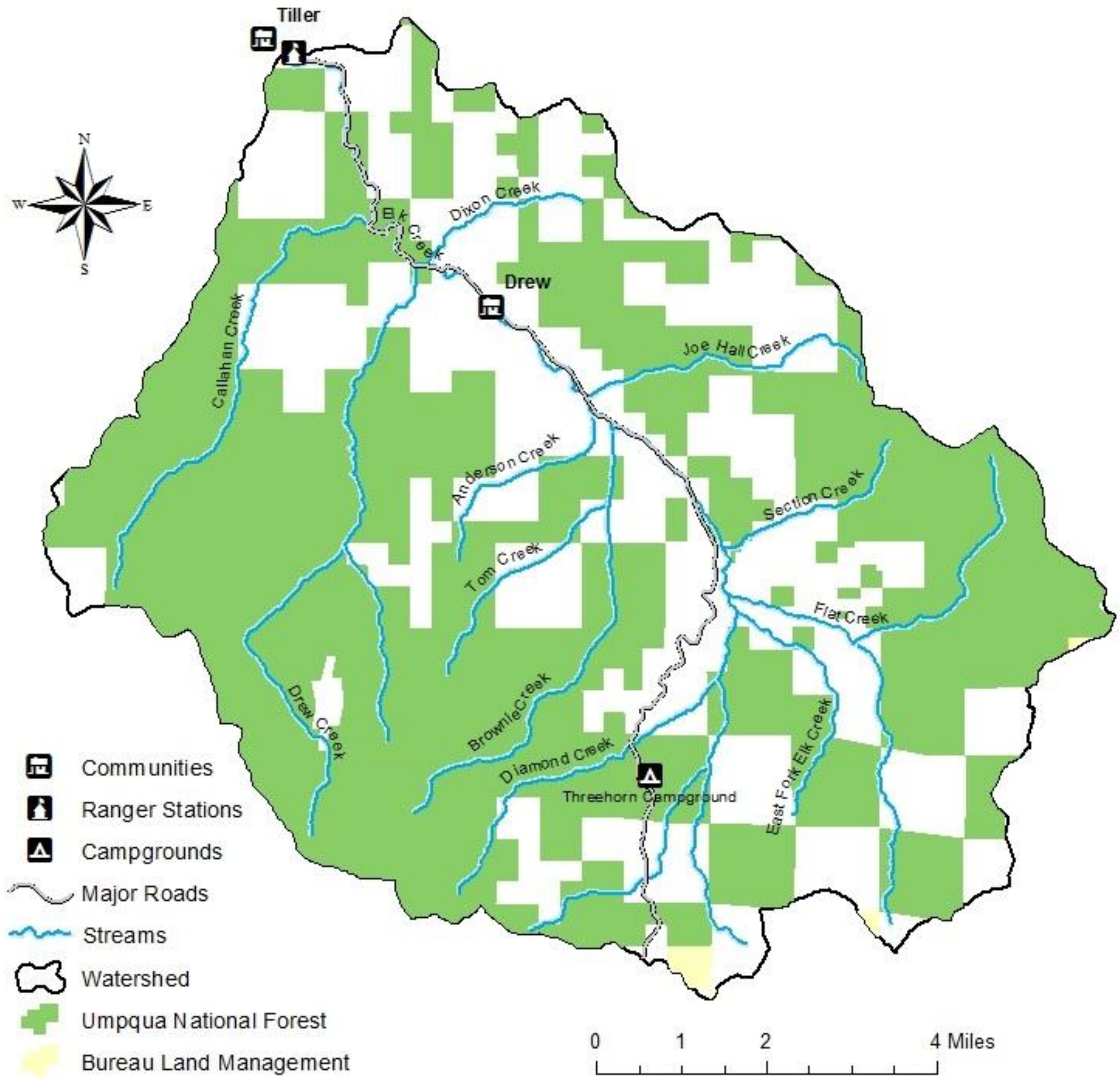

Figure 1. National Forest and Bureau of Land Management ownership, streams, communities, and recreation sites in the Elk Creek watershed.

1. General Characterization and Historic Context

1.1 Climate

The climate of the region is Mediterranean. Annual precipitation is generally high from 50 to 70 inches per year, with 80-90% occurring between October and May. Precipitation falls as rain or snow, with snow being much more common above 3000 feet elevation in winter months. Rain on snow events are most likely to occur in the upper portions of the watershed between 2000 and 5000 feet elevation, accounting for about XX% of the watershed. Precipitation is generally greater at higher elevations, although microclimates and terrain features affecting precipitation gradients also exist. Winter temperatures are generally between XX and XX degrees Fahrenheit while summer temperatures commonly sit between XX and XX degrees Fahrenheit. The Mediterranean climate with hot, dry summers and wet winters creates fire-prone conditions of generally warm weather, low humidity, and high vegetation cover (i.e. a fuel source). Summer weather disturbances often result in lightening-to-ground strikes accompanied by very little moisture, generating a long history of natural fire in the watershed and greater region during summer and fall months.

Temperatures across the Pacific Northwest have been in a general increasing trend, with recent annual average temperatures higher than historical averages by 1 to 3 degrees Fahrenheit. Coincident with this temperature trend is a trend toward generally wetter conditions with annual precipitation increasing on average by 10% of normal. Patterns of variability are evident across the region and may substantially affect year to year conditions (cite). Climate projections for the Pacific Northwest show continued increases in average annual temperature across all seasons, with accentuation of the Mediterranean climate (i.e. even drier summers and potentially wetter winters, cite).

1.2 Geology

The Elk Creek watershed ranges from 989 to 4,887 (check) feet in elevation (figure) and is composed of the edges of the Klamath-Siskiyou and West Cascades Geologic Provinces. The West Cascades are volcanic in origin while the Klamath-Siskiyou is a mix of igneous, metamorphic and sedimentary rock types (Coleman & Kruckeberg 1999). These parent rock materials have eroded through time to create a diverse set of substrate soils displayed in the highly dissected landscape of the Elk Creek watershed. The diverse substrates generally support great plant diversity especially due to inclusions of harsher soils jutting west from the Klamath-Siskiyou Region such as serpentine which supports rare and highly unique vegetation types.

Landform stability ranges from landslide - earth flow complexes (lec) to firm bedrock. Alluvial floodplains make up a minor component of landforms in the watershed but are nonetheless highly valuable growing sites as well as locations for recreation and building due to being generally very flat and near water sources. Landslide - earthflow complexes make up the majority of the watershed and are generally conducive to good tree growth due to their water holding capacity, rich soils and gentler slopes.

[Sediment and erosional processes].

[Landslide inventory].

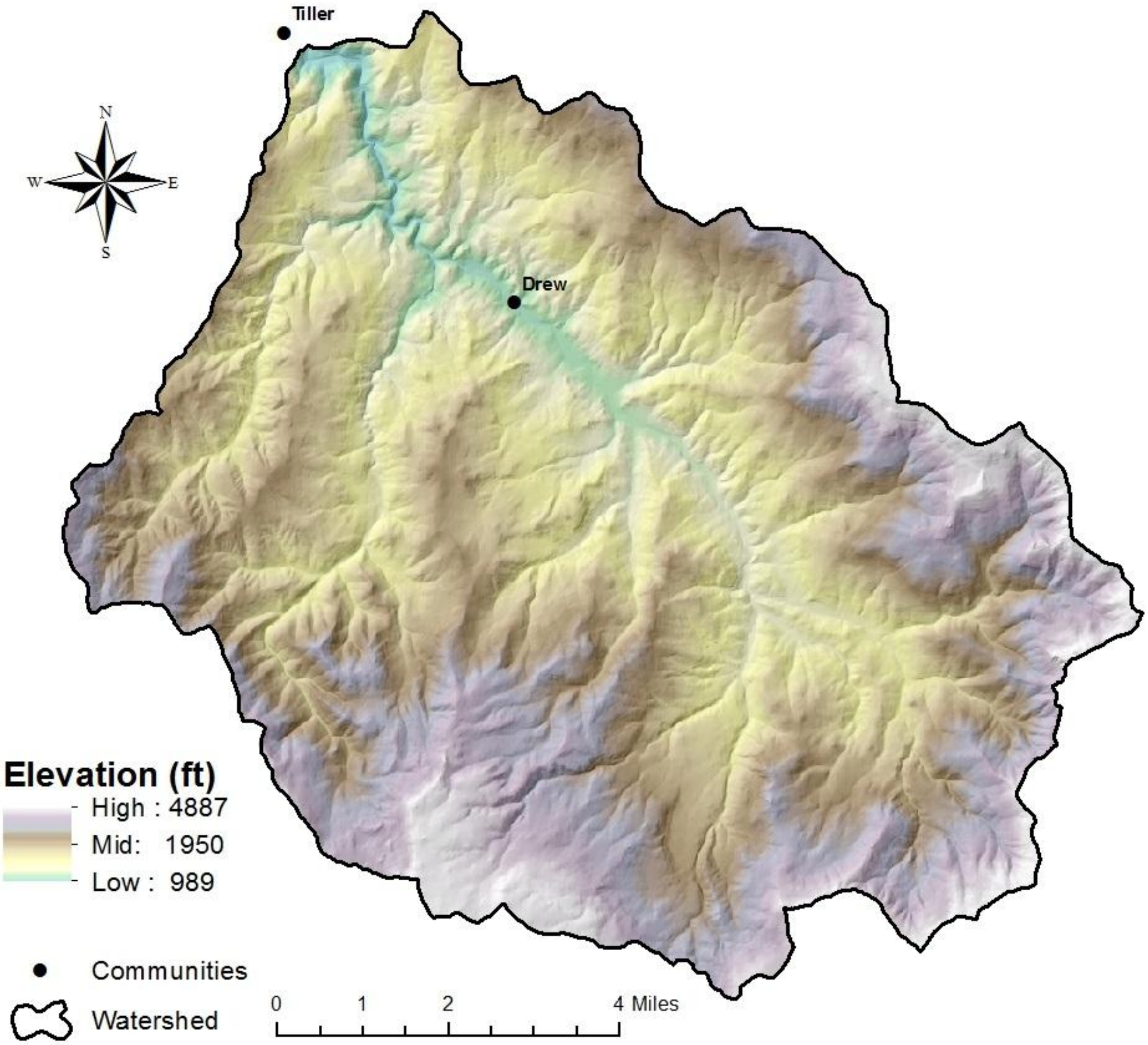

Figure 2. Elevation model for the Elk Creek watershed. Low lying areas are shown in green and beige while high elevations are shown in brown, purple and white.

1.3 Hydrology

Stream flows, flood disturbance regimes.

1.4 Vegetation-Conifer

The Elk Creek watershed, like the greater Umpqua River Basin and much of the Pacific Northwest, is home to great expanses of diverse, mixed conifer forest. These coniferous forests make up the majority of land cover in the Elk Creek watershed, and have been the most common vegetation type since pre-Euro-American settlement. Historically, conifer forests were characterized by a mix of seral conditions from complex, old stands to those comprised of thicker tree regeneration. Complex forest structures (e.g. virgin old growth) were generally predominant in mixed-conifer areas of the region, with intermediate and young stand structures making up a smaller portion of the landscape (Franklin & Dyrness 1973, Herman & Lavender 1990). Complex, late-seral stands contain trees of varying species, age and spatial arrangement, as well as important snag and tree cavity structures (Franklin & Waring 1980). Younger stands would have historically been generated by areas of high-severity fire and characterized by many snags in addition to thick shrub and young tree structures unique to open patches (cite).

Mixed conifer forests of the Umpqua watershed support a variety of conifer species including: Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), Shasta red fir (*Abies magnifica* var *shastensis*), grand fir (*Abies grandis*), incense cedar (*Calocedrus decurrens*), western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), Pacific yew (*Taxus brevifolia*), ponderosa pine (*Pinus ponderosa*), sugar pine (*Pinus lambertiana*), Jeffrey pine (*Pinus jeffreyi*), western white pine (*Pinus monticola*), and knobcone pine (*Pinus attenuata*). Broadleaf tree species and numerous understory shrubs are also found inhabiting mixed conifer ecosystems throughout the watershed. Bigleaf maple (*Acer macrophyllum*), Pacific madrone (*Arbutus menziesii*), giant golden chinquapin (*Chrysolepis chrysophylla*), California black oak (*Quercus kelloggii*), canyon live oak (*Quercus chrysolepis*), (Oregon myrtle?), red osier dogwood (*Cornus sericea*), and Rocky Mountain maple (*Acer glabrum*) can be found throughout conifer forests inhabiting the lower canopy and understory as sub-dominant associates. Many understory woody shrub species coexist in mixed conifer environments of the Elk Creek watershed as well.

