STEP 5. SYNTHESIS AND INTERPRETATION

The purpose of Step 5 is to compare current and reference conditions of specific ecosystem elements and to explain significant differences, similarities, or trends and their causes. Information from the previous four steps is synthesized and interpreted. The interaction of biological, physical and social processes taking place in the watershed are explained. The capability of the system to achieve key management objectives is evaluated.

Erosion Processes

Soil is considered a nonrenewable resource because soil formation requires very long periods of time. Soil is also considered a basic resource because the abundance and distribution of most other resources depends on soil characteristics. Soil erosion normally removes more of the surface than subsoil layers. Consequently, proportional nutrient losses are greater at the surface and effects on site productivity are proportionally larger as well. Accelerated erosion from management actions usually exceeds soil formation rates, whereas natural erosion is in balance with soil formation rates.

Under ideal circumstances soil formation is in balance with or occurs at a faster rate than soil erosion. The natural rates of soil formation are generally considered to be between 0.1 ton/ac/yr and 2.0 ton/ac/yr (Schumm and Harvey 1982). Soil development rates are believed to be closer to the lower range because of weather and climatic conditions characteristic of the area.

The two key factors involved in minimizing surface erosion, regardless of climatic conditions or topography, relate to live and dead organic matter and soil physical properties. The importance of a vegetative-organic matter cannot be over emphasized.

The cause of accelerated erosion is directly related to the degree of soil disturbance from all management activities occurring over time. The primary activities are road building, logging, grazing and burning. These are activities that remove the surface organic layer that provides protection to the mineral soil layer below and change the inherent physical soil properties that restrict water movement within the soil mantel. This restriction results in more water flowing over the surface which also contributes to increased erosion.

A. Roads

Analysis of erosional processes shows that roads are producing the highest rates of soil loss on a per acre basis. Soil loss means that material is moved from one location to another but it does not necessarily mean that all of the material will enter the stream channel. Roads alter the natural drainage patterns and concentrate surface and subsurface flows into ditches where erosion results. Road surfaces are usually compacted as well, which restricts infiltration of surface flows and further acts to concentrate flows moving down the road surface and/or ditch.

The amount of soil erosion related to this road network ranges from about 1.8 tons/acre/year to 3.7 tons/acre/year, depending on the erosion rate of the soil in each subshed. The subsheds are ranked in order of erosion potential below in Table 43.

Table 43. Soil Erosion Rates by Subshed

Subshed	Geologic Erosion Factor	Road Erosion Rate tons/acre/year	Timber Sale Erosion tons/acre/year
Big Valley	.86	3.7	.12
Lower Camas	.83	3.6	.12
Mud Creek	.68	2.9	.10
Cressler Creek	.68	2.9	.10
Upper Deep Creek	.65	2.8	.09
Burnt Creek	.59	2.5	.08
Crane Lake	.59		
Blue Creek	.57	2.4	.08
Lower Deep Creek	.56	2.4	.08
Willow Creek	.55	2.4	.08
Drake Creek	.54	2.3	.08
Peddlers	.5	2.1	.07
Gibson Canyon	.48	2.1	.07
Dismal	.46	2.0	.06
Horse	.44	1.9	.06
Upper Twelvemile	.42	1.8	.06
Fifteenmile Creek	.42	1.8	.06

Erosion rates relating to roads are consistently much higher in areas with rhyolite parent material and in alluvial deposit areas.

Culverts and water bars that are not properly spaced, maintained or constructed further aggravate the erosional process. Roads act as water collection devices, therefore proper spacing of culverts and water bars is essential to avoid concentrating flows to the extent that flowing water erodes either the ditch or soils below the diversion point.

Another major factor contributing to erosion relating to the road network is the condition of the soil material available for plant growth. Any road that is constructed by excavating into the hillside will result in subsoil and/or bedrock being the primary growth medium for reestablishment of vegetation. These subsoil materials are lower in fertility and organic matter, higher in clay, stonier and drier than the surface soil. Cut and fill slopes are often steep and will dry ravel for many years.

Mass movement is not a major concern within most of the subsheds. However, Upper Deep Creek subshed has areas of historic landslides (Current Conditions-4) which are susceptible to further mass failure. Projects within this area should be evaluated for the risk of mass failure with new roads and clearcuts being avoided where possible.

The potential also exists for debris avalanches on the steeper slopes on rhyolitic eruptive centers. The major areas of concern are within the headwater areas of Blue Spring, Peddlers, Drake, Mud, Upper Deep and Dismal Creeks. Road building and logging on these cohesionless soil types are the major activities increasing debris avalanche risk.

B. Logging

Timber harvest, utilizing conventional logging equipment, requires an extensive road network. Primary skid trails, secondary skid trails, temporary roads and landings are necessary with conventional equipment. Dispersed harvesting techniques utilized most frequently within the watershed resulted in additional soil disturbance (i.e. compaction, displacement and puddling).

The transportation system network results in surface soil disturbances similar to those described above for system roads. Skid trails, temporary roads and landings change the natural flow regime of the landscape and tend to concentrate flows just as system roads do. Any activity that acts to concentrate flows increases the risk for overland flow and erosion (Table 43).

Forested soils have a naturally low bulk density which ranges from about 0.7 to 1.2 grams/cm3 for surface soil layers. This means that forested soils consist of only about 30 to 50% mineral and organic matter and the remainder is air space partially filled with water. They are porous with high water infiltration rates. Because of this porosity, the forested soils are sensitive to compaction, especially the basalt soils. The rhyolite soils have lower risks to compaction.

One timber sale harvest unit (Willow Hawk) was intensively monitored to determine overall adverse impacts. This unit was sampled with random transects to evaluate cumulative effects from past impacts. The total adverse impacts were 40% in this area primarily from compaction exceeding Forest plan standards and guidelines.

Many areas have been logged several times over the last 50 years. Forest-wide monitoring data shows cumulative results that are typical across the forest with soil compacted in a range of 20 to 40% in tractor logged areas. Soil compaction may last for at least 40 to 60 years which means that adverse effects are cumulative over the years.

The cumulative effects of exposed mineral soil, compaction and displacement result in an estimated accelerated erosion rate from about 50 tons per year within the Cressler Creek subshed up to 600 tons per year in the Mud Creek subshed. This is due to the degree of past impacts and also the basic erosion rate as related to soil/bedrock characteristics. These estimates are erosion rates only and identify estimated rates of soil movement. It does not mean that this amount of soil is entering the stream systems as sediment.

C. Grazing

Almost all soil damage related to grazing is associated with riparian areas such as springs, seeps and wet and moist meadows. No damage of any significant extent is known to occur on well drained upland soils. Riparian soils have restricted internal drainage and the water table remains at or near the surface much later into the summer months as compared to upland soils. Wet and moist soils are very susceptible to damage because soil strength decreases rapidly as the amount of moisture in the soil increases. Soil strength is at a minimum when saturated.

During the early settlement period, grazing levels were intensive on the forest. Records indicate that season long grazing was the rule and extended for up to 8 months. For example, in 1910 cattle numbers were 26,000 and sheep numbers were 110,000 (1957 Range table available at Supervisor's Office). This is about 450,000 permitted AUMs for the forest. It is assumed that proportional use occurred within the Deep Creek watershed. Current permitted use on the Fremont National Forest is 71,000 AUMs from cattle which is about an 84% reduction from the 1910 level.

The intensive grazing resulted in gully erosion in meadows. Bradley (1915) states in part, "There are many instances of erosion due to grazing and in every case, as far as is known, cattle and horses were responsible. All over this Forest there are sage brush flats with channels of varying depths and steep banks which are continually sliding, being washed away every time there is abnormal flow. There is little doubt that these flats were originally small meadows, well irrigated by the water which used to spread all over them, there being no definite creekbed. Some of these flats are still meadow, with the grass dying out from lack of water and the sage brush coming in. In others there has been no erosion and the water spreads out as it always did, thereby supplying succulent forage and conserving the moisture, keeping up a gradual flow until later in the season".

Later Bradley states, "There are a great many areas on this Forest where erosion is occurring, due to over grazing which occurred before the National Forest was established, and some where the erosion has been arrested, or partially so". He documents a specific example on Dog Mountain Creek located outside of the watershed on the southern portion of the forest "Before this area was grazed the whole of the flat, approximately 200 acres, was a fine mountain meadow with a small stream running on to it and spreading out, naturally irrigating the grass, no pronounced channel being anywhere in evidence. Then came grazing by cattle and horses - principally cattle. Soon it was heavily overstocked and erosion commenced. The causes of erosion on areas like the above and the conditions which led up to it are plain, especially to those who have had the opportunity of watching the gradual change over a long period".

It is evident from documents such as that quoted above and other historical accounts that the current condition of riparian areas was initiated in the late 1800s to 1930s. The intense grazing which occurred during that time resulted in excessive removal of the protective vegetation. Gully erosion soon followed as the meadow had lost its protective mat and spring flows cut down into the mineral soil.

The current condition of most of the degraded meadows is less the result of floods than the damage that had already occurred as evidenced by the concern of Deputy Forest Supervisor Bradley in 1915. Also, most of the channel downcutting is not related to road building and logging as very few roads and only limited logging had occurred by that period of time.

D. Burning

Wildfires expose the surface mineral soil to erosion and result in hydrophobicity (water repellency) of the soil surface which reduces infiltration of water and increases erosion risk.

Severe fires did occur historically and continue to occur today. On the Fremont National Forest, aggressive fire prevention and suppression have resulted in increased quantities of fuel per acre and an invading white fir understory that provides increased ladder fuels. These factors have created a high risk of wildfire in many places on the forest. However, experience shows that the risk of catastrophic fires does not appear to be as great in this watershed.

Hydrology

A. Base Flows

1. General Discussion

Low flows during August through November are assumed to be base flows for the watershed. It is assumed that base flows are slightly lower today than during the reference period. Management activities including road building, logging, livestock grazing and the decline in beaver populations have contributed to lower base flows. These factors are discussed below.

2. Base Flow Responses to Road Building

Base flows are intercepted by roads that are cut through hillsides and intercept the subsurface flow. Most road cuts are shallow and this is not considered to be a large contributor to decreased base flows.

3. Base Flow Responses to Logging

Timber harvest can decrease evapotranspiration and potentially make more water available for base flow. Timber harvest has occurred over about 9,000 acres. However, planting of clearcuts and gradual replacement of ponderosa pine with white fir and pine undergrowth has occurred. Tables 12 and 38 show there has been a shift towards more canopy in forested stands today than existed in reference conditions. All subsheds, except Cressler and Dismal Creeks, have experienced a shift towards more canopy in the 26-55% range. ISAT shows that new openings are less than 12% of any subshed. This is verified by district information (Post 1998). Historically, about 8% of the forested watershed would have been in openings from fire/insect/disease (Petersen 1998). This indicates that there is slightly more openings today than in reference conditions.