Although conifer forests of Elk Creek and the greater Pacific Northwest are often generalized as "mixed conifer" forests, species are not homogenously distributed and strong plant associations form unique forest types dependent on more localized site conditions such as elevation, soil type, exposure, and climate. Many systems for identifying and categorizing different plant associations have been developed for forests and woodlands of the Pacific Northwest, with varying degrees of specificity. For the sake of maintaining focus of this plan to more general forest types that have very clear functional separation, mixed conifer forests of the Elk Creek watershed will be addressed here in several broad association categories: Douglas-fir, Douglas-fir/hemlock, Douglas-fir/pine, true fir (*Abies*), and conifer plantations.

1.41 Douglas-fir

Douglas-fir is the most abundant conifer species across much of the Pacific Northwest, and is consequently classified as the dominant tree species of numerous forest and plant species associations throughout its range (Hermann and Lavender 1990). This is also true in the Elk Creek watershed where the majority of mixed conifer forests are dominated by Douglas-fir, which occurs across environmental thresholds for many other species. This behavior can be thought of as "habitat generalist" as Douglas-fir tolerates a wide range of environmental and competitive conditions. In addition to inhabiting areas that are naturally or historically Douglas-fir dominated, this species is also a primary invader of vegetation types where it was historically less abundant (Reed & Sugihara 1987, Hunter & Barbour 2001, Kennedy & Sousa 2006, Skinner et al. 2006, Cocking et al. 2012). This is primarily due to changes in fire frequency and grazing pressure, where removal of fire or grazing catalyzes recruitment of young Douglas-fir cohorts across vast areas; especially slopes with better exposure and historically more open conditions where oaks, other hardwoods, and pines have declined in dominance. Douglas-fir dominance is generally improved in the southern and central extent of its range on north-facing slopes, steep canyon drainages, mid to high elevations and areas of generally more productive soil (Hermann and Lavender 1990).

Stands dominated by Douglas-fir in the Elk Creek watershed exhibit a wide range of species diversity and stand-level variability. Low to mid-elevation Douglas-fir stands often include substantial presence of hardwoods, especially bigleaf maple (on moist sites), Pacific madrone, and California black oak. In these lower elevation zones, occasional ponderosa pine, sugar pine, incense cedar, and western red cedar also occur. In higher elevation (3000 - 5000 ft) Douglas-fir stands, lower elevation hardwood associates give way to giant golden chinquapin and occasional Rocky Mountain maple and red osier dogwood. Pine and cedar associates are joined by western hemlock, white fir and occasional Shasta red fir and western white pine. On the periphery of serpentine sites, Jeffrey pine and knobcone pine are also found growing alongside Douglas-fir.

In many Douglas-fir dominated stands in Elk Creek a strong structural shift has occurred following timber extraction activities and the cessation of human and natural fires. Across the Pacific Northwest this change is often marked by increases in density of young trees and loss of forest structural complexity (Agee 1993, Franklin et al. 2002, 2006, Carloni 2005). Prior to industrial timber management, Douglas-fir forests in western North America were mostly old growth, exhibiting greater structural complexity and variability in tree ages and spatial distribution of stems than succeeding post-harvest forests. In these forests disturbances (especially fire) played an important role in creating stand heterogeneity by maintaining or creating small forest gaps, catalyzing patches of regeneration, initiating the formation of snags, and forming unique structural conditions necessary for associate species (Franklin et al. 2002, Franklin & Van Pelt 2004). These structural changes are well-studied throughout the western US and have been linked to various watershed health-related issues including old-growth mortality, loss of habitat, and greater susceptibility of forest stands to large, severe fires (Parsons & DeBenedetti 1979, Sweezy & Agee 1991, Agee 1993, Franklin et al. 2002). Changes in stem density are largely attributable to "habitat generalist" species such as Douglas-fir and white fir that benefit from fire exclusion and often regenerate well after timber harvest activities. Douglas-fir regeneration was often encouraged on private and public lands over other tree species because of its greater timber value [see plantation section]. The majority of Douglas-fir dominated sites in the Elk Creek watershed have received some level of timber management and many are currently at much lower levels of stand complexity than is the natural state for this forest type (i.e. many younger trees, fewer snags, less range of tree ages, and fewer forest gaps).

1.42 Douglas-fir/Hemlock

In moist locations, Douglas-fir forests mix strongly with western hemlock, a shade tolerant and moisture loving species. Western hemlock is a common associate in moist conifer types throughout the Pacific Northwest, and tends to increase in dominance with greater moisture and longer fire-free periods (Packee 1990). In older forests, western hemlock does not appear to be deterred by the dominance of larger Douglas-fir, as its shade tolerance allows it to grow well and persist despite competition with fast-growing Douglas-fir. Although information on stand dynamics for moist Douglas-fir/hemlock stands in the Elk Creek watershed is limited, increases in stem densities and loss of forest complexity within the last century has likely occurred where timber extraction has been performed [see discussion for "Douglas-fir" forest type].

1.43 Douglas-fir/Pine

On drier sites ponderosa and sugar pine may occur as co-dominants in mixed Douglas-fir/pine stands. East, south and west slopes, as well as many mid-elevation ridgelines and saddles often harbor this drier, more open forest type. Because of greater exposure or close proximity to fire-prone oak or pine ecosystems, Douglas-fir/pine dominated stands likely burned with greater frequency than moister Douglas-fir sites, enabling the increased presence of pine which requires more open growing conditions (Franklin & Waren 1980, Kinloch & Sheuner 1990, Oliver & Ryker 1990). Low densities of California black oak, canyon live oak and chinquapin are also present in this stand type. Among pines, ponderosa pine is generally more common than sugar pine, although historically this may not have been the case as sugar pine populations have declined due to mortality effects of the exotic disease white pine blister rust (*Cronartium ribicola*) as well as early logging which targeted large, canopy-emergent trees. Both ponderosa pine and sugar pine are susceptible to increasing density of Douglas-fir that occurs without frequent fire disturbance. Greater densities of Douglas-fir surrounding individual old growth pines affect tree vigor by reducing available sunlight and underground resources. This reduced vigor can increase large pine mortality by competition alone or by threat of severe wildfire and greater susceptibility to beetles (Kinlock & Sheuner 1990, Oliver & Ryker 1990, Sweezy & Agee 1991). Like much of the Elk Creek watershed, sites showing a mixed Douglas-fir/pine association have already undergone dramatic changes in Douglas-fir densities and are at risk of losing their pine component if this trend continues.

1.44 True Fir

Moist slopes at high elevations in the Elk Creek watershed support forest stands that lose some dominance by Douglas-fir, which is replaced with greater presence of white fir and some Shasta red fir. On drier slopes or serpentine soils true firs may also mix with western white pine, sugar pine, Jeffrey pine, knobcone pine, and incense cedar. These higher elevation forests are somewhat rare since they prefer elevations above 4,000ft which comprise a small portion of the watershed. Information on changes occurring in these forest types since Euro-American influences in the Elk Creek watershed is limited, however, the general trend of increased stem density (as observed in most forest types throughout the watershed) is likely also to have occurred in true fir dominated associations [see following section on forest structural changes]. Studies on similar forest types in other areas suggests that increases in stem density would most likely be attributed to more successful reproduction and recruitment of white fir and Douglas-fir in the absence of fire disturbance (Parsons & DeBenedetti 1979, Laacke 1990).

1.45 Conifer Plantations

Industrial forest operations and rotational harvesting techniques have resulted in large stands of plantation forest. Plantations consist of young conifers planted following clear-cut timber harvests, most of which are replanted with Douglas-fir, and to a lesser extent ponderosa pine. Conifer plantations display the most dramatic shifts in species and structural diversity when compared to pre-Euro American settlement forests. These stand types are highly homogenous, consisting of even-aged trees planted at prescribed spacing. Variation and complexity seen in natural forest development is not apparent in plantation settings as forest gaps, stem patchiness, snags and co-existence of different age classes are not expressed. Formation of complex structure in these stands may take centuries to develop without a natural disturbance agent such as fire. Natural thinning by fire (the primary historical disturbance process for the Umpqua Basin) is not allowed to occur, and mechanical thinning must often be performed to alleviate growth stress due to high stem density and aid in the recovery of stand complexity or to speed up timber production. Species associations are also altered by plantation forestry as non-valuable hardwood associates are intentionally eradicated from stands by cutting or herbicide. Overall, these stands have very low species diversity and severely lack structural variation.

Forest fuel arrangement in plantations presents another management issue as fuels are homogenously distributed across stands of even-aged trees growing at high density and with great canopy fuel connectivity. This continuous canopy fuel condition makes plantations more conducive to sever canopy fires. Plantation canopy fires may also threaten neighboring old-growth as fuels can carry fire into the canopy of the adjacent stand. On private lands in the watershed this practice of rotational forestry continues and is in large part the cause of the fragmented nature of mixed-conifer forests across the Elk Creek landscape. Although this practice is currently less common on Forest Service lands, past harvests on public land also contain large acreages of conifer plantation forest types from 20-80 years old that still exhibit homogenous and often unhealthy stand conditions.

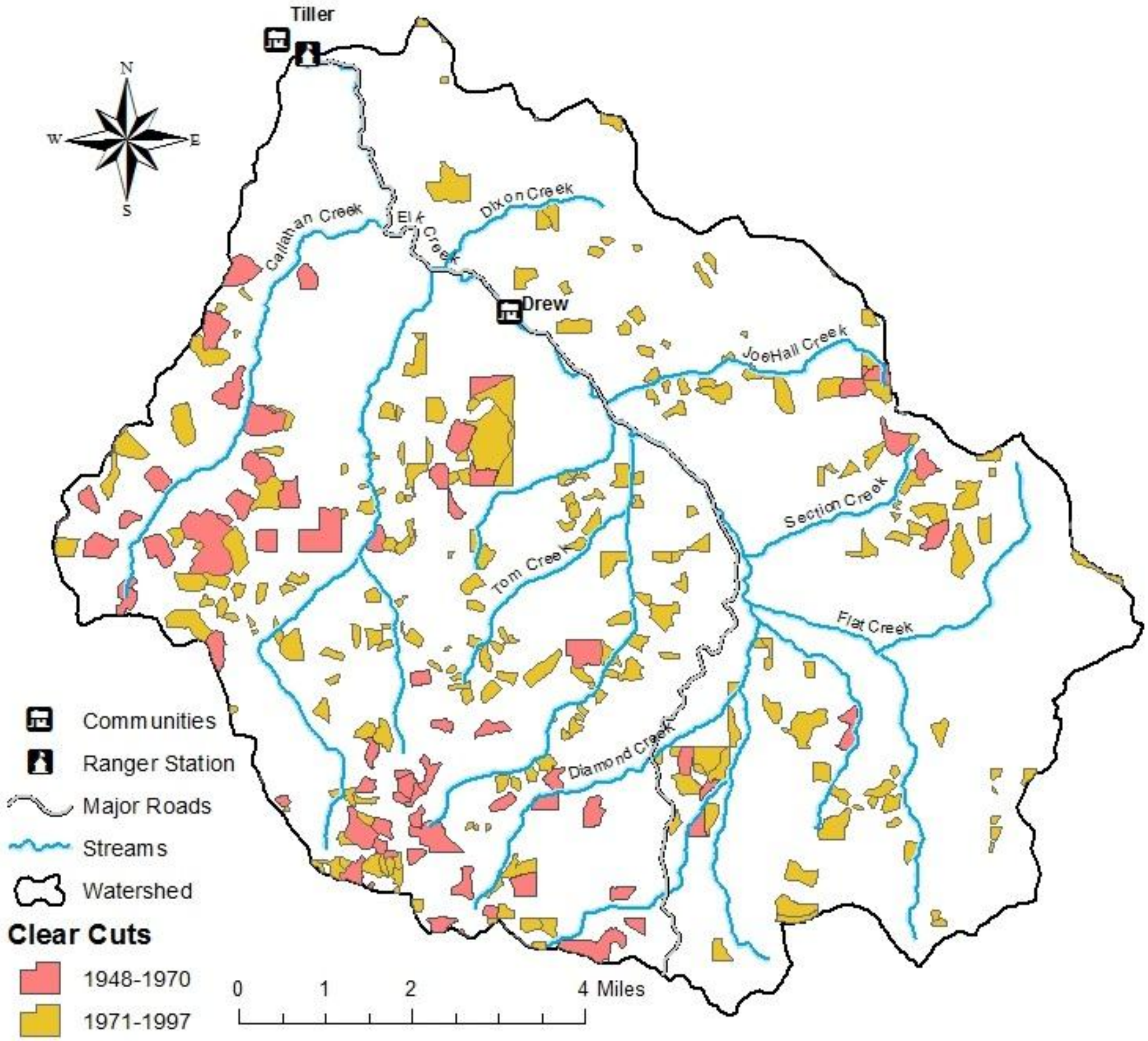

Figure 3. Clear cut areas within the Elk Creek watershed between 1948 and 1997. Clear cut areas comprise XX% of the watershed between 1948 and 1970 and XX% between 1971 and 1997.

1.5 Vegetation-Dry Pine and Hardwood

Oak woodland and savanna ecosystems of the Umpqua watershed are dominated by two principal species of deciduous oaks: Oregon white oak (*Quercus garryana*) and California black oak (*Quercus kelloggii*); which are sometimes co-dominant with dry site-tolerant conifers, especially ponderosa pine and sugar pine, and occasionally Douglas-fir and incense cedar. The Elk Creek watershed is approximately located in the middle of the north-south range of Oregon white oak which inhabits mid to low elevations on warm, generally gentle aspects from the Sierra Nevada in south-central California to southern British Columbia, Canada (Stein 1990). California black oak inhabiting the Elk Creek Watershed is at nearly the northernmost reach of its range as it grows in mixed hardwood, conifer, and chaparral ecosystems from northern Baja, Mexico to near Roseburg in Douglas County, Oregon (McDonald 1990). Only Oregon white oak grows in isolated pockets east of the Cascade crest in Oregon, otherwise both species are confined to areas west of the Cascades. In addition to the two oak species, madrone, canyon live oak, and many conifer species are common associates of oak woodlands; particularly where California black oak is supported.

Fire and the development of oak ecosystems are inherently linked (Abrams 1992, Peterson et al. 2007). Before Euro-American settlement fire return intervals in the Klamath-Siskiyou and Cascade regions were generally frequent (Agee 1991, Wills and Stuart 1994, Sensenig 2002, Carloni 2005). These frequent, low-intensity fires (originating often from tribal management practices) shaped and sustained species rich understories and unique structures in oak woodlands and savannas prior to the modern practice of fire suppression. Historic Oregon white oak woodlands and savannas generally contained many large, widely spaced oaks in mosaic patterns of alternating oak and grassland dominance with occasional open-grown and often isolated ponderosa pines or rarely Douglas-fir (Habeck 1961, 1962, Thilenius 1968, Carloni 2005). By contrast, California black oak mixed woodlands exhibited greater presence of other hardwoods and conifers, especially ponderosa pine, sugar pine, incense cedar, Douglas-fir and Pacific madrone (McDonald 1969, 1990). These species association patterns are remnants of a past regime in the Elk Creek landscape, as most of the oak dominated or co-dominated woodlands have begun shifting from open, dry oak and pine dominated systems to closed-canopy, moist

Douglas-fir and other conifer dominated stands following the cessation of natural and human fires.

1.51 Oregon White Oak Woodland

Remaining Oregon white oak woodlands and sites with potential to support Oregon white oak comprise a significant portion of the Elk Creek watershed (figure). These areas exist mostly in the lower elevation zones of the watershed (<3000 ft) on gentle, southerly aspects. Unlike the vast expanses of oak savanna that cover parts of Central Oregon (e.g. the Willamette and Rogue River Valleys), Oregon white oak ecosystems in the Elk Creek watershed form smaller isolated patches or islands of unique vegetation in a largely conifer dominated matrix. These islands likely exist due to a combination of local site conditions (i.e. exposure, elevation, and soil type) as well as historic cultural management by endemic tribes with fire. Patches exist in Elk Creek as closed woodland and sparse savanna. A common spatial arrangement found in Elk Creek, as well as many coastal Oregon white oak communities, are periphery oak woodlands that form a band between open grassland patches and mixed conifer forest. These communities are described in much of the literature concerning Oregon white oak in the coastal mountains of California and Oregon as “northern oak woodlands” or “coastal balds” (Reed and Sugihara 1987, Barnhart et al. 1996). In Washington and British Columbia, Canada this unique woodland type is referred to more commonly by the informal form of its Latin name, “Garry oak” (Fuchs 2001).

Oregon white oak savannas and woodlands are among the most diverse ecosystems of the Pacific Northwest. In the Umpqua Basin they support communities of plants and animals that are remarkably different from adjacent conifer forests; as well as many species that require both conifer and oak habitats. Oak woodlands and individual large oaks provide highly complex and variable structures essential to many types of wildlife. Oaks also provide food in the form of acorns and numerous palatable and seed-producing herbaceous understory species that do not inhabit conifer-dominated ecosystems. More than 200 vertebrate species are known to use oaks (O'Neil et al. 2001) as well as the majority of Oregon's native birds (Anderson 1972). Many federal and state listed endangered and candidate endangered species are highly dependent on Oregon white oak woodlands and savannas in southern Oregon and northern California (Citations). Among those listed are Pacific fisher, Gentner's fritillary, Kincaid's lupine, white breasted nuthatch, acorn woodpecker, western bluebird, Lewis' woodpecker, flammulated owl, Williamson's sapsucker, oak titmouse, northern goshawk, band-tailed pigeon, white-headed woodpecker, blue-gray gnatcatcher, sharp-tail snake, foothill yellow-legged frog, red-legged frog, western gray squirrel, fringed myotis, and hoary bat. Open, well-lit oak woodland understory environments support a host of native vegetation which provides high quality habitat for Gentner's fritillary, Kincaid's lupine and many other sensitive plant species.

The maintaining effects of fire that limit encroachment by conifers in Oregon white oak woodlands and savannas have long ceased, resulting in dramatic changes to the composition and extent of Oregon white oak woodlands. However, many of these patches remain in the Elk Creek watershed in deteriorated to somewhat intact conditions. Deteriorated stands consist of vigor-compromised oaks and large pines succumbing to increased shade and decreased resources from great numbers of encroaching conifers (largely Douglas-fir). Some more-or-less intact oak woodlands remain on various private parcels and in limited locations on public land across the central and northern portions of the Elk Creek watershed; especially where woodlands form a natural band between the few remaining open meadows or serpentine plant communities and the greater expanse of mixed conifer forests. In these locations, oaks may be able to migrate further into the interior meadow environment as they are pushed out of existing areas by encroaching conifers. However, even in this scenario, (with the exception of serpentine or other very harsh soil sites) the long-term projection for Oregon white oak ecosystems, without the presence of frequent fire, is to succeed to mixed conifer forest.

1.52 California Black Oak-Pine Woodland

Mixed pine-oak dominated forest types are also a natural component of the Elk Creek watershed, with greater presence often on southeast, south, and southwest aspects where drier conditions limit growth of more mesic species such as true firs, hemlock, or Douglas-fir (figure). These ecosystems are often described as California black oak or pine-dominated, but are ultimately a heterogeneous mix of a number of dry-tolerant species that prefer exposed, well drained, open stand environments. California black oak is particularly notorious for its common association with low densities of large, canopy-emergent, high light-tolerant and more fire-resilient conifers such as ponderosa pine, sugar pine, Douglas-fir, and incense cedar (McDonald 1969, 1990 Hosten et al. 2006). California black oak is rarely found in pure stands in Oregon, unlike Oregon white oak which forms extensive, relatively pure stands across many low elevation valleys and foothills outside the Elk Creek watershed. Historically frequent fires in California black oak-pine woodlands limited the establishment of young conifers and brush, and thereby maintained open conditions with well-lit understories that sustained California black oak and associated hardwoods and widely-spaced conifers. Native understory species including perennial grasses and herbs thrive in these environments, contributing greatly to the biodiversity and richness of native oak ecosystems.

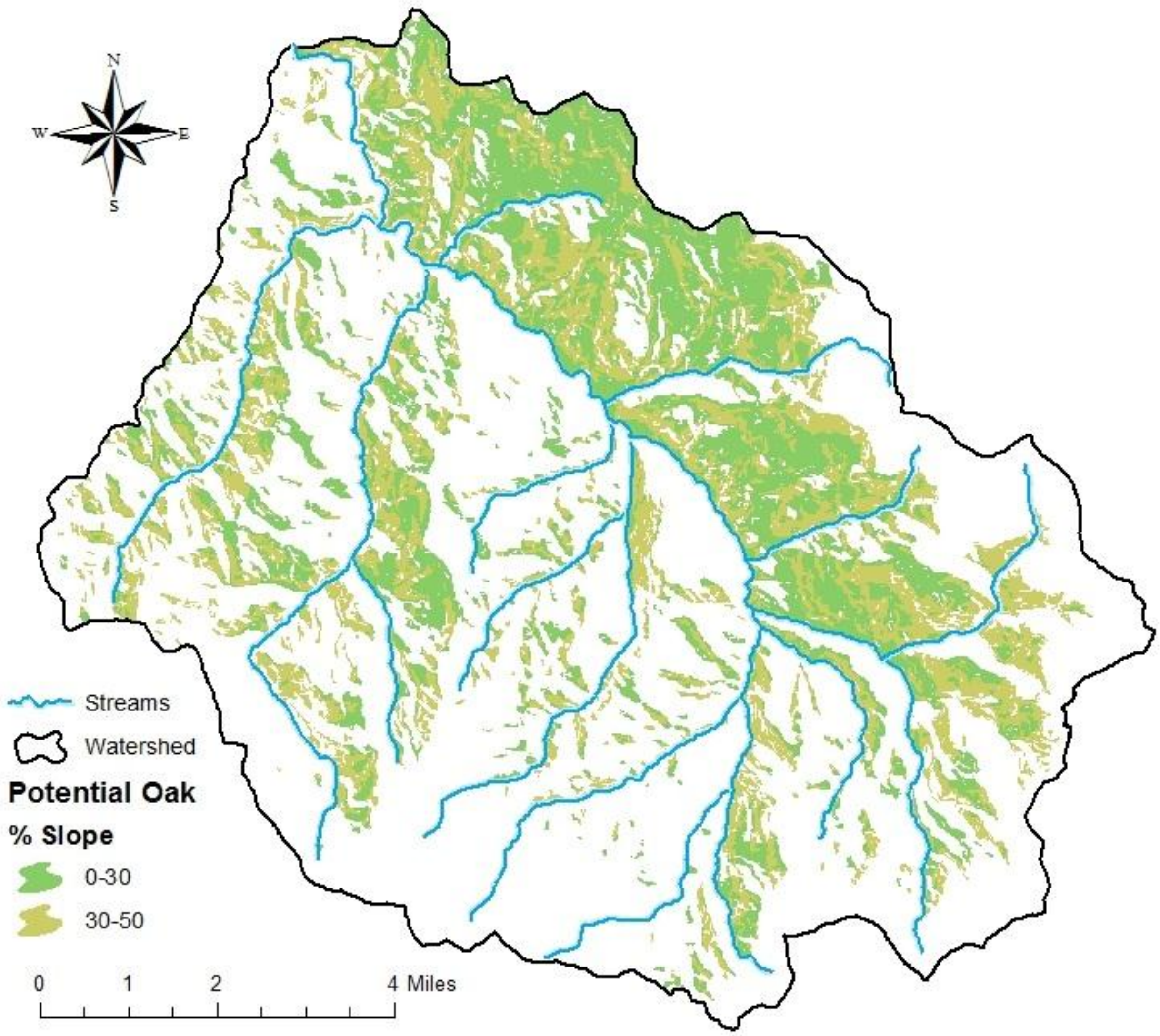

Figure 4. Delineation by slope, aspect, and elevation of areas where oaks are likely to occur in the Elk Creek watershed. Areas marked in green are most suitable gentle slopes and more conducive to restoration by thinning, while areas in yellow-green are steeper areas with potential to support oak. Most suitable, gentle slopes marked in green comprise 18% of the Elk Creek watershed area.