Any additional base flow that may have been derived from clearcuts is likely negated by increased canopy in timbered stands and encroachment of conifers and junipers into meadows and stringer areas. This is further verified by Baker (1988) who found that in arid situations, where water is limited, potential savings in water by partial cutting is often used by residual trees.

The effects to base flow of increased numbers of white fir and juniper are unknown. These trees continue to draw water from the soil during dry periods when ponderosa pine shut stomata and discontinue use of water. The increased number of white fir and juniper may result in some loss of water that would be available for stream flow. However, increased basal area within forested stands most likely have not decreased base flow to a large degree. Personal communication with Troendle (1998) shows that once trees have fully occupied a site, increased leaf area does not usually result in increased water use. Thus, base flow would not decrease from the increased understory. There is a data gap regarding site occupancy in historic conditions. For this analysis, it is assumed that the site was fully occupied in reference conditions and that excess water was not available for base flow.

4. Base Flow Responses to Grazing

Livestock grazing can affect the riparian environment by changing, reducing or eliminating vegetation and through channel widening, aggrading or degrading (lowering of the water table)

(Platts 1991). A study of almost 250 miles of National Forest System riparian areas in the Intermountain Region showed that grazing conflicts with riparian-dependent resources were most common in Rosgen B type stream channels with fine-textured soils and with most C type channels (Clary and Webster 1989). These are the soil and stream types described in the reference conditions for meadow areas.

Historic livestock grazing has led to downcut stream channels which created lower base flows. This is most evident in low gradient alluvial deposition areas. Many low gradient streams are on private property. Livestock grazing history on private property is unknown. Intensive livestock use on these lands is assumed to be a major contributor to riparian degradation. Lowering of the water table may have resulted in less water storage in alluvial depositional areas resulting in lower base flows.

5. Base Flow Response to Change in Beaver Community

In historic times, beaver populations in North America were estimated to be at least 60 million individuals over 15.5 million square kilometers. This equates to 4 beaver per km2 (Lowry 1993). Beaver density today is far below this number. Beaver dams act as storage sites for sediment and provide structure to the stream. This helps to create a favorable environment for developing riparian vegetation. Beaver dams also increase the lateral extent of bank saturation for increased groundwater storage. Greater storage in the stream bank enhances flow during summer months and causes improved distribution of stream flow throughout the year (Olson and Hubert 1994).

The decline in beaver populations has contributed to decreased base flow. This effect is most pronounced in alluvial depositional areas. The change in base flows from this cause is unknown.

6. Channelization

Base flows are lowered by channelization as discussed in Current Conditions-5.

7. Effects of Reduced Base Flow on Other Resources

The magnitude of change in base flows is unknown. However, factors identified above point toward reduced base flow in current conditions, mostly from lowered water table in alluvial depositional areas. To a lesser degree, base flows may have decreased as a result of interception of base flows by roads, conifer/juniper encroachment into meadow areas and increased evapotranspiration.

Reduced base flows and loss of water table affect other resources including fish populations, riparian vegetation, wildlife, recreation and agricultural crops that depend on irrigation. Fish populations are affected by lower water volumes. Lack of flow affects pool habitat by decreasing pool size and increasing water temperatures and shallow flows may create barriers to fish movement. Decreased base flow can decrease water for maintenance of riparian communities and negatively affect riparian associated wildlife resources.

Agricultural irrigation (March 1 - October 1) may be negatively affected by decreased flow during summer months because less water is available. Irrigation in Big Valley has altered base flows to an unknown extent below that location.

B. Mean Flows

1. General Discussion

Mean flows at the Deep Creek gauging station were compared using years with precipitation in the range of 9.9 to 18.3 inches measured at Lakeview. No significant shift in monthly mean flows were noted.

Troendle (1982) notes that generally 20 to 30% of a watershed has to be harvested before a significant change in flow can be detected. As shown in Tables 12 and 38, canopy has increased in forested areas and clearcuts occupy less than 12% of the watershed. Equivalent Clear Cut openings were estimated to be 8% of the watershed in reference conditions. The small increase in openings from timber harvest has not significantly changed mean flows.

C. Peak Flow

1. General Discussion

Increased peak flows are occurring in current conditions. Analysis of data from the Deep Creek gauging station shows increased duration of flows exceeding bankfull (Figure 1). A study by Troendle (1991) shows that timber harvest can alter peak discharge and change the duration of flows particularly in the range of 80 to 120% of bankfull flow. Flows in this range doubled as a result of timber harvest in the Fool Creek Drainage of the Fraser Experimental Forest in Colorado. Flows above 120% bankfull were less affected. The study was performed on a 290 ha area with 40% of the watershed harvested through alternating clearcut and leave strips. Similar results were obtained in the analysis of Deep Creek. It is assumed that the effects of timber harvest, mainly roads and to a lesser extent detrimental soil compaction, have created conditions that contribute to this change.

Natural climatic changes are beyond the scope of this analysis. However, a review of weather records for the Thomas Creek watershed showed that there had been a warming of ambient air temperatures in the Town of Lakeview from December through April. Climatic shifts and frequency of storms is unknown, but these may be contributing to increases in peak flows. Vegetation changes are not considered to contribute any significant amount to increased peak flows. Causes of change in peak flow are discussed below.

2. Peak Flow Responses to Vegetative Changes

Tables 12 and 38 show there has been a change in vegetation structure. The greatest change has occurred in ponderosa pine. More canopy (in forested stands) is present today than existed in historic conditions. This shift is within the natural range of variability.

Commercial timber harvest has removed merchantable trees through various silvicultural prescriptions. However, as a result of white fir encroachment in the understory, the overall canopy has increased instead of decreased, except in some clearcuts that are not fully stocked (less than 12% of any subshed). The result is more canopy in forested stands today with a few scattered clearcut openings. Peak flows have not increased significantly as a result of canopy removal.

Additionally, increased ground cover has reduced the possibility of above ground flow that can occur in response to intense rain storms. Flash flows from thunderstorm events are not estimated to be a factor.

3. Peak Flow Responses to Road Building

Roads affect peak flows by creating conditions of increased drainage efficiency. A USGS study showed that drainage density is directly related to flood runoff as measured by the mean annual flood, Q2.33=1.3 D2 (Carlston 1963). Table 9 shows drainage density is increased significantly by the addition of roads. Because roads can increase the mean annual runoff by a factor of square (Carlston 1963), they can be a significant contributor to instantaneous peak flows. This increase in drainage efficiency is considered to be the largest factor affecting increased peak flows.

4. Peak Flow Responses to Compacted Soil

Soil compaction is contributing to increases in peak flow. Compacted soils from logging operations have been measured across the forest in the range of approximately 35 to 45%. Similar compaction levels are assumed to have occurred in the watershed on tractor logged ground.

Research shows that when 12% of the watershed is in a compacted condition, peak flows can increase by 50%. The percentage of compacted soil appears to be a good indicator of the increased size of peak flows (Harr et al. 1979). However, not all areas of compacted soil contribute toward increased runoff to the same degree.

5. Summary of Peak Flows

Increased drainage efficiency from roads and compacted soil are estimated to be the primary causes for increased peak flows. Clearcut openings are a small part of the watershed (less than 12%), and are not considered a factor in peak flows. Future projects should seek to minimize increases in peak flow. This can potentially be achieved by planning vegetative treatments that stay within or above the mean of natural range of variability for canopy.

Peak flows are important for providing flood water and sediments to adjacent floodplains. Stream channels with good riparian vegetation and properly functioning stream morphology can withstand high flows and are less vulnerable to degradation.

Vegetation

A. Upland (Forested) Vegetation

Main contributors to the difference between current and reference conditions for forested communities are increased timber harvest and associated road building, alteration of the natural fire regime and repeated insect attack.

1. Timber Management

Timber harvest reduced the acreage dominated by large old trees. Road construction has removed a significant portion of the forested land base from coniferous tree production. Related timber management practices, such as machine piling of logging slash, scarification of skid trails, closure of temporary roads and erosion seeding have prepared a seed bed for nonnative grasses to invade forested sites. A common practice was to seed with nonnative grasses during any ground disturbing activity.

In reference conditions, many of the present low elevation pine associated stands were more open and park like. The east slope of Crane Mountain below 6,500 feet is in the drier rain shadow of this range and had more open pine stands extending up slope to this elevation. The east-west drainage of Camas Creek usually had the open pine stands extending only to about 6,000 feet in the pine associated type because of increased moisture on north slopes.

Ponderosa pine stands during the presettlement and early historic periods were large groups of large old trees with small patches of reproduction where an event, most likely from insect attack, had released growing space for new trees. These stands have become more dense with the advent of modern fire suppression. Many large old pine in these stands were removed during the early logging era and the remaining pine cultured into the future crop. These stands are presently in a pole to small saw log condition and have had fire suppressed as in the pine associated stands.

Pine associated stands were becoming dense with shade tolerant white fir as fire suppression became more effective. By the 1950s, much of the white fir understory was developing into a pole sized component. The advent of logging further changed species composition of large stands. Logging practices of the 1950s through the 1980s removed large valuable ponderosa pine in a selective harvest covering large blocks of many hundred acres. Only the biggest and best pines were removed on a regular basis. This led to a dysgenic selection against the best of the ponderosa pine gene pool while leaving large blocks of young white fir. A common practice was to remove the large pine and culture the white fir second growth. The white fir component was to be grown quickly to an average stand diameter of fourteen inches, cut and replanted to ponderosa pine seedlings. The process had many years of implementation before many of the thinned and cultured stands suffered mortality with the drought in the 1980s and early 1990s. The lower moisture regime stressed stands and made them more susceptible to fir engraver as a secondary mortality agent. The increased amount of foliage on true fir also shortened the time between epidemic attacks of Modoc budworm.

2. Fire

The inherent fire disturbance regime for pine and lower elevation pine associated in reference conditions was a return interval range of 25 to 75 years. Modern fire suppression methodology and objectives have changed this regime to one of more infrequent higher intensity fires. More fire disturbances now are a stand-replacing event where reference condition fires were low intensity maintenance fires in the lower elevation pine stands and more infrequent, small and scattered events in the higher elevation mixed conifer forest. Fire frequency probably declined with increasing elevation.