1. 6 Aquatic/Riparian Environments

1.61 Vegetation

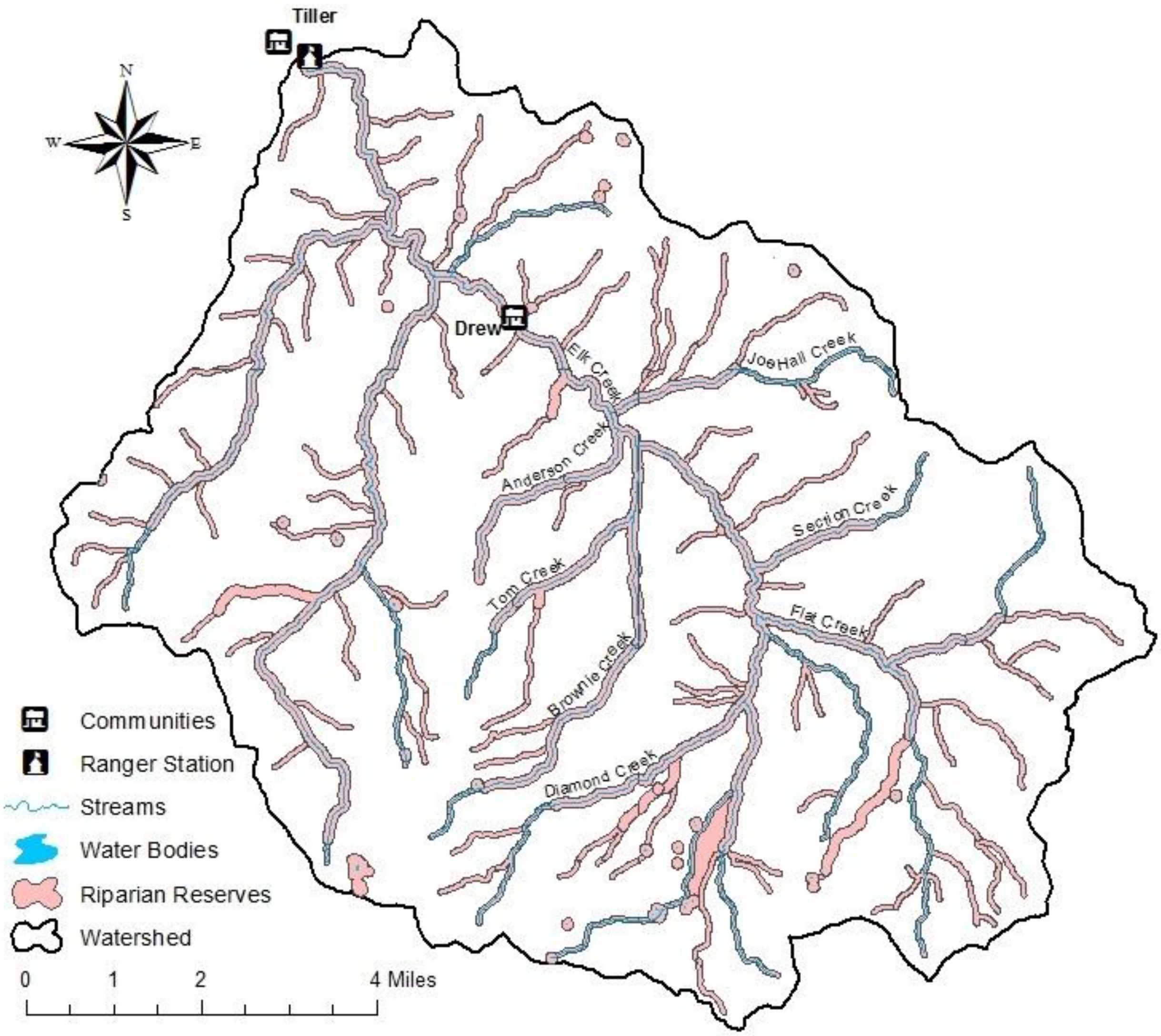

Figure 5. Designated riparian reserves surrounding streams and other water bodies within the Elk Creek watershed. Riparian reserves comprise XX% of the Elk Creek watershed area.

1.62 Wildlife

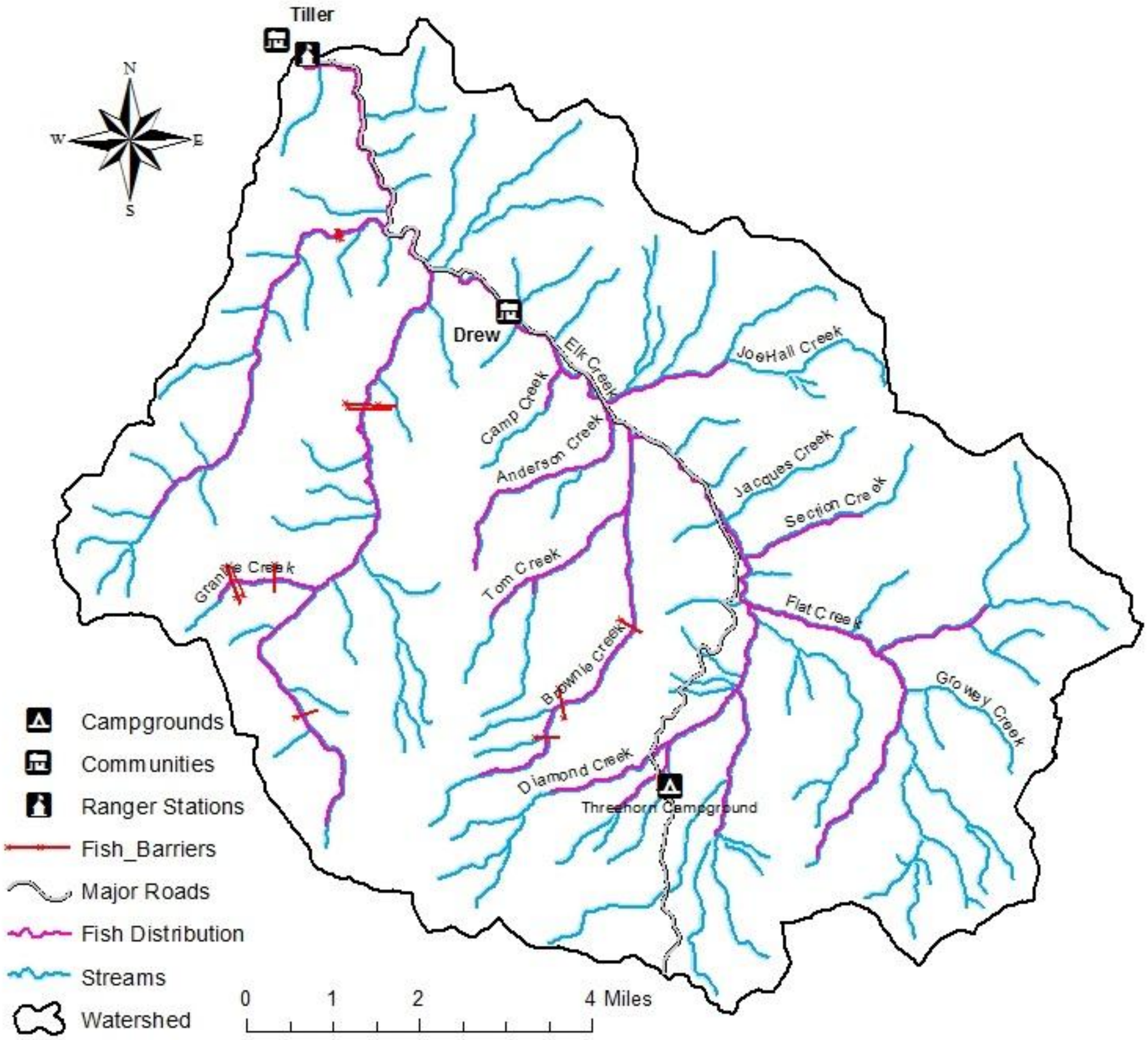

Figure 6. Anadromous fish distribution, streams, and fish barriers in Elk Creek and its tributaries.

1.7 Natural Fire Processes

1.71 Vegetation Type Indicators

The Elk Creek watershed contains a number of vegetation types and plant and animal species that are well adapted to or dependent on frequent fire disturbance. Most prominent are the islands of oak woodland and open meadow that occupy low to mid elevations throughout the watershed. Many of these specialized habitats likely exist because of frequent fire; particularly those set by native tribes (Cow Tribe locally). Early accounts of settlers and surveyors in the Umpqua watershed describe greater expanses of oak woodland and open forage land prior to the cessation of prescribed burning by Native Americans and early ranchers (Carloni 2005). In addition to oaks, the Umpqua is home to many other hardwood tree and shrub species that vigorously re-sprout if top-killed by fire; a plant trait globally distributed in places where fire plays a constant and important role (Bellingham and Sparrow 2000, Barton 2002, Hoffmann and Solbrig 2003).

The presence of pines in the Elk Creek watershed is also a strong indicator of historic fire processes. Pines as a genera are generally more successful in dry forest types where fires are common globally by human or natural ignitions. Pines have evolved many fire-enduring traits such as long tap roots, thick bark, and sparser crowns (cite). Research in California has also shown that many oaks and potentially certain pine species have adapted leaf structures that perpetuate frequent, low-intensity fire by forming fast-burning and highly flammable litter beds when leaves accumulate on the forest floor (cite).

Chaparral communities present in the Elk Creek Watershed occur in localized pockets and suggest historic presence of high severity fires. Chaparral species are renowned for their diversity of fire adaptations and resilience to repeated, stand-replacing fire; as well as the propensity for colonization of severely burned sites. Such communities are comprised of manzanita sp., Ceanothus sp., and etc….. In the Elk Creek watershed (and many other forests throughout the Klamath-Siskiyou region), these chaparral communities also associate with knobcone pine, a species similarly adapted for moderate to high-severity fire regimes. Knobcone pine reproduction depends on fire to release seed from its serotinous cones that require high temperatures to loosen the resin than keeps them bound tight. These cones may lay dormant in the forest canopy for many decades, containing viable seed even after the parent tree has died (cite).

Some understory plant species that are now endangered occupy parts of Elk Creek, including (Kincaid's lupine, others) and indirectly benefit from the transforming effects of fire by inhabiting locations historically sustained by recurring, frequent burns. Culturally significant plant species that were historically managed with prescribed fire by local tribes are also abundant in Elk Creek; most notably oak woodlands, which were managed for acorns, a primary tribal food source. Other understory species such as hazel, bear grass, and willow were managed for their vigorous post-fire sprouting response that produces strait-stemmed materials for basket weaving and other crafts.

Many animal species also follow this pattern of fire-adaptation and resilience, as fire stimulates higher quality forage, formation of den and nest structures such as snags, and open conditions in which many food bearing species (including berries, nuts, and acorns) thrive.

1.72 Fire history

Given the presence of fire-adapted and fire-shaped habitat types in the Elk Creek watershed, it is not surprising that early accounts by settlers and surveyors, as well as fire-ecology and history research have supported the historic presence of frequent fire in the Umpqua River Basin (Carloni 2005). Although fire-history studies have not been conducted specifically within the Elk Creek tributary watershed of the South Umpqua, studies have been conducted for other parts of the Basin, and show a clear presence of natural and aboriginal fires prior to Euro-American settlement. Research on fire scars found in tree rings and analyses of stand age and initiation both show a decreasing presence of fire with the evolution of modern fire suppression management (Carloni 2005).

Reconstructing fire patterns and behavior from 100-200 years before present day can be very difficult and poses its own unique set of limitations. While there is a great deal of certainty that fires were more common historically, the extent and severity of fire is more hotly debated. Studies of other tributaries in the Umpqua Basin indicate that fires in low to mid-elevations were frequent enough, and tame enough to allow formation of wide-open oak woodlands, meadows, and much more open mixed conifer-oak and pine-oak assemblages (Carloni 2005). Patches of moderate to high intensity fire also likely occurred historically in the watershed, as fire naturally exhibits variable severity, especially in higher elevations and steep slopes where fuel types change from light, continuous understory fuels, to more ladder or canopy fuel-driven systems such as chaparral and montane conifer.

1.8 Human Use/Resources

1.81 Indigenous Peoples

The Elk Creek watershed has been inhabited for at least 10,000 years. Recent inhabitants were hunter/gatherer people, relying heavily on anadromous fish populations and many plant foods. The Cow Creek Tribe??? Rich traditions and culture. Verbal history and social system. Tool use highly complex from stone weaponry to basket weaving.

Indigenous populations began to decline prior to 1800(??) as diseases introduced by early Spanish, Russian, and French explorers were particularly infections to Native People who had little immune resistance to common European diseases. Further decline of population and loss of culture continued as US settlers moved west in search of prospects in the resource rich region. Across the west native tribes were persecuted, and if not killed in extended conflicts with settlers, were moved onto designated reservations, often hundreds or thousands of miles from home.

1.82 Settlement and Early Industry

Initial Euro-American settlement of the Pacific Northwest occurred between 1700 and 1900 AD. This period was marked by settler interest in homesteading, mining, and various young industries. In general, prosperity of the West was preached and sought by many US citizens. Did mining occur in Elk Creek???

Ranching (primarily wool), fur trapping, and logging were primary industries of the settlement period. Sheep ranching had major impacts in many areas in the Pacific Northwest. This introduced disturbance affected many plant communities, suppressing herbaceous growth and tree regeneration until the wool industry declined. Following the removal of sheep, many areas responded with tremendous recruitment of young trees (cite). This accentuated similar effects of fire suppression that began at the end of the settlement period, resulting in substantial increases in tree densities.

Fur trapping spanned the early portion of settlement and possibly prior to most settlement in the Pacific Northwest (cite). Furs of numerous species were highly valuable, which incentivized the largely unregulated hunting of mammals across the entire western US. Among species hunted were martin, mink, fisher, otter, and beaver. Early fur industry was dominated by the Hudson-Bay Company, whose trapping expeditions reached unexplored areas before US officials could, resulting in reports from early surveyors of already depleted fur animal stocks even before settlement began in many watersheds (cite). Several species believed to have been very widespread are now uncommon (beaver, mink, martin), or extinct (??, cite). The impacts of the disappearance of these animals from many watersheds are not well known as early information on populations, distributions, and biological functions are lacking. However, recent research suggests that the near extinction of North American beavers (*latin*) in the West (esp. in

California) has played a major role in anadromous fish population declines and fish survival, as well as maintenance and creation of extremely valuable and highly complex, diverse riparian habitat (cite Pollock, and others). The ecology and restoration of beavers within the Elk Creek watershed is discussed later in this plan [pp.].