Average stand diameter between reference and current forest conditions has been lowered drastically. Removal of large diameter trees and the change in disturbance regimes has allowed forested stands of most species to become denser with small diameter trees. Prior to management activities and fire suppression, native grasses and shrubs were dominant in the nontree layer. The change in fire patterns and management activities has allowed a shift toward shrubs such as sage and nonnative grasses until the forest canopy closes enough to shade out shrub and grass development.

Historically, frequent fires (25 to 75 year return interval) in ponderosa pine prevented large scale establishment of young trees over large areas. Pockets of regeneration would occur where large trees died or were flamed-out or where fire would consume small areas of heavy fuel and burn intensely. In current conditions, the lack of stand cleansing fires may have allowed the survival of more small trees, both ponderosa pine and juniper. Many acres of ponderosa pine have a higher understory density along with the remaining large overstory and are becoming more susceptible to western and mountain pine beetle. Shrubs that remain today are beyond the normal range of maturity and replacement cycle associated with frequent fire. It is a decadent condition.

Juniper woodland expansion is still relatively constant in the absence of a natural fire regime, but the rate of its establishment is somewhat slower than the period prior to 1945. The time sequence of wet climatic conditions, overgrazing by livestock and the advent of fire suppression in the early 1900s created the conditions favorable to a considerable increase in the distribution and density of juniper along the forest/desert ecotone. These new juniper woodlands pose a serious threat to watershed and ecosystem health on many sites. Juniper competition leads to fewer understory plants, less soil cover, lower water infiltration rates, more opportunity for overland flow and soil erosion, greater nutrient loss, and a less productive site both from the standpoint of plant species and animal species richness and abundance.

Higher elevation white fir and lodgepole pine probably have not been as radically altered by the advent of fire suppression as have low elevation pine and pine associated. Historically, these stands had a longer fire return interval of 60-300+ years. When an event did occur, it was a small to large scale stand-replacing event that covered several hundred if not thousands of acres. The fire intensity was high enough because of the large fuel loading to consume most of the biomass under dry conditions. The larger patch size of evenaged forest created from these scattered events was different from the current condition. Patch size and structure would vary across the landscape at any one time with large evenaged and unevenaged stands. The shrub-grass-nontree layer would also fluctuate across the landscape depending on overstory cover, stand density, moisture and available light.

3. Insects and Disease

Insects, most specifically fir engraver and Modoc budworm, have impacted vegetation in the forested environment as a result of the changed vegetation density and composition between reference and current conditions. On the 1947 timber type map, there was much less white fir noted within the pine associated forest type. By this time, wildfire would have been suppressed for almost forty years and a marked increase in white fir understory should have been apparent. However, the lack of reference to white fir on the 1947 map may have been due to data collection and/or the lack of interest or understanding of white fir, its ecology and successional development. Stems present at that time were probably still small saplings and relatively nonsusceptible to insect attack. In reference conditions, both insects were present in the area, but maintained at an endemic level due to food supply. Increased white fir size and density, and drought caused insect populations to increase rapidly in the 1980s and 1990s. The natural population suppressors of food supply and the virus control of Modoc budworm had less of a control effect.

Historically, western and mountain pine beetle were active in forested stands killing large diameter ponderosa pine when its vigor was reduced by old age, drought, poor soil or a variety of conditions that increase stress on large old trees. During drought cycles, the western pine beetle would take out large blocks of large old trees. Much of this large tree component has been removed by harvest in the current period. Western pine beetle continues to be a major threat to the remaining large old trees because of increased stress from the dense understory for moisture and nutrients. Ponderosa pine and pine associated will continue to be at risk of mortality where the density remains above the upper management zone for Stand Density Index (SDI).

Lodgepole pine is currently at risk in the Dismal and Deep Creek drainages where the density of nine inch dbh trees exceeds thirty per acre. These stands are vulnerable to attack from mountain pine beetle and will likely undergo major change in the next decade or two. Insect attack appears to be a major player in the development and replacement of these stands.

Historically, dwarf mistletoe was scattered throughout the landscape and had little impact on ponderosa pine or true fir. While always present, localized pockets of infection developed and when a fire swept through the infected pockets a small group of trees usually flamed-out as fire caught the mistletoe brooms. The pockets were sanitized and new seedlings were established from surrounding seed sources. The increased density of understory trees has increased the level of infection over reference conditions. There are localized areas of infection in Willow and Burnt creeks that are continuing because of fire control. Eglitis et al. (1993) identified the potential for spread of mistletoe infection to be the greatest in single species stands with multi-storied canopies. Current conditions and management emphasis to develop and maintain structure or multi-layered canopies, especially in ponderosa pine, is ideal for the maximum spread of mistletoe.

Root diseases, especially Annosus root disease (<u>Hetrobasidium</u> <u>annosium</u>), is prevalent in true fir and pine associated. It is at a higher potential for spread and effect than in reference conditions. The increased stress caused by density of all species has been compounded by harvest activity. Eglitis et al. (1993) indicated that white fir or stands with a major component of white fir that have been entered twice or more for harvest are at very high risk of the spread of Annosus root disease to 100% of the stems. Increased stand density over reference conditions has also resulted in an increased potential for the occurrence of Armillaria. Root disease has a major impact on the reduction of wood production for commercial use by reducing the growth and increasing mortality of the managed species.

B. Rangeland

Livestock grazing is argued by many researchers as having the most widespread influence on native ecosystems of western North America (Fleischner 1994, Belsky and Blumenthal 1995, Madany and West 1983, Harris 1991 as referenced in USDI, BLM 1996). Numbers of studies report effects associated with livestock grazing in western North America including disruption of ecological succession by producing and maintaining early seral vegetation; loss of microbiotic soil crusts which play an essential role in nutrient cycling and nitrogen fixation in arid ecosystems; deterioration of soil stability and porosity with concomitant increases in soil erosion and compaction; alteration and degradation of riparian habitat; destabilization of plant communities by aiding the spread and establishment of exotic species such as cheatgrass (<u>Bromus</u> <u>tectorum</u>); reduction of biological diversity; and major alterations and conversions of community organization such as transforming native grasslands to juniper woodlands.

Livestock have altered the species composition of plant communities, ecosystem structure and ecosystem functioning. Species composition of plant communities are affected in essentially two ways: (1) active selection by herbivores for or against a specific plant taxon, and (2) differential vulnerability of plant taxa to grazing (Fleischner 1994 as referenced in USDI, BLM 1996). Because livestock prefer native grasses to exotics, native grasses have been replaced by exotic graminoids and weedy species which are more successful in colonizing areas that have been grazed or disturbed.

Livestock grazing has been and still is the most significant impact on low sagebrush communities. Wildfires are rare with the fire return interval estimated to be 150 years (Miller 1998).

The condition and trend of sagebrush and juniper/sagebrush communities are of primary importance because sagebrush is either the dominant or codominant rangeland type in the watershed.

The unregulated and excessive grazing in the first half of this century probably reduced the amount of Idaho fescue and bluebunch wheatgrass present on low sage sites easily accessible and close to water. Currently, these sites are rated in mid-seral condition and it is often the abundance of bottlebrush squirreltail that results in the mid-seral rating. Bottlebrush squirreltail is a prolific seeder that increases under favorable climatic conditions. Therefore, when excessive grazing reduced Idaho fescue, especially during drought years, bottlebrush squirreltail was ideally suited to take advantage of the opening in the plant community and increased on these sites. Under current management with rest rotation and deferred rotation grazing and utilization levels less than 50%, Idaho fescue and bluebunch wheatgrass appear to be at least stable and may be increasing in some areas.

Juniper-low sagebrush grass sites with large old growth (125+ years old) juniper escaped wildfires in the past because these sites are on shallow soils with relatively low plant productivity. About 22% is in late seral condition. These large old junipers with a good grass understory create a unique habitat and any prescribed fires in these areas should be done to maintain this habitat.

Only 4% of the juniper-big sagebrush-grass acres is in a late seral condition compared to 27% for big-sagebrush-grass. This smaller proportion of late seral vegetation means juniper dominated sites have lower production of desirable perennial grasses such as Idaho fescue and bluebunch wheatgrass. The lower production usually corresponds with less ground cover and ultimately more soil erosion. This is especially a concern in Gibson Canyon, Drake and Peddlers Creek subsheds where the juniper-big sagebrush-grass is now more abundant than big sagebrush-grass. Most of the junipers in these sites have established in the last 100 years and are at least partially the result of man's activities. The initial disturbance from excessive grazing in the early part of the century combined with aggressive fire fighting has allowed junipers to establish and flourish in big sagebrush-grass. Once established, junipers with their extensive root systems compete well with sagebrush and herbaceous vegetation. The presence of young junipers illustrates that juniper continues to invade sagebrush-grass but probably not at the pace it did in the first half of this century. The use of prescribed fire combined with good grazing management should reduce the amount of juniper. This should improve ecological condition by increasing the production and diversity of herbaceous vegetation.

Antelope bitterbrush and mountain mahogany appear to be at least stable under current management. Any prescribed fires and post fire management should be done to enhance these types and not damage them.

Aspen patches are small and not even mapped as a separate vegetation type. However, they are unique and therefore valuable as wildlife habitat. Junipers are invading many of these patches in the absence of fires, and the short lived aspens (125 years) will eventually die out and be replaced by junipers.

Structural changes in forests have also resulted from livestock grazing. Livestock have reduced the amount and vigor of the native grass and herbaceous cover on the forest floor, resulting in both an increase in tree seedling density and a reduction in fine fuels that carry frequent, low-intensity ground fires (Miller 1988, Karl and Doescher 1993 as referenced in USDI, BLM 1996). The increase in tree seedling density and disruption of the natural fire regime have led to the increase in dense understories of shade tolerant conifer species such as white fir and the reduction of shade intolerant conifer species such as ponderosa pine. Forest structural changes have in turn led to increases in water and nutrient stress among trees, disease and insect problems, and ladder fuels and woody fuel loads on the forest floor that increase the risk of high intensity, stand-replacement fires.

C. Noxious Weeds

The numbers and species of noxious weeds continue to grow each year. Weed seeds are transported along roads by vehicles of all types and by livestock coming from weed infested areas. Disturbed sites, such as logged areas, road construction and areas of livestock concentration are areas susceptible to weed infestation. Weed infested hay brought in to feed horses at recreational sites and hunter camps is also a source of weeds. Many of these species are still in isolated populations and can be exterminated or contained if found and treated. The BLM portion of the watershed has been inventoried for noxious weeds and currently these sites are being treated and monitored. The current weed treatment contract also includes National Forest System lands. The current strategy is to use an integrated weed management plan that includes inventory, monitoring and treatment using chemicals, biological agents, prescribed burns and mechanical means.