Early logging was much different from that of post-settlement and current management regimes. Technology had not yet been developed to support logging in many virgin forests as there were no means for cutting and removing trees at an efficient rate from remote locations and rugged terrain. In addition, road and rail networks essential to timber extraction took many decades to develop. As a result, much of logging prior to 1800 was restricted to easily accessible, low elevation and gently sloped areas (cite). The boom of the early timber industry picked up at the end of the settlement period (1850 - 1900) as infrastructure improved. This resulted in the establishment of many hundreds of timber towns, each often supported by an independent mill or several mills (cite). Early mills were designed to process very large diameter logs as virgin old-growth forests were extremely widespread. The timber industry grew rapidly once infrastructure was in place, and wood products were distributed globally from the Pacific Northwest (cite).

1.83 Post-Settlement Land Use and Industry

Of settlement period industries, fur declined initially, as stocks were quickly depleted. This was followed later by a short mining rush, and finally by a decline in wool. Logging, however, continued to be a major driver of the economy of the greater Pacific Northwest. While early logging largely depleted and set back forests in easily accessible areas, technology and infrastructure continued to improve into the post-settlement period, enabling extraction of timber in remote and rugged terrain where forests were still untouched. Industry innovation came in many forms, improving mill capacity and log movement capability. Improvement in technology also enabled extensive, effective suppression of natural and human caused fires which was strongly driven and supported by the timber industry. Major impacts of these developments were the near extermination of virgin forest, extensive erosion and hydrological shifts from increases in road densities, and shifts in forest density, structure and function.

By the 1970's the majority of virgin old-growth forests had been either completely or partially cut. Loss of old-growth logs catalyzed further innovations in the timber industry. Lumber companies no longer had access to virgin forest and were forced to begin harvests of second growth trees. This meant that mills had to shift capacity toward processing of smaller diameter logs, and stimulated the evolution of modern silviculture which focused on growth and production of timber resources in managed stands. Rotational forestry, involving clear-cutting and maximized growth of timber trees, perpetuating an agricultural approach to forest management, became the dominant strategy of the post-settlement timber industry.

Industry in the Elk Creek watershed remains largely dominated by modern timber extraction involving rotational forestry. Cattle ranching is also present, although of very minor importance in relation to timber. Other inhabitants of the watershed are sustained by small-scale farming/ranching. Hunting and gathering also occur within the watershed and are regulated generally by the state; however, this resource use is not industrial in nature and has low overall impact on resources within the watershed.

1.84 Recreation

Minor. One campground? Some hunting and gathering, state regulated, on federal and private land. Wilderness interest??

2. Current Watershed Conditions and Trends

2.1 Terrestrial/Upland Environments

2.11 Mixed Conifer Forests

The majority of mixed conifer forests in the Umpqua have undergone several major changes since pre-Euro-American management. These changes have been a result of two developments: 1) the cessation of frequent natural and cultural fire 2) Rapid advances in technology and trade that led to large-scale industrial timber harvest practices. These two developments have caused initially an increase in tree density as forest and non-forest areas responded to fire exclusion, and later forest fragmentation by the practice of rotational clear-cut forestry and associated road building. Both of these conditions have serious environmental implications for the watershed which are discussed in this section.

Exclusion of fire across the western United States is a leading topic of forest research, management and watershed health. The impetus for suppressing fire in the western US is historically driven by economic interest in sustaining greater quantities of viable timber resources. By reducing the occurrence of fires, public agencies and private companies effectively increased density and stocking of trees throughout many parts of the western US, a management strategy that began in the early 1900s. Although this attempt was successful (even despite vast acreages of timber harvests), the implications of removing natural fire processes from an ecological standpoint, with regard to overall forest ecosystem health and biological function, were not considered in administering the late forest management regime. As a result, shifts in forest structure and composition that affect forest ecological health and biological function at a landscape scale are becoming ever more apparent. Foremost among changes associated with fire exclusion is the general dramatic increase in the density of trees and quantity of forest fuels accumulated in fire-suppressed ecosystems across much of the western US (Parsons & DeBenedetti 1979, Laacke 1990, Agee 1993, Collins et al. 2011). This widespread development poses national, regional, and local challenges to addressing watershed health concerns, ecosystem resilience, and the future of natural and managed forests in Elk Creek and the greater Pacific Northwest.

Increased stem densities and unnaturally high fuel loads are a common condition throughout the Elk Creek watershed, affecting many stands. This condition is a national concern and priority (cite) and falls into management considerations for forests at many regional, state and local levels as well (cite), including Oregon (cite). Although this condition is widespread, it does not warrant the assumption that all stands have substantially changed in composition or density since Euro-American management. Some unmanaged locations can remain largely unchanged or are naturally more immune to the effects of fire exclusion (Duren et al. 2012). For areas that are substantially affected by increasing tree density, recruitment following exclusion of fire can comprise many species depending on regional or site-specific conditions. In the Umpqua watershed (as noted in previous sections) many mixed conifer stands are affected by increases in Douglas-fir or white fir following timber harvest and/or fire suppression practices. These species are particularly aggressive, and grow well in a multitude of habitat conditions (Herman & Lavender 1990, Laccke 1990). However, conifer saplings (especially Douglas-fir and white fir) are generally highly susceptible to fire (Ryan & Reinhardt 1988, Laccke 1990) which when frequent, will keep Douglas-fir densities lower than at present in many stands, even in areas naturally dominated by Douglas-fir.

Many mixed conifer stands are now at high densities in the Elk Creek Watershed, with a great portion of trees accounting for that density in age classes less than 120 years (indicating the shift at the beginning of the 20th century toward fire suppression and synonymous decline in grazing). Much of this relatively young, post-fire suppression age component is made up of Douglas-fir or white fir. In some of these stands, dry-tolerant, high light-dependent species that historically dominated many areas (e.g. ponderosa and sugar pine, and oak) are losing a competitive edge to younger, shade-tolerant fir trees that sap resources and create deeper stand shade.

In addition to compromised health of certain gap and light-dependent oak and pine species, overall stand condition is often affected by this increased stem density. Although Douglas-fir will naturally thin as certain individual trees gain height advantage over others, this process does not act as thoroughly as natural fire disturbance or artificial thinning, and trees will continue to grow to old ages at high density and competition, limiting growth and resulting in poor tree canopy crown conditions (Cahill et al. 1986, Herman & Lavender 1990). Increases in tree density also lead to increased recruitment of dead fuel to the forest floor as stands naturally thin and lower branches die and break off. These higher fuel loads, when expressed continuously across watersheds and in combination with greater amounts of ladder and canopy fuels, increase the potential for vast acreages of high-severity fire, which is less likely to occur at great scales under heterogeneous, fire-maintained fuel conditions (Agee 1993, Agee & Skinner 2005, Collins et al. 2011).

Structural changes occurring as a result of increasing stem density are also important when considered in relation to forest ecological or biological function. The natural variation resulting from repeated fires ensures a wide variety of habitat types are present within stands or across landscapes, supporting a large cast of species specifically evolved to occupy or forage in different stand ages or across various canopy layers and structures. For example, the highly complex structures found in late-seral conifer forest (i.e. large and small trees, forest gaps, and large snags) have been consistently shown to be the most viable habitat for the endangered northern spotted owl (cite). Multi-storied canopy structures created by the association of species with different habit or different tree ages in certain Pacific Northwest mixed conifer stands also represents highly valuable diverse structure, affecting forest cover and forage characteristics from the forest canopy to the forest floor (Van Pelt & Franklin 2000, Franklin & Van Pelt 2004). When structurally unique species (such as pine, oak or other hardwood) cannot compete with increasing Douglas-fir and other shade-tolerant conifers in crowded stand conditions, the structural functions these species provide are lost with them. This process is evident in stands in the Elk Creek watershed where large pines and hardwoods are showing signs of mortality or are already dead, leaving behind skeletons of a former forest disturbance regime (picture!!) [this process is discussed in greater detail in the Oak Woodlands section].

Watershed function is also strongly affected by upland forest and vegetation conditions. Trees require water, and some studies are suggestive of a pattern of lower water yield, soil moisture, infiltration and stream flows with increased forest and vegetation densities (Hibbert 1967, Biswell 1999) or shifts in species composition (Devine & Harrington 2007). This is particularly important for the Elk Creek watershed where streams and groundwater are fed from direct precipitation, and early snowmelt; while late summer becomes very dry and snowpack generally depleted by June. Also of concern at a watershed scale is the previously mentioned possibility of vast areas of high severity fire that may result from changes to stand fuel load and arrangement. After such a high-severity fire event, watershed health can become threatened by increased sedimentation, loss of critical habitat, and increased stream temperatures if riparian areas are intensely burned.

Higher elevation mixed conifer forests show similar changes in density across much of the Pacific Northwest. In the Sierra Nevada of California, and Western Cascades of Oregon, studies have shown substantial density increases are often a result of greater recruitment of white fir than Douglas-fir, or a combination of both species (Parsons & DeBenedetti 1979, Laacke 1990, Agee 1993, Collins et al. 2011). At these elevations higher densities of stems are a concern in relation to individual tree health, stand health, and watershed health as described above, while oak woodland encroachment is generally less of a concern as oaks do not occur at high elevations in more than shrub form. Pines in these snow zone mixed conifer forests are an encroachment concern where white fir and Douglas-fir density has increased, especially on ridgelines and south slopes where pines are more apt to have been dominant historically.

Modern industrial forest harvest practices are variable, although market conditions and other economic drivers tend to favor more homogeneous styles of management. Such styles arose with the objective of maximizing timber production and industry profit (regardless of other environmental factors), and continue to be used widely in Oregon on private timber lands. These large-scale systems tend to grow trees of the same age in large 20-60 acre blocks to a commercially viable size, at which point trees are stripped from the site and generally replanted in plantation style [see above section title “Conifer Plantations”]. Many studies have focused on the effect of this rotational forest management on wildlife and forest health. In general, research has shown that plantation and rotational, block harvesting systems create tracts of homogenous forest with much less diversity in structure, age, and species than less intensely managed and natural forests (cite). This type of forest management leads to what is often called a “fragmented” or “compartmental” landscape where stands at various stages in industrial timber production exist across vast acreages separated by stark geometry and abrupt transitions from recently cut parcels, to moderately aged stands. Much of the private and public lands in the Elk Creek watershed have been managed in this fashion at some period in the past century, and many even-aged, structurally homogeneous plantation stands at various stages in growth are present. These stands require substantial restoration and alternative management techniques if they are to be set on a trajectory toward more complex, diverse, fire-shaped ecosystems with ecological functions emulative of historic pre-Euro American settlement conditions.

Older forests are generally very rare on private industrial timber lands, although in areas like the Elk Creek watershed, a patchwork of US Forest Service lands and private timber lands enables survival of some islands of older forest within a matrix of different ownerships. Federal agencies are often tasked with balancing the heavy take of timber from nearby private land by limiting harvest and thinning operations on public lands. This can cause great management concerns when federal agencies are also tasked with reducing tree density to alleviate fuel and forest health problems, and generate a predetermined timber harvest quota as local economic stimulus. In many ways, Federal agencies are pressured through internal policy, local forest directives, and the harmful environmental impacts of too loosely regulated private forest practices to sacrifice some minimal level of forest or stand health (e.g. by allowing larger than desired timber sales, or cutting larger trees). This can lead to division among community stakeholders (i.e. businesses, residents, government employees, tribes) regarding the complex range of solutions to this problem, and how the process of making management decisions is carried out. Interests in watershed resources within Elk Creek are varied in this manner, generating a difficult framework within which balancing of production and economic needs with ecosystem health and restoration objectives is extremely difficult.