A formal weed advisory group is being formed to coordinate weed treatment between all landowners in the Warner Valley. This group includes several landowners in the watershed.

D. Riparian Vegetation

Few examples of pristine riparian areas remain due mainly to past grazing practices. More than 75 years of intense grazing from domestic livestock have modified the riparian species composition. Cattle browse and trample shrubs and tree seedlings and reduce soil productivity through compaction and nutrient export. They can also contribute to bank sloughing and erosion. These can lead to channel downcutting and lowering of the water table. Lower water tables in riparian zones have changed the vegetative character and impaired floodplain functions. Willows and cottonwood diminish as the water table lowers. Soil that is no longer held in place by the vegetative system is subject to rapid erosion. The eroded material quickly contributes to the sediment load in the stream.

There is wide variation in the type and condition of riparian areas within the BLM portion of the watershed. Riparian areas have been some of the most impacted areas during the last 100 years. About 17% of riparian vegetation is in early seral condition and this is all within the Nevada bluegrass type. About 48% is in unknown condition because of the large amount of private land. Approximately 70% of riparian vegetation is on private land and only 30% on public land.

Much of the damage to riparian woody vegetation, such as the loss of cottonwood and willow, was done in the first half of this century when there was little or no livestock management of public lands. Current grazing management is slowly correcting much of the damage done to riparian areas on public lands. About 66% of public land stream reaches are excluded from grazing and 25% are only being grazed early in the spring every other year. In these areas, there is evidence that willows are returning and sedge and rush are becoming more established on sand bars and bare areas. Some of the private land is being managed in conjunction with public land, such as along Deep Creek in the Sagehen allotment. However, for most private land, riparian condition, trend and management is unknown.

Fire suppression has affected the vegetative component of the riparian zones by allowing encroachment of shade tolerant conifers into aspen and cottonwood. This combined with livestock use has reduced the ability of these deciduous communities to compete for site resources and to regenerate in the low light conditions caused by conifer encroachment.

E. Sensitive Plant Species

These plant populations will continue to be monitored and managed in accordance with the Endangered Species Act of 1973 and subsequent rules and regulations. In addition, the watershed will be managed in accordance with BLM and Forest Service policies and conservation strategies for sensitive plants and their habitats to prevent them being listed under the Endangered Species Act.

Livestock grazing has occurred in the Dismal Swamp area for the past century with apparently little effect on this habitat type. Current grazing standards will ensure continued existence of this unique habitat type. There is currently low-standard road access for pickups or passenger vehicles.

F. Cultural Plants

These plants and their habitats will be managed in consultation with Native Americans.

Stream Channel

A. Canopy Impacts

The Forest plan includes limits of impacts that may occur in commercial forested portions of the watershed. For the Deep Creek watershed, there is a threshold of 30% that can be impacted at any one time (35% for the Twentymile subshed), unless more stringent requirements are necessary for other resources. Presently, less than 12% of any subshed has canopy in an impacted state (Table 45), thus, the Forest plan standards and guidelines are met.

Canopy impacts are derived from ISAT using Petersen's (1998) work for this analysis and from clearcut information provided by Post (1998).

B. Road Impacts

The effects of roads on hydrologic functions and resultant water quality are well documented in the literature. Roads influence groundwater interception, runoff distribution over time and space, and the potential for sediment production and delivery to streams.

Table 44 places road densities into three risk classes (low, moderate, high) relative to overall watershed relief.

Table 44. Road Density (mi/mi2)

	Watershed Relief >30%	Watershed Relief <30%
Low Risk	<2	<3
Moderate Risk	2.1-3.5	3.1-4.5
Highest Risk	>3.6	>4.6

In all cases, watershed relief is less than 30%, therefore, the second column of Table 44 will be used.

Table 45 uses a graph from a process developed by the USDA Forest Service (1993, as amended by Fremont National Forest in 1997) to rate the watershed risk from the combined effects of road and canopy impacts.

Table 45. Watershed Risk Rating

	Canopy Impact (% Subshed)	Road Density (Mi/Mi2)	Watershed Risk Rating Roads and Canopy
Mud Creek (01)	5	5.1	High
Lower Camas Cr. (02)	2	2.9	Moderate
Horse Cr. (03)	4	2.5	Low/Moderate
Burnt Creek (04)	6	4.4	High
Crane Lake (05)	4	2.3	Low
Upper Deep Creek (06)	3	1.7	Low
Dismal Creek (07)	1	2.4	Low
Willow Creek (08)	8	5.1	High
Cressler Creek (09)	1	2.7	Low
Big Valley (10)	~	0.5	~
Lower Deep Creek (11)	4	1.1	Low
Blue Creek (12)	4	1.6	Low
Peddlers Creek (13)	0	1.7	Low
Drake Creek (14)	0	1.3	Low
Upper Twelvemile(101)	~	0.4	Low
Fifteenmile (103)	~	2.5	Low
Twentymile (104)	~	~	~

C. Determination of Cumulative Watershed Effects (CWE)

The method chosen to evaluate CWE uses the above watershed risk rating in combination with stream channel conditions. This method follows the USDA Forest Service ESA Section 7 process as amended by the Fremont National Forest (1997) to reflect current State of Oregon standards, percentiles in the ICBEMP and biological thresholds for sediment. The intent is to allow a comparison of variables that could be limiting to fish populations in a given watershed. Recommended key variables include the following:

- Primary pools (pools per mile),

- Large pools per mile,

- Large woody debris (pieces per mile),

- Temperature (degrees F or C),

- Sediment (percent surface fines, embeddedness or substrate fines).

-Stream Bank Stability (% stable banks)

1. Pools and Large Woody Debris

Pools per mile, deep pools and large woody debris are evaluated against percentiles referenced in the ICBEMP. The following ratings are assigned when using percentiles.

Table 46. Percentile Rating

Percentile	Rating
<50	Poor
50-75	Fair
>75	Good

2. Temperature (degrees F or C)

Water temperature controls the rate of biologic processes and is of critical concern for fish populations and a primary indicator of habitat and channel conditions. Oregon Department of Environmental Quality standards for stream temperature are for a 7-day moving average of the daily maximum temperatures.

Based on these standards the following habitat rating is recommended:

Table 47. Water Temperature Rating

Water Temperature	(oC)
Good	<17.8
Poor	>17.8

3. Sediment

Sediment levels in streams which exceed the stream's natural sediment capacity can have significant effects on habitat for salmonids. These effects can be directly linked to individual fish species and life stages. There are a variety of ways to measure sediment levels relative to fisheries concerns. Three of these measurements are: (1) percent surface fines, (2) cobble embeddedness, and (3) direct measurement of fines in the potential spawning substrate. For this analysis, direct measurement of fines in the potential spawning substrate is used.

Table 48. Habitat Condition by Fines in Potential Spawning Substrate

Habitat Condition	Percent Fines in Substrate
Good	<20
Fair	20-30
Poor	>30

4. Bank Stability

Eroding stream banks can be a primary source of fine sediment in streams and can result in habitat degradation including loss of overhanging banks and floodplain functioning. Spawning substrate, shading, water table, pools and riparian vegetation are all negatively affected when bank instability occurs.

Standards and guidelines in the Forest plan identify management-induced instability as occurring when 20% or more of banks are unstable (p. 30). This standard and guideline was used to develop Table 49.

Table 49. Habitat Condition by Bank Stability

Habitat Condition	Percent in Stable Condition
Good	>90
Fair	70-90
Poor	<70

5. Overall Channel Condition Rating Summary

The following is an evaluation of the key variables for channel condition and shows that habitat conditions vary from good to poor depending on the stream and the reach. Table 50 evaluates the key variables using the Section 7 process (Fremont National Forest 1997). The table provides information by reach with an overall rating for each stream.

Table 50. Channel Condition by Stream Reaches

Reach	Temp Rating	Pools/ Mile	LWD/ Mile	Pools/ Mile >2.6 ft	Unstable Banks	PFC	Sediment Rating	Overall Rating
Mud Creek Subshed (01)								
Mud Creek								
1	Poor	Good	Fair	Good	~	PFC	Good	
2	Poor	Poor	Poor	Good	~	~	Poor	
Overall	Poor	Fair	Fair	Good	~	~	Fair	Poor
Blue Creek Subshed (12)								
Camas Creek								
1(BLM)	Poor	Good	Poor	Good	Good	PFC	~	

Reach	Temp Rating	Pools/ Mile	LWD/ Mile	Pools/ Mile >2.6 ft	Unstable Banks	PFC	Sediment Rating	Overall Rating
2(BLM)	Poor	Good	Fair	Good	Poor	FAR^	~	
3(BLM)	Poor	Good	Fair	Good	Good	FAR>	~	
Overall	Poor	Good	Fair	Good	Fair	~	~	Poor
Horse Creek Subshed (03)								
Horse Creek								
1	Poor	Good	Poor	Good	~	~	~	
3	Poor	~	~	~	~	PFC	~	
5	Poor	Fair	Fair	Good	~	~	~	
7	Poor	~	~	~	~	50% FAR^	~	
						50% PFC		
Overall	Poor	Fair	Poor	Good	~	~	~	Poor
Burnt Creek Subshed (04)								
Burnt Creek								
2	Poor	Good	Poor	Good	~	~	~	
3	Poor	Fair	Poor	Good	~	~	~	
4	Poor	Good	Poor	Good	~	FAR^	Poor	
6	Poor	Poor	Poor	Good	~	~	~	
8	Poor	Poor	Poor	Fair	~	PFC	~	
9	Poor	Poor	Poor	Good	~	FAR^	Good	
Overall	Poor	Poor	Poor	Good	~	~	Poor	Poor
Upper Deep Creek Subshed (06)								
Deep Creek - South Fork								
1	~	Good	Poor	Good	Good	~	Good	
2	~	Good	Poor	Good	Good	~	~	
3	~	Fair	Poor	Good	Fair	~	~	
Overall	~	Good	Poor	Good	Good	~	Good	Poor
Deep Creek-Middle Fork								
1	Poor	Good	Fair	Good	Good	~	~	
2	~	Poor	Poor	Fair	Good	~	~	
3	~	Good	Fair	Good	Good	~	~	
4	~	Good	Poor	Good	Good	PFC	~	
5	~	Good	Poor	Good	Good	~	~	
6	~	Poor	Poor	Good	Good	~	~	
Overall	Poor	Good	Poor	Good	Good	~	~	Poor
North Fork Deep Creek								
1	~	Good	Poor	Good	~	AR^	~	Poor
Mosquito Creek								
1	~	Good	Fair	~	~	~	Good	
2	~	Good	Fair	~	~	~	~	
3	~	Good	Poor	~	~	~	~	
4	~	Good	Poor	~	~	~	~	