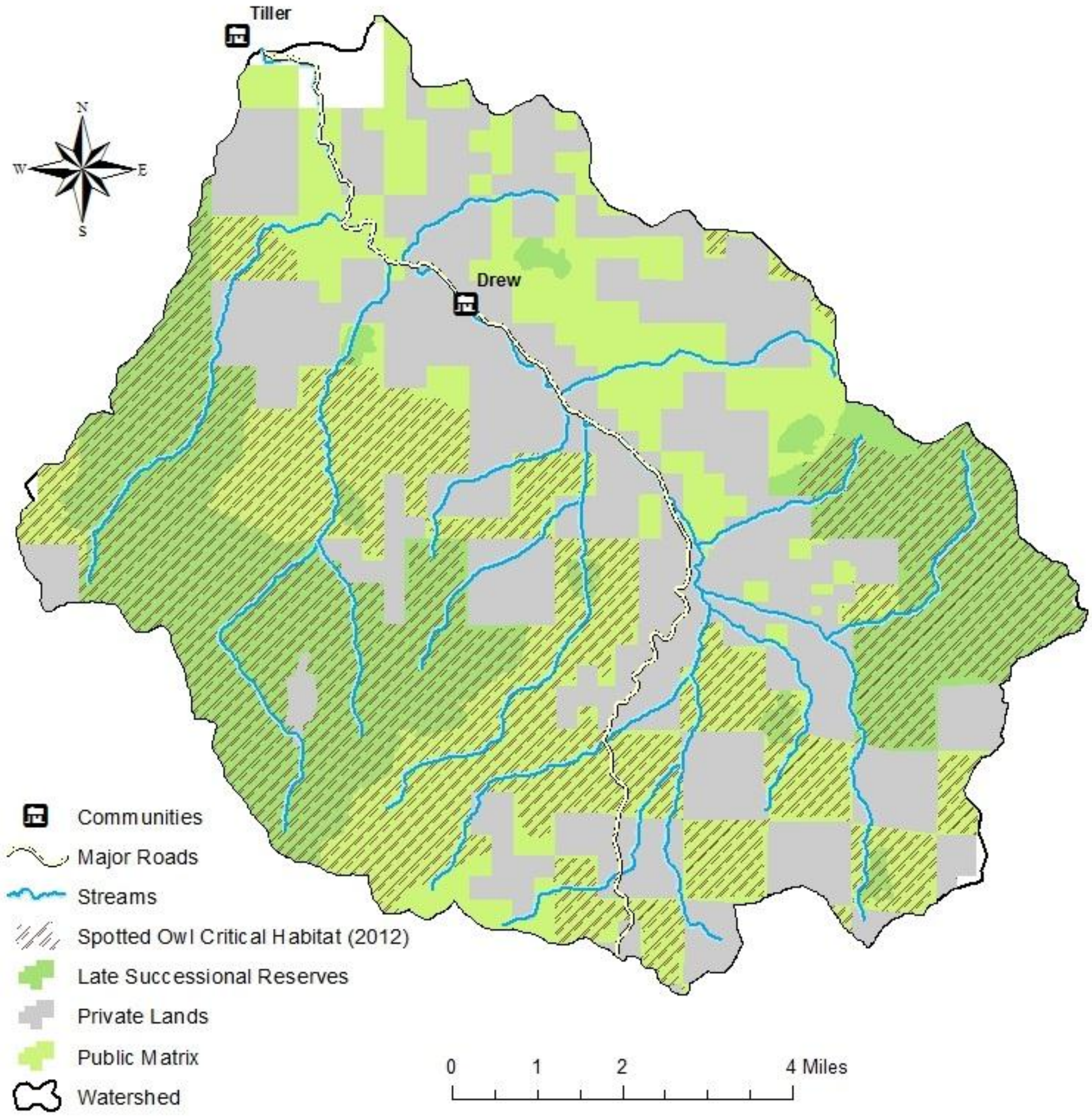

Figure 7. Late successional reserves (Northwest Forest Plan), public matrix lands, and private lands within the Elk Creek watershed. Critical spotted owl habitat designated in 2012 is hash-marked and covers all of public late successional reserves and significant portions of other public forest lands.

2.12 Oak Woodlands

Despite their ecological and biological importance, oak woodlands in the Pacific Northwest are declining. Since European settlement substantial acreage of Oregon oak woodland and savanna habitat has been lost. The Oregon Department of Fish and Wildlife (ODFW) has recognized oak woodlands as important wildlife habitat in the "Oregon Conservation Strategy", in which ODFW estimates at most 7% of historical Oregon oak habitat remains (cite) making it critically imperiled. Urban and agricultural development, tree disease, poor oak regeneration, deforestation, introduction of non-native species, heavy grazing and removal of natural wildfire through the practice of fire suppression have all contributed to this loss (Vankat & Major 1978, Tveten & Fonda 1999, Thysell & Carey 2001, Duren et al. 2012). At present, remaining oak woodlands (even in poor condition) represent a rarified ecosystem within the Pacific Northwest, especially in more conifer-dominated watersheds such as Elk Creek.

The absence of fire in oak ecosystems under the modern practice of fire suppression initiates a process of conifer encroachment. In the Umpqua Basin this process has been termed "infilling" and is well documented from analyses comparing historic records with present data (Carloni 2005). Conifer encroachment in oak and oak-pine woodlands involves over-establishment of younger conifers (especially Douglas-fir, white fir, and incense cedar) that would be periodically thinned or excluded from oak woodlands under natural fire disturbance regimes. Wide-scale fire suppression for more than 100 years, in combination with other Euro-American management changes, has led to this encroached condition in many oak woodlands throughout Washington, Oregon and California (Vankat & Major 1978, Reed & Sugihara 1987, Tveten & Fonda 1999, Stewman 2001, Thysell & Carey 2001, Garrison et al 2002, Engber et al. 2011, Cocking et al. 2012, Duren et al. 2012). Oaks in Conifer-encroached woodlands decline over time as they succumb to decreasing light levels and available resources brought on by crowded conditions (Devine and Harrington 2007) and conifers that grow through and overtop the oak canopy (Hunter and Barbour 2001). Conifer-encroached oak woodlands may also pose forest fuel concerns as the increase in conifer density equates to greater surface and canopy fuel loads.

Oregon white oak and California black oak/pine woodlands and savannas cover a significant portion of the Elk Creek watershed and are biologically highly valuable ecosystems within the region (Anderson 1972, O'Neil et al. 2001). Existing oak woodlands and pine-oak woodlands in the Elk Creek watershed are generally in poor or declining condition. This is largely due to encroachment by Douglas-fir and general increase in stem densities of many tree species. Encroachment by white fir, incense cedar, and Pacific madrone also pose a competition threat in locations where these species have increased substantially in density.

Fire has been particularly absent in the Elk Creek watershed, although neighboring watersheds have experienced some natural fires in recent years [see fire history]. The long duration without disturbance in Elk Creek has allowed many encroaching conifers to reach merchantable size or greater (potentially up to 100 years of growth), and in the most severely encroached sites, numerous large dead oaks, ponderosa pines, and sugar pines, are still standing or laying on the forest floor. Mortality of oak and pine in these locations (especially of large, old, remnant trees), is likely to continue without intervention management activities that reduce conifer density and maintain open stand conditions (Devine & Harrington 2006, 2007, Cocking et al. 2012).

Woodland understory environments also decline as a result of increasing conifer density. Many herbaceous and shrub species endemic to woodland habitats cannot survive deeper shade caused by conifer encroachment (cite). These species provide critical forage and cover habitat for a multitude of wildlife species (Anderson 1972, O'Neil et al. 2001). Open, well-lit understory environments are also critical to oak and pine regeneration as seedlings of both tree forms require substantial canopy gaps for successful growth (cite). In addition, formation of dense fir needle mats may suppress pine and oak seed germination which requires precise exposed soil conditions (cite). In many ecosystems, germination often occurs when soil has been exposed by fire (cite). In oak woodlands, regeneration also occurs by post-fire re-sprouting of top-killed oak stems (McDonald 1969, Cocking et al. 2012). Shifts in the type of fine fuels that cover the woodland floor can inhibit these processes in encroached oak woodlands. As the overstory gradually changes from oak and pine to Douglas-fir, leaf litter composition shifts from light, airy pine and oak litter to compact, thick Douglas-fir needle mats. Laboratory controlled research on litter flammability has shown that this may affect the ability of woodlands to perpetuate frequent low-intensity fires since fir litter dampens fire behavior (Engber et al. 2011). This can pose problems for restoring oak woodlands with prescribed fire as it may be challenging to encourage fire to adequately burn encroached restoration sites under mild weather conditions (Cocking et al. 2012). Without fire disturbance, oak and pine environments are at risk of continued replacement by conifers as parent oaks and pines decline and die, seeds and sprouts fail to germinate or to survive in deep shade, and woodland understory species disappear or migrate to other open environments.

Oaks often fare worse on private timber lands where they are killed with herbicide to promote greater dominance and cover of more valuable timber species, primarily Douglas-fir. Thinning, and reintroduction of fire are desperately needed in the Elk Creek watershed if high quality, substantial stands of oaks are to be restored and sustained.

2.13 Mixed Conifer Conditions and Spotted Owls

2.2 Aquatic/Riparian Environments

2.21 Anadromous Fish Populations

2.22 Anadromous Fish Habitat

2.23 Beaver Ecology and Habitat

North American Beavers (*Castor canadensis*) historically inhabited rivers, streams and lakes across nearly all of North America. Due to fur trapping between 1700 and 1850 AD, beavers have been extirpated from many watersheds across western North America (Mackie 1997). In many areas, beavers have yet to return, and efforts to aid in their recovery have grown substantially in the past couple decades. Improved science on the ecology and biological importance of beavers to anadromous fish survival has supported restoration efforts (Murphy et al. 1989, Snodgrass & Meffe 1998, Pollock et al. 2003, 2004). Reintroduction and restoration of beavers and their habitat has begun in the Elk Creek watershed, and is a desired component of future watershed actions.

Beavers historically inhabited streams in nearly all watersheds of the Pacific Northwest, building characteristic dams and den structures out of riparian vegetation and wood debris. These damns represent ecological legacy structures, catalyzing the expansion of riparian and wetland habitats which support great biological diversity (Pollock et al. 1998, 2003). Research has shown strong correlations between young salmonid habitat preference, success and survival and the presence of beaver structures (Bustard & Narver 1975, Swales et al. 1986, Pollock et al. 2004). Since salmon declines are a major management concern for the Pacific Northwest, the Umpqua Basin, and Elk Creek watershed (cite), protection and restoration of beaver populations is an essential component of protecting and restoring salmon populations. Loss of beavers due to historical trapping is a likely contributor to continued decline of anadromous fish in the Elk Creek watershed.

Beavers are a quintessential keystone species, manipulators of the natural environment who create dam and den structures that sustain many highly specialized aquatic and riparian species (Naiman et al. 1988, Pollock et al. 1994). In order to build dam and den structures, beavers require substantial woody material bordering streams. Although beavers generally prefer non-conifer riparian species (Naiman et al. 1988), they will make use of a variety of tree and shrub species (Hall 1960, Naiman et al. 1988). In the Umpqua drainage, alder (*Alnus* sp.), willow (*Salix* sp.) and black cottonwood (*Populus trichocarpa*) are the most suitable endemic species for beaver building material. Beavers are vegetarian, consuming a wide range of woody, herbaceous, and aquatic plant species. Beavers aid their own cause by expanding or creating the habitat in which they and other species thrive as beaver ponds increase available water edge and aquatic habitat (Naiman et al. 1988, Pollock et al. 1994, 2003). Beavers build dens in stream banks as well as on small island mounds within ponds to protect themselves from predation.

2.24 Other Sensitive and Indicator Species

2.3 Natural Fire Processes

2.31 Recent Fire Occurrences

One of the most important natural processes in Northwest forests and woodlands is fire disturbance (Agee 1993). Although some recent large fires have affected portions of the Umpqua Basin, the Elk Creek Watershed has been largely unburned for at least 100 years. Only one small fire has been recorded since 1970 that was completely contained within the watershed, and a second fire was suppressed at the very edge of the Elk Creek Watershed in 2002 (name of fire). The (name of fire), while not reaching deep into the Elk Creek Watershed, was nonetheless one of the most extensive fires recorded in modern Umpqua Fire history and generated substantial controversy over the past, current and future management of forests within the region.

Although fires have been uncommon, it has not been the result of lack of ignition sources, but rather a result of diligent suppression. The Tiller Ranger District has recorded suppression of XXX small fires since 19XX that grew to more than XX acres in size. XXX of these suppressed fires were ignited by naturally occurring lightning. Had these fires been allowed to burn, forests, meadows, and woodlands within Elk Creek would look much different than they do today.

2.32 Forest Fuel Conditions

2.33 Projected Fire Behavior

2.4 Roads

3. Restoration Goals, Objectives and Opportunities

3.1 Desired Conditions - Terrestrial Forests/Vegetation

The following desired conditions pertain to terrestrial vegetation and forests within the Elk Creek watershed. These conditions are derived from several broad characteristics desired for the watershed: 1) Enhancement of ecological/biological function and overall ecosystem and watershed health; 2) Improved forest and woodland resilience to fire; 3) Protection of communities, dwellings and critical habitat or other valuable resource areas.

3.11 Reduced Overall Stand Densities

The most basic future desired condition of forests across the Elk Creek watershed is more historically emulative tree densities distributed in mosaic, or more variable and natural patterns. Many stands across various forest types in Elk Creek are at much higher tree densities than historic conditions. These higher stand densities indicate a deviation from healthy, fire-resilient, biologically diverse forests that exhibit heterogeneity in density, structure, and composition. Forests have overall become more homogenous as a result of fire suppression and plantation forestry, and previously non-forest elements (i.e. oak/pine woodland and savanna) are converting to conifer dominated systems. General reductions in tree density, at variable levels of treatment intensity, will help improve stand resilience by reducing unnaturally high tree densities and forest fuels, and arresting conversion of historically unique ecosystems to conifers.