Reach	Temp Rating	Pools/ Mile	LWD/ Mile	Pools/ Mile >2.6 ft	Unstable Banks	PFC	Sediment Rating	Overall Rating
Overall	~	Good	Poor	~	~	~	Good	Poor
Dismal Creek Subshed (07)								
Dismal Creek								
2	Fair	Good	Fair	Good	~	~	Good	
3	Fair	Good	Poor	Good	~	~	Good	
Overall	Fair	Good	Fair	Good	~	~	Good	Fair
Willow Creek Subshed (08)								
Polander Creek								
2	Poor	Good	Poor	Poor	~	~	~	
3	Poor	Poor	Poor	Good	~	~	~	
Overall	Poor	Fair	Poor	Fair	~	~	~	Poor
Willow Creek								
1	Poor	Good	Poor	Poor	~	PFC	~	
2	Poor	Good	Fair	Fair	~	~	Good	
3	Poor	Fair	Poor	Fair	~	AR^	~	
4	Poor	Fair	Poor	Good	~	~	~	
6	Poor	Good	Good	Good	~	~	Good	
7	Poor	Good	Fair	Poor	~	PFC	~	
8	Poor	Good	Good	Good	~	~	~	
9	Poor	Good	Fair	Good	~	~	~	
Overall	Poor	Good	Fair	Fair	~	~	Good	Poor
Lower Deep Creek Subshed (11)								
Lower Deep Creek								
5(BLM)	Poor	Good	~	Good	Poor	PFC N(0.35MI)	Fair	
6(BLM)	Poor	Good	~	Good	Poor	FAR^	Good	
Overall	Poor	Good	~	Good	Poor	~	Fair	Poor
Peddlers Creek Subshed (13)								
Parsnip Creek								
1(BLM)	Poor	Good	~	Good	Poor	FAR^	~	
2(BLM)	Poor	Poor	~	Good	Poor	PFC	~	
3(BLM)	Poor	Good	~	Good	Good	PFC	~	
4(BLM)	Poor	Good	~	Good	Fair	PFC	~	
5(BLM)	Poor	Good	~	Good	Good	PFC	~	
Overall	Poor	Good	~	Good	Fair	~	~	Poor
Drake Creek Subshed (14)								
Drake Creek								
1(BLM)	Poor	Good	Fair	Good	Good	PFC	~	
2(BLM)	Poor	Good	Poor	Good	Good	PFC	~	
3(BLM)	Poor	Good	Poor	Good	Good	PFC	~	
4(BLM)	Poor	Good	Fair	Good	Fair	PFC	~	

Reach	Temp Rating	Pools/ Mile	LWD/ Mile	Pools/ Mile >2.6 ft	Unstable Banks	PFC	Sediment Rating	Overall Rating
5(BLM)	Poor	Good	Good	Good	Good	PFC	~	
6(BLM)	Poor	Good	Good	Good	Fair	FAR^	~	
Overall	Poor	Good	Fair	Good	Good	~	~	Poor
Roaring Spring Fork								
1(BLM)	~	Fair	Good	Good	Good	PFC	~	
Overall	~	Fair	Fair	Good	Good	NA	~	Fair
Gibson Canyon Subshed (15)								
Lower Deep Creek								
1(BLM)	Poor	Good	~	Good	Poor	PFC	~	
2(BLM)	Poor	Good	~	Good	Poor	PFC	~	
3(BLM)	Poor	Good	~	Good	Poor	PFC	~	
4(BLM)	Poor	Good	~	Good	Fair	PFC	~	

6. Summary

The overall risks of cumulative effects are the same as those shown in Table 6 of the biological assessment (BA) of the formal consultation with the U.S. Fish and Wildlife Service (1997). This analysis determined that high temperatures in Lower Deep Creek moved this stream into a high risk for cumulative effects instead of moderate as shown in the BA.

Individual reaches were rated in Table 50. These ratings can be used as a guide for assessing limiting factors for stream channels and improving the channel condition rating. Canopy impacts are estimated to be low when comparing current with reference conditions. Roads have a large effect on the watershed risk rating. Road impacts can be ameliorated as shown in the Recommendations section. Water temperature is the largest limiting factor in the stream channel. Other factors of large wood, pools/mile, sediment and unstable banks affect a stream's overall ratings. Factors affecting these habitat variables are discussed below.

a) Roads and Timber Harvest/Sediment

Extensive logging in the uplands has resulted in high road densities. Roads lead to increased drainage efficiency, creating improved conditions for runoff and sedimentation. The number of stream crossings and roads within 300 feet of the stream channel are high (Synthesis and Interpretation-23). Roads crossing ephemeral streams have been identified as a major source of sediment to the stream system (Bilby et al. 1989). Roads are projected to be a large source of sediment in the stream channel. Prior to development of best management practices and Forest plan standards and guidelines, logging activities often included skidding logs in ephemeral and intermittent stream channels. The amount of LWD in ephemeral and intermittent streams is generally fair or good, however, LWD is considered lower than reference condition due to the effects of logging. Removal of large wood reduced the sediment storage capacity of these channels and disturbed soil that resulted in downstream sedimentation. These disturbances have created the opportunity for sediment to enter the perennial stream system and create increased levels of fines that fill pools and decrease spawning habitat quality. Additionally, roads can result in increased runoff and erosion of the stream channel.

b) Timber Harvest and Grazing/Shade

Stream temperature is a limiting factor in the majority of streams. Seven-day average maximum temperatures varied from 5.9oC to 28.6oC. The State of Oregon standard is a 17.8oC seven-day average. Dismal and Twelvemile Creeks were the only streams that met this standard. Seven-day average maximum temperatures were below lethal levels (26.6oC), except in Lower Camas Creek. Streamside vegetation provides shade to the stream and is a significant factor in the regulation of stream temperatures (Platts 1991). Stream shading has decreased as discussed in Synthesis and Interpretation-25.

Prior to recent Forest plan standards and guidelines, timber harvest occurred along most riparian areas. This reduced large trees. The large tree component consisting of aspen, cottonwoods and conifers provided shade for the stream system and decreased water temperature. Removal of overstory trees has had only a small effect on stream temperature, because overall canopy has generally increased from fire suppression.

Reduced shading due to herbivory by livestock and wildlife has occurred on all perennial streams. The most evident changes from grazing occur at the low gradient stream reaches primarily in alluvial depositional areas (See Map 4). A general observation is that riparian plant communities have been altered in some of these areas to such an extent that local xeric species such as sagebrush and juniper have invaded historic meadow systems, further reducing shade.

Removal of streamside vegetation usually increases summer water temperatures in direct proportion to the amount of increased sunlight on the water surface (Chamberlin 1982). The ability of plants to control stream temperature varies with stream morphology. Grass crowns provide modest overhanging cover and keep much solar radiation from reaching the water, especially along very small streams. Larger streams require higher streamside vegetation to effectively intercept the sun's rays (Platts 1991). Changes from willow sedge to grass and brush are affecting temperatures by providing less shade for intercepting direct solar radiation.

Because shading levels are unknown by specific reaches, determination of potential natural vegetation along with shade monitoring will help to determine areas where shading can be improved. In areas where shade producing vegetation has been reduced, continued improvement toward potential natural conditions will result in improved shade and lower stream temperatures. Historically, many sites had higher levels of shading from willows and overhanging sedges prior to high levels of grazing. Restoring these areas to willow will provide more shade and help maintain lower stream temperatures.

c) Grazing/Channel Condition

The Deep Creek watershed has 20 grazing allotments (Current Conditions-43) which use five different grazing systems: deferred, deferred rotation, rest rotation, early season and season long.

Literature shows that grazing systems affect riparian resources differently. Platts (1991) rates Season Long as the lowest, providing poor conditions for stream bank stability and stream riparian potential. Deferred is rated as poor for stream bank and fair for stream riparian potential. Deferred rotation is rated as fair for stream bank stability and stream riparian potential. Rest Rotation is rated as fair to good for stream bank stability and fair for riparian potential. Early season grazing is not rated, however, experience on the Fremont National Forest shows this is the best grazing system for stream bank stability and riparian potential.

When allotment management plans with grazing systems were implemented, following the intensive livestock grazing that occurred in the late 1800s and early 1900s, riparian conditions began to improve. At present, riparian conditions are on a steady rate of improvement on most lands managed by both agencies. Table 50 showed that of the 35 reaches evaluated for proper functioning condition, 94% were at PFC or on an upward trend (Table 51).

Table 51. Stream Reach Summary of Proper Functioning Condition

	Total Number	Percent of Total
Proper Functioning Condition	24	68
Functioning at Risk with an Upward Trend	9	26
Functioning at Risk with No Apparent Trend	1	3
Nonfunctional	1	3

Water Quality

A. General Discussion

Section 303(d) of the Clean Water Act requires each state to identify streams, rivers and lakes that do not meet State water quality standards. These streams have been included in the EPA 303(d) list (Table 27). Water temperature is the limiting factor that resulted in listing of these streams. Macroinvertebrates are also identified on Burnt Creek. State water quality parameters of dissolved oxygen, bacteria, total dissolved solids and toxic pollutants are not addressed as separate subjects because monitoring data for these parameters are not available.

B. Fine Sediment

Recommended levels of fine sediment vary, depending on the literature source. Levels of 30% are considered attainable as discussed in Reference Conditions-13. Results of instream monitoring and embryo survival rates are shown in Table 28.

On the average, the watershed is within recommended thresholds for fine sediment. However, a reach of Mud and Burnt Creeks exceed recommended levels. Fine sediments in stream substrates are important parameters for salmonids. Both embryos and fry require accessible intergravel voids and adequate water circulation. Also, stream substrate composition is a factor that regulates the production of aquatic invertebrates that process organic material and are an important part of the fish food chain.

1. Fine Sediment from Stream Banks

Channel forming flows of bankfull and greater have increased in frequency in the current time period. This increase, along with unstable banks (in low gradient alluvial depositional areas), is resulting in increased sediment movement. Stream banks in the upper watershed are mostly stable and do not contribute significant amounts of sediment to the stream.

Many of the low gradient alluvial depositional areas have changed to downcut streams that are deeply entrenched Rosgen type F channels. During floods, water moves at high velocity and scours exposed bank material. In proper functioning streams, the floodplain dissipates energy and stream banks remain stable. The downcut streams are now unstable and will proceed through an evolution of meandering and cutting across the entire floodplain. This process will result in the introduction of high amounts of sediment into the stream channel until the stream develops a new floodplain at a new elevation (Rosgen 1994). During this development, streams are continually adjusting for new sinuosity and eroding banks in the process. The eroded bank material is deposited into the stream channels. Historically, wide meadow areas are reduced in size as a result of this evolution process.

2. Fine Sediment from Roads

Roads are contributing sediment to streams. The amount of erosion that becomes sediment is unknown, but estimates are that 10-20% of eroded material can enter the stream as sediment. Sediment entering streams from roads is delivered by processes including surface erosion, mass soil movements, failure of stream crossings, diversion of streams by roads, washout of road fills and accelerated scour at culvert outlets (Furniss et al. 1991).

Road surface erosion has been observed to severely affect streams below right-of-ways (Furniss et al. 1991). The distance that eroded material travels below the hillslope determines the degree of sedimentation in streams. A study of eroded material travel distances below fill slopes shows that more than 95% of the relief culverts can be prevented from contributing sediment to streams if the travel distance is 300 feet or more. Roads with broad-based dips have nearly 100% of the contributing eroded material stopped within a travel distance of 100 feet (Burroughs and King 1989). Additionally, a study on the Medicine Bow National Forest showed that embeddedness and fine sediment increased as culvert density increased (Eaglin 1991).

Table 52 shows road miles within 300 feet of a perennial, intermittent or ephemeral stream. Roads are a major contributor of sediment to stream channels. Maintaining a buffer between the road and stream channel provides a filter that minimizes the introduction of fine sediment into the stream channel. The number of stream crossings and roads within 300 feet of streams were identified from GIS road data. A map of these areas is found in the project file. These are best estimates using GIS and should be ground verified.

Table 52. Roads within 300 Feet of Streams and Road Crossings

Subshed	Miles of Road Within 300 Feet Perennial, Intermittent or Ephemeral Stream	Number of Road Crossings: Perennial	Number of Road Crossings: Intermittent	Number of Road Crossings: Ephemeral
Mud Creek (01)	27	16	32	10
Lower Camas Cr. (02)	25	10	38	21
Horse Cr. (03)	10	3	11	10
Burnt Creek (04)	14	4	11	17
Crane Lake (05)	12	5	11	9
Upper Deep Creek (06)	8	9	1	1
Dismal Creek (07)	13	12	8	10
Willow Creek (08)	13	12	11	11
Cressler Creek (09)	6	5	7	10

Subshed	Miles of Road Within 300 Feet Perennial, Intermittent or Ephemeral Stream	Perennial	Number of Road Crossings Intermittent	Ephemeral
Big Valley (10)	2	1	0	1
Lower Deep Creek (11)	7	2	8	2
Blue Creek (12)	13	3	14	1
Peddlers Creek (13)	8	2	7	2
Drake Creek (14)	~	2	34	2
Gibson Canyon (15)	~	0	1	0
Upper Twelvemile (101)	0	0	0	0
Fifteenmile (103)	3	1	5	3
Twentymile (104)	0	0	0	0

3. Fine Sediment from Upland Timber Harvest

Until recent implementation of the Inland Fish Strategy, stream vegetation buffers specified in timber sale contracts have been minimal to nonexistent. Studies have shown a buffer distance of about one site-potential tree height (120 feet in this watershed) would effectively remove sediment in most situations (FEMAT 1993).

4. Beaver Dams

Beaver dams are important for trapping sediment and providing cool water refugia for fish. Under reference conditions, sediment would be trapped behind beaver dams and cleaner stream substrate would be found below the dams. The decrease in beaver dams has resulted in an even distribution of sediment throughout the entire length of the stream channel and higher levels of fines in spawning substrates than existed historically.

5. Large Woody Debris

Lack of large wood in some stream reaches has been identified as a limiting factor. Typically, large trees have been harvested for timber which has reduced the source of large wood in perennial, intermittent or ephemeral channels. Large wood helps to trap and retain fine and course sediment (Duncan et al. 1987). A study in southwestern Washington shows that approximately 34% of surveyed road drainage points entered mainly first or second order stream channels. Thus, the delivery of road sediment to larger streams often depends on its transport through smaller channels (Bilby et al. 1989). Woody debris has been shown to be extremely effective at retaining sediment in small systems by both slowing water velocity upstream and trapping transported sediment. Large wood provides storage of sediment in the tributaries and contributes to the maintenance of water quality and productive fish habitat (Duncan et al. 1987). Low to moderate sediment levels in perennial streams may be partially due to an adequate supply of large wood in areas of the upper watershed. Large wood is a necessary component of ephemeral, intermittent and perennial streams for storage and sorting of sediment.

6. Sediment Summary

Fine sediments in stream substrate is an important parameter for salmonids. Analysis of stream sediments shows the majority of stream reaches have levels of fines that are in an acceptable range for salmonids.

C. Water Temperature in Perennial Streams

1. General

Except for Dismal, Twelvemile and Rosa Creeks, elevated water temperatures have been identified as a limiting factor on monitored streams. Elevated temperatures are occurring as a result of reduced riparian vegetation from grazing, loss of shading from trees that have been harvested adjacent to the stream channel and widening of stream channels. Higher water temperatures may also be a natural condition where shading was not present in meadows and where beaver dams created higher exposure to direct solar radiation. Factors that affect temperature are discussed below.

2. Riparian Vegetation

Riparian vegetation has changed along perennial streams. Intensive livestock grazing that occurred in the late 1800s and early 1900s resulted in loss of riparian vegetation. At present, riparian conditions are on a steady rate of improvement on most lands managed by both agencies. Tables 50 and 51 show that of the 35 reaches evaluated for proper functioning condition, 94% were at PFC or on an upward trend.

Continued improvement toward historic conditions will result in improved shade and lowering of stream temperatures in areas where shade producing vegetation has been reduced. Also, improved riparian vegetation will result in narrower and deeper stream channels. This change will result in decreased surface exposure to solar radiation decreasing water temperature.

3. Beaver Dams

Beaver dams create conditions of increased groundwater storage. Greater stream bank storage enhances flow during summer months and causes improved distribution of stream flow throughout the year (Olson and Hubert 1994).

Beaver ponds warm stream temperatures as water passes through a series of ponds. However, beavers improve riparian habitat by enhancing subirrigation of adjacent land, by elevating water tables and expanding wetland areas. Elevated water tables enhance growth of deciduous woody vegetation that provides shade. In the Rocky Mountain Region, elevated temperatures downstream from beaver dams has seldom exceeded tolerable high water temperatures for trout (Olson and Hubert 1994). Temperature monitoring on the Fremont National Forest showed that temperatures above and below beaver dam complexes in meadows did not increase temperatures to lethal levels. Temperature increases were equal to or less than temperature increases through systems without beaver dams (Friedrichsen, personal communication). However, data from the Silver Creek Watershed Analysis indicate that stream temperatures may occur naturally that exceed State of Oregon standards in these systems.

Beaver ponds may have resulted in some localized areas where State of Oregon standards were exceeded for stream temperatures. However, beaver ponds can provide deep water habitat with cool refugia areas. Loss of beaver dams has created streams that are less complex with less cool water refugia. Under these conditions, temperatures are more evenly distributed with less influx of cooler water for refugia.

4. Summary of Stream Temperature

Water temperatures in all of the streams except Dismal, Twelvemile and Rosa Creeks exceed State of Oregon standards. Further intensive monitoring to determine the locations and possible causes for elevated stream temperatures will be needed for site-specific recommendations. It is not known if State of Oregon recommended thresholds of 17.8oC are attainable. However, shading was more prevalent in historic conditions prior to channel widening and loss of shade from degradation of riparian vegetation. Therefore, it is assumed that shading can be increased, banks can be narrowed and temperatures can be lowered from existing conditions.

D. Macroinvertebrates

Species of macroinvertebrates vary greatly depending on water quality within a stream. The macroinvertebrate biotic index (BCI) provides general information regarding the integrity and health of stream systems (Table 30). The water quality trend, as it relates to macroinvertebrates, is an overall decline in habitat conditions in Willow Creek, with Burnt Creek remaining in poor condition. These ratings primarily occurred because of high sediment tolerant species. Current conditions showed some organic enrichment. There is a data gap regarding the level of organic enrichment. This supports the need to reduce erosion and sedimentation and improve riparian vegetation as a filter.

Deep and Twelvemile Creeks decreased in the BCI rating. Parsnip and Camas Creeks remained the same. Current conditions showed that slight to moderate organic enrichment occurred at the sites. There is a data gap regarding numeric values and sources of enrichment and levels of sediment.

<u>Species and Habitats</u>

A. Terrestrial

1. Threatened, Endangered, and Sensitive Species

a) Northern Bald Eagle (Threatened)

Although no known bald eagle roost or nest sites exist in the watershed, the forest may have provided more suitable habitat prior to 1950. Timber harvest, plant succession and fire suppression have reduced the abundance, distribution and quality of potential bald eagle nesting/roosting habitat on the landscape since 1950. Overstory, partial removal and regeneration timber harvest treatments in LOS ponderosa pine have removed preferred nest/roost trees and fire suppression has resulted in an increase in stand densities contributing to mortality of the large overstory trees preferred by bald eagles for nesting and roosting. The current trend of large tree mortality due to high stand densities and insects and disease must be reversed if potential nesting/roosting habitat is to be maintained through time. Plant succession is also causing a change in plant species composition in many stands from true pine to mixed conifer which is less suitable for nesting/roosting.

Prey habitat suitability has been marginal within the watershed during both historic and current time periods.

b) American Peregrine Falcon (Endangered)

American peregrine falcon establishment is dependent upon prey availability of marsh-related species, as well as, terrestrial small mammals and birds. Marsh birds are most abundant during wet cycles that occur about three in ten years in southeastern Oregon. During drought years, waterfowl and shorebird numbers are low and any nesting peregrines would have to also prey on small mammals and birds. Small mammal populations are cyclic with explosions and crashes and are currently rebuilding after a crash in population two years ago.

Wildfires maintained the upland prey habitat for peregrines prior to 1945. Fire suppression in recent years has allowed sagebrush to dominate sites and alter small mammal and bird habitat. Some open hunting areas have probably been lost due to fire suppression, making prey detection by peregrines difficult especially when small mammal populations are at a low.