3.12 Inclusion of Large Trees

Treatments that aim to create resilient stands in western forests should focus on leaving a substantial component of large trees (Agee and Skinner 2005). Classified old growth with no prior thinning or other management (as of the date of publication of this watershed action plan) should be retained and should only be treated by restoration activities when encroachment of younger trees as a result of fire exclusion is clearly established and negatively affecting stand health. Thinning restoration treatments in old growth will be most applicable for more historically open forest types like pine and oak, and will likely not be as appropriate (given historic context) in virgin (unmanaged) moist Douglas-fir or hemlock stands. However, treatments that protect existing spotted owl habitat or other old growth from severe fire should be considered [pg].

Old, large retained tree composition should emulate the natural composition and variability within stands and across the watershed. For example, sites that are more pine-dominated should focus on retention and protection of large pines while sites that are fir and hemlock dominated should focus on retention of large trees of those more mesic species. Areas where large trees are showing signs of mortality due higher stem densities should be noted and where possible released [see radial thinning section]. In general oaks greater than 100 years old and conifers greater than 200 years old should be especially considered and protected from further decline by unnatural causes such as encroachment, commercial harvest or non-native diseases.

3.13 Increased Forest Heterogeneity

Natural forest ecosystems of the Pacific Northwest are unique in their historical tendency to exhibit a wide variety of species, structures, spatial patterns, and mosaic of tree groupings, gaps, and multi-layered canopies (Franklin & Dyrness 1973, Franklin & Waring 1980). Such diversity is essential to the biological health and natural function of many ecosystems. Stand conditions that allow for the reintroduction of natural frequent fire disturbance (without damaging outcomes) and sustain structures and patterns that enable high biodiversity and biological function within a necessarily evolving and changing landscape are desired. The most basic step to achieving these conditions is to create or catalyze greater heterogeneity by reducing tree densities at variable spatial arrangements. Post restoration forests should not lose any range in tree age or size across stands, but should express greater range in density and exhibit seral or structural conditions that may have become less frequent during the past century. This will enable the presence of a greater variety of niche environments for wildlife, from closed dense forest patches, to open pine woodland and canopy gap environments. Future forests should also contain healthy and successful populations of all extant, native tree species (especially those in current decline such as pine or oak), snags and other unique structures, and multiple successional forest stages. Variable density thinning concepts which intend to increase heterogeneity are a desired component for designing and implementing future forest management in the Elk Creek watershed and are discussed in a separate section [pg].

3.14 Sustained or Improved Native Species Populations

Invasive, introduced species are a major concern in many parts of North America. In the Umpqua watershed, many non-native species have been introduced, and some are highly aggressive invaders. In general, invasive non-native species are not desired in the Elk Creek watershed beyond the confines private back yards. Control of woody species, species with slower life cycles, and species only recently arriving in the watershed have a higher likelihood of responding to eradication treatments. Woody species such as Armenian blackberry (*Rubus armeniacus*), Scotch broom (*Cytisus scoparius*), French broom (*Genista monspessulana*), English ivy (*Hedera helix*), hawthorn (*Crataegus* sp.), and English holly (*Ilex aquifolium*) may pose an invasive concern in the watershed. Native understory herbaceous and grassland plant communities devoid of introduced species are extremely rare in the Pacific Northwest. Understories dominated by introduced grasses, forbs, or shrubs are common in open environments in Oregon. Some of these non-native grasses and herbs are so common, that eradication is a nearly impossible feat. None-the-less, such exotic species should be monitored so as not to dramatically increase their cover, and restoration treatments should seek to decrease their cover while increasing native species cover where feasible. Seed used for restoration sites or for land improvement should contain native species. In general, native plants, animals, and biotic communities should be protected, enhanced, or sustained.

3.15 Reduced Forest Fuels in WUI and Selected Sites

In the past several decades, forest managers and scientist have taken steps to address forest fuel conditions resulting from fire exclusion specific to forest health, human life and property safety. A large portion of this focus has been on reducing potential fire behavior, often for the sake of neighboring communities or sensitive environmental or economic resources. The evolution of this cultural line of thought has produced concepts and practices now commonly utilized in forest management and restoration such as the “shaded fuel break”, “wildland urban interface” (WUI), mastication, “fuel reduction”, and revitalization of socially acceptable prescribed fire. These new forest practices draw justification from the desire to force tame fire behavior (especially around communities) and also from science that has unlocked knowledge on how, and why fires occur and why they exhibit severe or muted behavior.

Greater tree densities, higher fuel loads, and greater fuel continuity are clearly correlated with more intense or exacerbated fire behavior (cite). These conditions around inhabited areas (i.e. in WUI zones) naturally put communities and other sensitive resources at risk should fires occur. Elk Creek is no stranger to these suppression-era forest conditions, and substantial acreage has been identified in the watershed as WUI by the US Forest Service (figure).

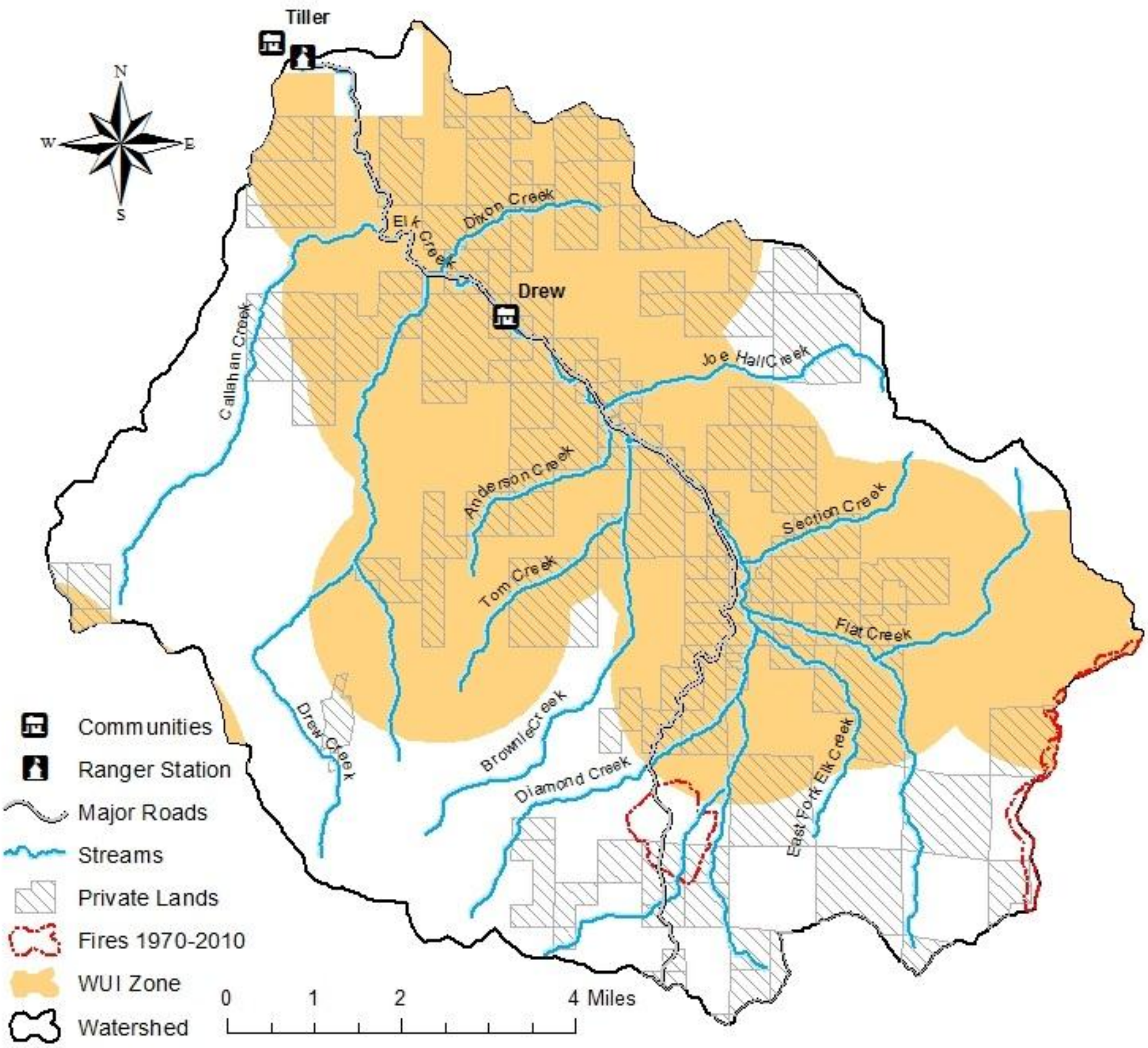

Figure 8. Wildland urban interface (WUI) defined for the Elk Creek watershed around homes and communities. XX% of the watershed area is defined as WUI.

To provide safety to human inhabitants, WUI areas generally require aggressive thinning and fuel reduction treatments that reduce potential fire intensity in defined buffer zones surrounding dwellings or communities. However, unnaturally high forest fuel and tree density conditions are prevalent throughout the entire watershed, and in places where communities are not threatened, broad, fuel-focused treatments may not be the most restorative method for instilling ecosystem health and resilience. Emerging science now supports several novel hypotheses 1) that fires naturally burn at varying severities (suggesting that small patches of high-severity fire are not necessary unnatural) (cite), and 2) that generic fuels reduction treatments may not restore natural structural conditions since they often tend to produce homogenous areas of low fuel loads and tree densities, rather than heterogeneous, patchy forest stands with great structural and age diversity (cite) [see stand heterogeneity section above]. These two novel ideas should be considered in forest management within the watershed, and treatments that are specified and designed as strictly "fuel reduction" should be conducted in WUI locations and in some cases near other sensitive resources, and not as a general application across the entire watershed. In areas where risks are strictly related to potential fire behavior and desired resource protection is identified, fuels treatments should be driven by improving forest fuel conditions with adequate commitment to maintain fuel breaks and defensible space. Outside of these select areas, management should focus on forest ecological restoration, sustainable management, and wildlife concerns.

3.16 Renewed Fire Processes

One of the primary disturbance forces behind the evolution of endemic species and ecosystem patterns in the Elk Creek watershed and greater region has been fire. This essential cyclic process is responsible for creation of multiple habitat types, highly variable forest composition and structure, and high regional diversity. With this process now significantly suppressed for a century or longer, many ecosystems have responded with dramatic changes that tend to reduce diversity and lower overall ecosystem resilience. The ultimate goal of restoration and immediate management within the Elk Creek watershed is to enable the re-introduction of fire regimes to the watershed as prescribed and natural fires. The immediate focus of restoration should be to restore conditions that are similar to, or mimic fire-adapted and resilient conditions, such that reintroduced fire will have desirable effects and will not pose a threat to life or property. Management should consider timelines and requirements for reintroduction of fire to specific locations when planning forest projects. By eventually re-introducing natural fire regimes to the watershed, greater diversity, more natural conditions, and overall improved watershed health will result. Inclusion of fire should also allow more efficient and natural maintenance of resilient ecosystem conditions.

3.17 Restored Oak-Pine Ecosystems

Oak and oak-pine woodlands have declined in the Elk Creek watershed. The extent of remaining oak woodlands and oak associated forest types in the watershed is currently unknown. Efforts to locate these areas and record them for future restoration should be made as many oak habitats may be on the brink of disappearance. These ecosystems are highly dependent on frequent fire disturbance and comprise a crucial habitat for the vast majority of Oregon vertebrate wildlife. Oak woodlands and dry oak-pine forests in the watershed should be released from encroaching conifers and fire should be reintroduced to these ecosystems so that oak and pine regeneration improves and mesic conifers remain at low densities. Restored oak habitat should contain healthy, overstory dominant oaks and pines, large amounts of cavity sites in snags and dead limbs for wildlife, and vigorous, diverse herbaceous understory growth. Restoration efforts in these forest types should also take careful measures to protect and enhance any young trees of desired pine or oak species.

3.18 Fewer Roads

Roads account for substantial sedimentation to watershed streams as well as forest fragmentation. In general, fewer roads are desired. Decommission of roads should focus on roads where future timber harvests are not going to occur and where roads are not necessary for management.

3.2 Desired Conditions - Riparian Ecosystems

3.21 Improved Anadromous Fish Habitat

3.22 Improved Riparian and Stream Conditions

3.23 Improved Beaver Habitat

3.3 Management Objectives

3.31 Align with Identified Goals and Desired Conditions

3.32 Align with Local Community Priorities

3.33 Align with Federal Regional/National Forest Priorities

3.34 Align with State and Local Government Priorities

3.4 Desired Practices to Achieve Objectives

The following desired practices are designed to achieve desired conditions within the watershed. The practices outlined draw on science and conceptual frameworks regarding sustainable management, ecological restoration, and environmental health. Practices that do not mitigate impacts or have potential to cause environmental harm or create unsustainable, unhealthy, or dysfunctional watershed conditions are not desired. The practices and restoration strategies described in this section draw largely on those developed and improved over time by practitioners, managers, and scientists from many organizations, but especially Lomakatsi Restoration Project (Ashland, OR), South Umpqua Resource Community Partnership (SURCP), and their affiliates.