Timber harvest treatments that opened the forest canopy have gradually increased foraging habitat suitability in all forested subsheds. However, habitat for prey species and hunting will diminish as early and mid-structural stands progress in succession to an eventual overstory condition. Large created forage areas available for this species are not likely to occur in the future under predicted land management policies.

The possibility does exist that large forage areas will be created by wildfire. Large fires that remove forest overstory are likely to be more common in the decades to come given the acres of stands in a dense vegetal state where the risk to stand-replacement fire is high. Predicted reductions in road densities will reduce disturbances and increase habitat security within potential habitat.

c) Western Sage Grouse

Sage grouse habitat was maintained by wildfire prior to Euroamerican settlement. Fire suppression and livestock grazing have changed this habitat dramatically. Fire suppression has allowed sagebrush to dominate sites and replace areas previously occupied by grasses and forbs. This change in plant composition and structure has not benefitted sage grouse productivity. Livestock grazing has removed grasses and forbs (the fine fuels necessary to carry a fire) and accelerated succession to sagebrush dominance. The loss of the grass/forb component has reduced nesting and escape cover and eliminated or drastically reduced the forb component critical for rearing broods. These two factors in combination with weather have probably contributed to the general decline of the species throughout its historical range.

d) California Bighorn Sheep

California bighorn sheep habitat has also been altered by livestock grazing and fire suppression. Early livestock grazing included domestic sheep use that impacted bighorns directly by competing for forage and space and indirectly through the introduction of disease and parasites. Grazing by domestic sheep is no longer practiced, however, competition for forage still exists between cattle and bighorns. Bighorn sheep utilize steep, rugged terrain inaccessible to cattle for foraging and lambing. However, competition for forage and space can occur if bighorns expand to new areas and water is limiting within the rimrock itself.

Fire suppression has created climax sagebrush communities with limited grass/forb production. Wildfires caused by lightning maintained the bunchgrass communities important to foraging bighorns, especially bluebunch wheatgrass. Livestock grazing and fire suppression have changed the native perennial bunchgrass to native and nonnative annual grasses which are not used as much by California bighorn sheep.

2. Keystone Species

a) Big Game

Seasonal big game ranges and migration corridors on private and public lands have been altered considerably within the past 50 years. Agents of change, including commercial timber harvest, fire suppression, wildfire, plant succession, livestock grazing, transportation corridors for public and industrial access and recreational developments that have cumulatively altered the landscape. Drought and insects and disease in recent years are currently making additional modifications to all seasonal ranges and migration corridors in all ownerships.

Prior to 1950, big game ranges were partially maintained by natural wildfires that created a mosaic of successional stages from early to climax. This provided a vigorous supply of winter browse, cover and early green-up grasses and forbs necessary for reproduction and survival.

Fire suppression as a habitat change agent since 1910 has created an unnatural condition in that it benefitted browse species such as antelope bitterbrush and curl-leaf mountain mahogany in the short-term by protecting stands from fire, but in the long-term it created evenaged decadent stands with little or no reproduction or vigor. Fire suppression has also allowed western juniper woodlands to establish in areas where juniper was a minor component of the landscape. In the absence of natural wildfires, juniper has expanded at the expense of the understory shrubs, especially antelope bitterbrush, and native herbaceous species. Natural fire regimes maintained stands in a mosaic of plants in various age classes and allowed vigorous growth and seedling establishment.

Livestock grazing, drought cycles, and insect outbreaks have also negatively effected big game range. Intense livestock overgrazing in the early 1900s by domestic sheep, cattle and horses created severe competition with mule deer for early green-up grasses and forbs and winter browse. BLM livestock management plans have reduced conflicts between livestock and wildlife by limiting livestock numbers and season of use. The drought cycles that occur periodically further limit grass/forb production and browse seedling establishment. Insect infestations also contribute to the decline of browse species by limiting flower and seed production and affecting the overall vigor of plants.

The loss of riparian deciduous vegetation (willows, aspen and shrubs) and lowered water tables in riparian zones as a direct result of overgrazing through the early 1900s has altered the abundance and distribution of fawning/calving and rearing cover and forage. Recovery of riparian vegetation is gradually occurring around many stream and spring areas under present livestock management and should benefit deer and elk, as well as, pronghorn kidding and foraging (forbs) habitat.

The amount and distribution of effective cover currently exceeds optimal levels in most areas within the forested portion of the watershed. Since cover/forage ratios were not available for the historic condition, the relationship between historic and current conditions is not specific. It can be assumed that more frequent fires historically allowed more forage habitat. Fire suppression throughout the twentieth century has caused a transition in stand structure from more open to more dense understories. Fire suppression has also precluded creation of short-term forage areas. While forage areas were created by timber harvest activities, creation of openings has not occurred on a large scale since the late 1980s. Most man-created forage areas have since reforested and are transitioning to a state of cover. The lack of forage will become even more pronounced in the next several decades with large-scale wildfires and insect outbreaks creating the only forage habitat. Prescribed fire is a tool that can be used to restore foraging habitat on a more predictable schedule.

Big game security has been reduced by increases in road densities in the past 50 years. Road prisms have reduced the amount of available habitat and vehicle traffic has displaced big game from areas adjacent to open roads. Roads have also increased vulnerability to harvest and poaching, further reducing big game security. If road closures and obliterations are implemented, habitat availability and security will increase.

Rocky mountain elk populations are expanding and will continue to grow in numbers unless harvest can control the population at the management objective of 500 animals. At the current population no negative impacts to the mule deer herd or major competition with domestic livestock exists. However, as the population expands to 500 animals there may be competition for grass forage with cattle and additional stress put on winter browse used by deer and elk. More elk could potentially reduce the carrying capacity for deer and precipitate a slow decline in deer numbers and distribution. This condition may require readjustments in livestock/wildlife AUMs.

b) Beaver

Livestock grazing, fire suppression, trapping and plant succession have contributed to a decline in beaver habitat and numbers that probably began around the turn of the century. Fire suppression and plant succession have reduced the availability and abundance of some important deciduous forage species. Shade intolerant and fire-associated species, such as aspen and willow, have most likely declined in density and distribution as decadent stands are replaced by shade tolerant conifers.

Historic as well as more recent livestock grazing has reduced the availability and abundance of summer herbaceous and winter deciduous forage species, and altered channel conditions and flow regimes to the extent that beaver habitat needs for water and food may no longer be met in some stream systems. Upland timber harvest and road construction have contributed to altered runoff and stream flow regimes to the detriment of favorable beaver habitat conditions.

Trapping harvest and transplant records indicate that direct removal of beaver from the watershed has also affected populations and most likely distribution as well. It appears that trapping pressure was heavy from settlement time through around 1920, and again from 1950 to 1970. The trapping closure initiated in 1988 and still in effect has probably protected beaver populations.

As beaver are lost from the system, wetland habitat is reduced along with associated plant and animal diversity and productivity, water and sediment storage and transport are altered, and nutrient cycling and decomposition dynamics change.

Recent riparian recovery, where willow and other deciduous riparian species are limiting population growth, has benefitted beaver populations in local areas by allowing them to occupy new areas and be more productive in areas where they have existed since historic times.

c) Nongame Species

Shrub-steppe dependent nongame species have declined in distribution and numbers from livestock grazing, fire suppression and plant succession. The natural mosaic of shrublands in a variety of seral stages maintained by wildfire has been allowed to convert shrub dominated sites with very little herbaceous understory. Grazing also has removed much of the fine herbaceous understory needed to carry a fire. Current livestock grazing should allow some recovery of upland shrub-steppe habitat. Full recovery may require the introduction of fire.

Riparian-dependent species have also demonstrated declines in distribution and abundance with the loss of riparian woody vegetation. These species will benefit from current livestock management and future aspen/cottonwood management.

3. Management Indicator Species Associated with Late and Old (LOS) Forest Cover

a) General

Based on historic and current estimates, total acres and continuity of LOS forested stands are currently less than what occurred historically (Table 42). Acres and patch size of interior LOS have declined as well. Table 34 shows average LOS interior patch size being only 22 acres, where historically patch size probably averaged in the hundreds or thousands of acres.

Available and suitable LOS forest and dead wood habitat has decreased since 1945 primarily as a result of timber harvest activities and, to a lesser degree, wildfire. Insect and disease outbreaks, blowdown events, firewood cutting, hazard tree removal, road construction, and in some instances fire suppression also have contributed to the loss of habitat. These disturbance agents have removed large diameter live trees, snags and down wood, reduced patch sizes and connectivity, and diminished the amount of high quality LOS interior habitat and overstory canopy cover. Increased gaps and fragmentation have in turn increased the amount of lower quality LOS ecotone habitat. Wildfire has generally increased the amount of dead wood habitat over the burn area, but follow up salvage treatment removes most of the large dead wood from the area.

True ponderosa pine has experienced the greatest reduction in dead wood and LOS forest habitat. Past management practices of overstory and partial removals of pine, as well as fire suppression, have converted forest stands previously dominated by open large diameter pine to stands now characterized as mixed conifer with more shade tolerant, dense white fir understories. Also, large areas of LOS pine were removed by regeneration harvest treatments. As a result, habitat suitability has declined for species associated with open, large diameter pine stands such as white-headed and Lewis woodpeckers, flammulated owl and goshawk. Overall abundance and distribution of these species has most likely declined from historic levels.

Succession of forest cover above 6,500 feet and on warm fir sites at lower elevations toward a mixed conifer composition appears to be providing more habitat for pileated woodpecker, marten and other associated species as these forest stands develop LOS structural conditions. Succession of early/mid-seral lodgepole pine to late seral pine has created additional habitat for associated species such as black-backed woodpecker.

The loss and fragmentation of available dead wood and LOS forest habitat since 1945 has reduced habitat availability and suitability. Smaller, scattered LOS patches amid large areas of forest habitat where large overstory trees are uncommon or early/mid-seral forest habitat dominates may no longer meet the habitat needs of some LOS associated species such as marten and pileated woodpecker which require large areas of contiguous LOS to meet home range habitat requirements. Isolation and crowding of individuals and pairs into these patches threatens the stability of some species. Sink populations in marginal habitat patches cannot maintain themselves without continuous recruitment from source populations in preferred habitat conditions. Even the improved stand conditions which presently exist for species associated with LOS mixed conifer and lodgepole pine such as the marten, pileated and black-backed woodpeckers are offset by the fragmented nature of LOS patches and loss of interior habitat conditions. Fewer marten could mean higher rodent populations which damage or kill tree seedlings. Loss of dead wood and subsequently smaller populations of cavity excavators with more restricted distribution means less predation on insect populations. Strong populations of woodpeckers can actually help suppress epidemic outbreaks of insects that cause extensive forest mortality.