3.41 Ecological Restoration

Restoration and management within the Elk Creek watershed should be performed in a manner that upholds ecological principles of watershed health, sustainability, biological/ecological functions, healthy and sustained endemic species populations, and overall high watershed diversity and habitat quality. These environmental qualities are synonymous with and not exterior from the needs of human inhabitants within the watershed who aim to persist in sustainable and balanced coexistence with wildlife and forests in their affected region.

Inhabitants of the Elk Creek watershed wish to sustain high ecosystem resource health, quality, and function not only for their own subsistence and health but also for the overall persistence of the watershed and its native life forms in their natural state(s), in perpetuity. To accomplish this, it is recognized that humans are a necessary component of the watershed with the power to aid and restore quality, healthy, and sustainable watershed conditions. Ecological restoration offers a framework for helping to achieve these watershed conditions that does not compromise the environmental health ethics of the greater Elk Creek community. Ecological restoration is the process of assisting the recovery of a degraded, damaged, or destroyed ecosystem. This entails returning an ecosystem, as closely as possible, to its pre-perturbed condition. The process of ecological restoration considers natural resources and associated human activity or management in the context of entire ecosystems (i.e. communities of many coexisting and codependent organisms) rather than production or management of a single component within the ecosystem. Implicit in this definition is that ecosystems are naturally dynamic rather than static (unchanging). Therefore, ecological restoration focuses ultimately on enabling the re-instatement of ecological processes and ecosystem functions that produce dynamic rather than static conditions benefiting the entire biotic community.

Ecological processes and ecosystem functions are the dynamic attributes of ecosystems, including interactions among and between organisms and their environment, and are the basis for self-maintenance of an ecosystem. Some examples are: carbon fixation, decomposition, nutrient cycling, substrate stabilization, microclimate control, species habitat differentiation, pollination, seed dispersal, and natural disturbance (e.g. wildfire, storms or floods). Ecological restoration prescriptions are tailored to allow these natural, self-sustaining processes and behaviors to take hold in the target ecosystem and function in perpetuity with minimal maintenance.

Central to the principle of ecological restoration is the concept of ecosystem health. Ecosystem health is the state or condition of an ecosystem in which its dynamic attributes are expressed within 'normal' ranges of activity relative to its ecological stage of development and historic context. A restored ecosystem expresses good health if it functions normally relative to its reference ecosystem, or to an appropriate set of restored ecosystem attributes. Ecosystem (watershed) health is a concept used throughout this document and is central both to the overall Elk Creek watershed objectives and the concept of ecological restoration, the framework desired to inform and carry future planned actions for the watershed.

3.42 Variable Density Thinning

Variable density thinning techniques, in which thinning intensity and tree marking rules are varied within the stand of interest (Carey 2003, Carey and Curtis1996), are a useful approach to increasing heterogeneity of vertical and horizontal structure, species composition, and tree age; all of which are critical to forest complexity and resilience (Franklin et al. 2002, Franklin & Van Pelt 2004). This approach thins to a wide range of tree densities at various spatial scales where some areas may be thinned lightly or not at all and others more heavily. This provides a wide variety of forest structures, tree ages, and stand conditions where dense, closed canopy tree groupings, in addition to well lit, open areas with canopy gaps, are retained in the stand. Variable Density Thinning can be applied in many different vegetation types with site specific adjustments made to accommodate the favored species historically suited for each specific ecosystem or location.

This approach allows creation of diverse forest structures and composition needed to establish and maintain resilience to disturbances such as fire or disease. Forests exhibiting such heterogeneity and diversity are more resilient and ecologically valuable. Some widely accepted and studied reasons for this improved resilience and ecological value are:

1) Pests and diseases have greater difficulty moving through stands due to gaps and open spaces where hosts are not present (Hessburg et al. 1994, Condeso & Meentermeyer 2007)
2) Many tree ages are represented providing resilient older trees as well as enabling future overstory recruitment should old trees die (Moore et al. 1999, Franklin et al. 2002, Agee & Skinner 2005)
3) Many tree species are represented, limiting the spread and impact of pests and other disturbance (Hessburg et al. 1994, Knops et al. 1999) and environmental or climatic changes (Van Mantgem et al. 2009)
4) Light levels vary greatly enabling a diversity of understory environments for unique herbaceous and woody species to develop (Allen et al. 2002, Metlen & Fiedler, 2006)
5) A variety of physical structures provide many needs of wildlife (including nesting, cover, and various foraging areas) rather than just a single need (Allen et al. 2002, Franklin et al. 2002, Carey 2003, Carey & Curtis 2004)

Restoring or maintaining these variable aspects supports healthy ecosystem functions and coexistence with natural, ecological processes such as fire. Descriptions of several key components to consider during variable density thinning and ecological restoration projects including ‘advanced regeneration retention’ and ‘patch retention’ or prescribing treatment ‘skips’ are described in the following short sections.

Advanced Regeneration Retention

It is important in all ecosystems to account properly for natural life cycles and allow some survival of young individuals to replace old trees that will eventually die. The number of young trees retained will vary depending on forest type, forest age, and desired ecological conditions. If regeneration is rare, special attention is usually paid to retaining saplings. Certain rare species such as oaks or pine in declining woodlands may also take precedence for retention over more common encroaching species. In general, adequate numbers of saplings should be retained to serve as replacement trees should larger trees die. Retained young trees may occur individually or in patches (skips) as described below.

Patch Retention/Skips

Patch retention involves leaving sufficient representation of various vegetation patch structures in a stand. Patch retention acts as a detailed extension of variable density thinning but applies to tree and shrub layers and may involve fairly large (0.25-3 acre) areas. Often, stands that have not burned in many decades have an overabundance of old, decadent shrub structures or very high tree densities. Alternatively, stands may have a shortage of dense vegetation structure. It is important to try to maintain some of these structures to include the variety of habitat cover and forage they provide. To achieve this, a general rule used by Lomakatsi Restoration Project is to leave occasional tree or shrub patches (as many as 1-2 per acre) with patches being <0.5 acres in size. Other prescriptions may call for retention of specific patches up to 3 acres in size. Patch size and structure should be within limits of historical or natural stand conditions. Retention patches may consist of several to many trees or shrubs per patch and can be even or uneven-aged. A unique patch type found in oak woodlands is the oak “clump” (Engber et al. 2011) where many sprouts originate from the same parent stump. For shrubs, it is also common practice to leave untouched thickets of various size depending on the species composition and specific site characteristics. Large patches of unique structure such as shrubland or chaparral should generally not be treated with thinning unless next to homes or other fire-susceptible sites.

Guidelines for determining patch selection:

- The majority of trees/shrubs within the clump are healthy
- The clump includes forked or multi-stemmed trees
- The clump includes good seed producing individuals
- The clump is providing valuable habitat (e.g. nests, roosts, nest material, shelter or cover)
- The clump is sheltering unique and thriving fungi, lichen, or moss populations
- The clump includes trees with unique interlocking crowns, boles, or large branches

Additional objectives and goals of variable density thinning:

- Creation of canopy gaps of varying size and shape
- Creation or retention of groupings of trees in varying age and size classes
- Retention of occasional untouched groupings of trees or shrub thickets for wildlife habitat and structural diversity
- Enhance or maintain understory shrub and herbaceous vegetation by maintaining or increasing understory light levels
- Retention of large downed woody debris for soil health, mychorrizal inoculation, and wildlife habitat
- Retention or creation of a diversity of decaying snags and logs for wildlife habitat
- Representation of all age and size classes of all native species for vertical and horizontal structural diversity
- Representation of natural, native diseases such as mistletoe and fungi as these aid important natural processes and help create structural diversity
- Retention of vegetation with visual evidence of wildlife use

2.43 Radial Thinning (Tree Release)

Radial thinning involves removing encroaching or other competing vegetation from around large trees that are to be retained in the stand. These are typically 'legacy' trees or smaller, younger trees that are extremely vigorous and have the potential to be future legacy trees. In radial thinning the majority of vegetation is cut directly beneath the legacy tree as well as a predetermined distance from the crown edge (e.g. 2X dripline). The magnitude of release (i.e. radial distance to remove trees from the legacy dripline) varies by size and species of the legacy tree. In general bigger trees will require greater magnitudes of release. Tree requiring more sunlight and open conditions (e.g. oak and pine) will also require relatively greater magnitudes of release. Another technique for species needing greater exposure is to focus the release on the southerly side of the retained legacy tree. Radial release techniques can also be applied to tight groupings of old trees. This often occurs with pines, and care should be made to identify old tree characteristics (cite) so that old growth or smaller legacy trees that comprise a legacy grouping are not inadvertently removed from around other old trees.

3.5 Science and Project Monitoring

3.51 Surveys and Watershed Inventories

Currently, several of the most threatened habitat types highlighted in this plan for specific restoration treatment and continued management are not well documented for the Elk Creek watershed. Oak woodlands comprise a substantial historical and current component of the watershed, but estimates of total historic and present acreage of this valuable habitat type are not available. In the interest of restoring greater amounts of this unique forest type, efforts need to be made to survey the watershed for oak and other unique forest types and species to assess their condition, whether they are in decline, and what their extent within the watershed is. Surveys of forest stands (of all types) that captures forest structural conditions and needs for management intervention (rather than how much wood volume is present) will enable higher quality restoration and ensure that the most degraded forest types and specific areas are addressed in future management actions. Such surveys of sensitive, threatened, and biologically valuable vegetation types (e.g. oak and pine) should be performed prior to launching major restoration efforts so that energy directed toward restoration techniques (e.g. thinning, prescribed burning, etc.) is spent on the most critical and most responsive locations. These specific sensitive forest types, areas where ecosystem condition is degraded, and sites that will require continued maintenance (such as with prescribed fire) should be permanently mapped when identified so that continued observation and maintenance of those sites is possible. Surveys and inventories conducted throughout the watershed should include both terrestrial and aquatic systems and will require strong collaboration between difference government agencies and non-governmental organizations.

3.52 Project Monitoring

Watershed projects (restoration, prescribed fire, aquatic, or upland management) should be monitored with data and documentation carefully recorded before and for many years after treatment. The duration of monitoring will vary by treatment type. For example, desired forest structures may take decades to develop from restoration thinning projects in upland forests and should be monitored at wider intervals to capture those developments. Alternatively, desired effects of prescribed fire (e.g. sapling mortality or herbaceous understory growth) may occur only several years after fire and may need to be monitored much differently. Project monitoring should focus on collection of data pertinent to the objectives of the project such that success, failure or basic effects of treatments are determined and available to inform future similar projects.

3.53 Science and Research

Many of the problems associated with the current conditions of the Elk Creek watershed and greater Pacific Northwest are a result of lack of science to inform past management or a disregard for science and lack of environmental health values or ethics. Managing ecosystems when there is poor understanding of treatment effects, biotic responses, and ecological processes is a poor model for watershed management. Future management should be informed by leading, peer-reviewed, and well-established science in addition to ecological and sustainable environmental values. Research studies that advance understanding and knowledge of ecosystems within the watershed should be performed. Agencies and community organizations must work to attract study of ecosystems in the watershed by collaborating with inter-agency science groups, academic institutions, and private research organizations. Research should focus on both current and historical conditions of natural ecosystems within the watershed. Studies that attempt to understand and analyze the ecological or restorative effects of management and restoration treatments should be especially encouraged as this will inform and improve forest management and conditions. Science should be developed specific to Elk Creek watershed that focuses on the potential for sustainable management with high watershed function and overall ecological health.

3.6 Opportunities for Local Development

3.61 Byproduct Utilization and Market Development

Often materials created during forest ecological restoration projects are usable. This byproduct utilization is much preferred to burning all materials on site which eliminates and wastes any use newly cut material may have. Common restoration byproducts are saw logs, poles, firewood, and biomass, (as an alternative to on-site burning). Trees removed from upland restoration sites can also be utilized in other watershed projects such as aquatic structure or habitat enhancement.

NOTE: Byproduct utilization is very different from most timber production, forest agriculture, and forest management projects than lean more heavily on economic gain than ecological values. Byproduct utilization makes use of materials that would be created by ecological restoration activities REGARDLESS of whether there was a plan or need to use those materials. Byproduct use must be sustainable or balanced with desired environmental conditions and not conflict with restoration objectives. For example, if cut logs are removed as firewood from a habitat enhancement restoration site (e.g. oak woodland), prescriptions and oversight must be conducted such that the site isn't stripped of every last piece of wood and that adequate amounts are retained on site, as downed wood is a highly valuable habitat structure. In general, byproduct utilization should not force restoration projects away from focusing on restoration or enhancement of endemic species and environmental, habitat, or watershed health.

3.62 Socio-Economic Development

3.63 Partnerships

SURCP, LRP, and others involved. Opportunities for partnership and collaboration.

3.7 Specific Projects

3.8 Costs

3.9 Timelines and Project Scheduling

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