Under an assumed forest management scenario on private lands similar to present management, LOS forest and dead wood habitat that has been or is eliminated and replaced by early/mid-seral forest will never again be a part of the landscape. Forest habitat that matures on private lands in the future probably will be harvested before it develops LOS forest characteristics, and will always be marginal sink habitat for MI and other species associated with LOS forest and dead wood habitats. Potential forest regeneration treatments on private lands in the future could continue to create edge habitat for goshawk prey species.

On forest lands, LOS forest and dead wood habitat should gradually increase in abundance, continuity, distribution and quality over the long term as forest management shifts to longer rotation unevenaged treatments and tree plantations grow into mature forests. Smaller openings created by future unevenaged treatments could create more suitable prey and hunting habitat for goshawks and marten. Edge contrast between existing LOS forest and early/mid-seral forest will slowly diminish as tree plantations mature over time and are managed more for forest structural diversity. However, as plantations grow into the mid-seral condition class, habitat conditions for goshawk and marten prey species will decline. Road closures and obliterations will help reduce habitat fragmentation. Sanitation/salvage harvest prescriptions and underburning will continue to reduce dead wood habitats, but sufficient snags and down wood should be protected and created through insects and disease and wildfire to maintain stable populations of most dead wood associated MI and other species.

Prescribed underburns and thinning as now proposed should help restore more open park like stands of LOS pine habitat for associated wildlife species. Without treatment, existing stands of LOS forest and dead wood habitat are at risk to potential insect and disease outbreaks and catastrophic wildlfire. The risk to higher, wetter and cooler true mixed conifer sites would be lower than the risk to lower elevation true pine and warm site mixed conifer stands. The risk for the occurrence of these events has increased in the last 50 years.

Habitat security has gradually declined since 1945 as disturbances associated with a greatly increased road density and extensive timber harvest activities escalated through at least 1990. However, predicted road closures/obliterations and lower levels of timber harvest activities in the future should reduce disturbances to LOS forest habitat and associated species.

It is unlikely that the watershed will ever again provide LOS forest habitat within the range of historic variability. Also, the intermingled ownership pattern will continue to contribute to the gaps and fragmentation of LOS forest habitat that is evident presently. It is also highly unlikely that LOS open, park like, single story ponderosa pine forest habitat will ever be as abundant and contiguous as it was prior to 1945. However, more acres of LOS mixed conifer forest should be present in the future. Overall, the future abundance and distribution of wildlife species associated with LOS forest habitat, especially ponderosa pine, will be less than occurred historically.

b) Red-naped Sapsucker

Aspen is gradually being replaced by conifers over time primarily as a result of plant succession and fire suppression. The decadent condition of mature aspen, the change in forest structure to dense conifer stands, encroachment of conifers into meadow areas, rangelands and riparian stringers, and the buildup of debris on the forest floor has resulted in a decrease in aspen regeneration. The regeneration that does occur is set back by livestock grazing and big game browsing pressure. Where stream channels have been downcut and/or widened and the water table lowered, the site potential for aspen may have been significantly reduced or permanently lost.

As aspen disappears from the landscape, preferred habitat for beaver, red-naped sapsucker and other aspen associated species is lost and wildlife habitat and diversity will decline. Population levels and distributions of these species will decline as a result. To help maintain wildlife numbers, management actions such as the current grazing strategies implemented for Section 7 consultation for the Warner sucker must be implemented and complied with to halt the gradual loss of aspen from the landscape and restore its presence to areas that historically supported aspen. The reintroduction of fire will be needed along with aggressive conifer management to restore and maintain these stands.

Stands that are currently regenerating in areas where livestock are excluded hold promise for successfully transitioning to later structural stages.

B. Aquatic

1. General

The redband trout can be found in a variety of habitats depending on its life stage. Adults are generally found in areas of abundant cover associated with deep pools, large organic material, undercut stream banks and overhanging vegetation. Juveniles and young-of-the-year are often found in shallow stream margin habitats, high cover areas and interstitial substrate spaces. The redband trout is a spring (March through June) spawner with eggs usually hatching in four to seven weeks, then taking an additional three to seven days to absorb the yolk before becoming free swimmers (Sigler and Sigler 1991). The average age at first spawning is typically two to three years. Redband trout up to 12 inches in length require access to spawning gravels of up to 2.5 cm in diameter with less than 30% fine sediment. Generally, water temperatures in excess of 21oC (70oF) are unfavorable and may cause stress to all age classes (Sigler and Sigler 1987). Temperatures in excess of 25oC and 29.4oC have been shown to be lethal (Bjornn and Reiser 1991). Temperatures of about 15oC (58-69oF) are ideal for optimum growth of rainbow trout (Leitritz and Lewis 1980).

The term limiting factor relates to those factors that have or continue to limit redband trout populations. Habitat needs of redband trout were selected to assess limiting factors within the watershed because it is believed addressing these factors will provide healthy, stable aquatic ecosystems that meet the needs of all aquatic dependent species.

2. Barriers

Barriers consist of waterfalls that divide upper and lower stream reaches of streams to fish movement (Current Conditions-41). It appears from fish presence data that there are no barriers to brook trout or stocked hatchery fish to prevent their upstream movement into the headwater sections of streams.

Weirs are located on private property. The status of the weirs are unknown with regards to fish barriers.

Few culverts have been noted as a barrier to fish passage, however, site specific information on the majority of culverts with regards to fish passage is unknown.

3. Spawning and Incubation Habitat

Spawning habitat ranges from good to poor. According to Behnke (1992), spawning success may be severely limited in low gradient areas where reproduction is typically restricted by high sediment loads that blanket redds with silt during spring runoff.

The filling of interstitial spaces with fine sediment reduces oxygen flow to the redd, which reduces egg incubation success and alevin survival (Young 1989). Fines can also act as a physical barrier to fry emergence (Weaver and White 1985). Salmonids are dependent upon aquatic invertebrates for food. Fine sediment covers food production areas in rubble and gravel areas, reducing aquatic insect habitat and in turn reducing the quality and quantity of food available to salmonids. Accelerated erosion can favor populations of fall spawning, nonnative brook trout over native trout. This is the case in a few streams that have fines in excess of the 30% threshold in the redd habitat areas (Mud and Burnt Creeks).

Fine sediment is also high in Willow (29%) and Lower Deep (28%) Creeks. Table 28 identifies that substrate fines range from four to 40% within perennial streams. Mean values of substrate fines and embryo survival rates also are shown in Table 28.

Sampling of stream substrate within potential redd areas shows that the percentage of gravel in the substrate is generally adequate and is not a limiting factor in the stream channel. Flushing of fines would result in adequate supplies of gravel above 6.4 mm in size.

Factors that affect fines have been discussed in Synthesis and Interpretation-22 to 25.

4. Low Flows

Spring spawning trout like redband will use intermittent streams for reproduction (Behnke 1992). The use of intermittent streams by redband trout has been documented within the Klamath River watershed on Bly Ranger District (Nichols, Personal communication). The success of this spawning strategy is largely dependent upon sufficient water in tributaries to allow spawning trout to access the intermittent streams through road culverts and for young trout to move downstream to the mainstream.

Evaluation of Deep Creek gauging records shows that mean spring runoff in the form of peak flows has increased over historic conditions, but this should not have effected spring spawning in intermittent streams.

There are few active side channels along perennial streams in low flow conditions, particularly along entrenched channels. Rearing habitat is considered to be limited because water is mostly confined to the thalweg portion of the stream during low flow periods and there are few side channels. Historic beaver dams created backwater habitat for rearing. Loss of the beaver dams has resulted in reduced backwater rearing habitat.

Loss of beaver dams also can decrease base flow. Loss of base flow negatively effects pool rearing habitat. Less water in late summer and winter further reduces residual pool depth which concentrates fish and magnifies negative impacts.

5. Pools

Pools are important summer and winter habitats for both juvenile and adult trout (Decker and Erman 1992). Generally, the number and frequency of pools in a stream are a good indicator of the overall quality of the habitat to support trout populations. The frequency and depth of pools is dependent upon the geomorphic character of the stream bed, flow and balance of the sediment supply. Pool frequency was measured as fair to good in all streams except Deep Creek Middle Fork, Mud, Parsnip, Polander and Burnt Creeks.

Generally, pool habitat has been lost by pools filling with sediment. Several factors have contributed to this occurrence. One of the major factors occurred when beaver were trapped and abandoned beaver dams failed. These riparian areas were then grazed and stream channels were downcut with narrower floodplains. Lower gradient streams have changed from historical Rosgen type E channels to wider and shallower Rosgen type C or F. Widening of the stream channel has resulted in loss of deep pool habitat. Also, sediment is produced from erosion caused by unstable stream banks, roads, logging impacts and from loss of large wood. Loss of wood in intermittent and ephemeral channels results in sediment being quickly transported downstream to perennial reaches.

Deep pool habitat is identified in the ICBEMP as pools that are greater than 2.6 feet in depth. Polander and Willow Creeks showed poor deep pool habitat. Both of these streams also showed poor large wood ratings and they are also within areas that have higher road densities. This indicates that a lack of large wood and the influence of sediment from roads may be contributing to loss of pool depth.

Streams rated with poor deep pool frequency are most susceptible to freezing. During winter months, reduced pool depth along with colder water temperatures and increased stream bed disturbance form ice scour and gouging can stress fish. Maintaining conditions that provide deep pools is an important component during the winter months.

6. Large Woody Debris (LWD)

All streams rated for LWD content had some poor ratings except Parsnip, Roaring Spring Fork of Drake and Lower Deep Creeks. Both Parsnip and Lower Deep Creeks did not have potential for large wood due to a natural lack of suitable material. Other sites with low ratings should be field verified to determine if they have potential for large wood.

Large wood in perennial streams provides hiding cover, sorts gravels, produces aquatic insects, creates pool habitat and hydraulic refuge (Sedell et al. 1989). Large wood in ephemeral and intermittent channels slows erosion and fosters deposition of organic and inorganic materials. Deposited material becomes a source of food for macroinvertebrates both on site and downstream.

The amount of large wood within most of the intermittent and ephemeral streams is unknown. It is assumed that the large wood in perennial streams can be extrapolated to intermittent and ephemeral streams. Therefore, some of the streams have potentially low LWD. The consequence of this poor rating for large wood in intermittent and ephemeral channels is that sediment which may normally be trapped in these streams is now quickly routed to the perennial streams below where primary fish habitat is affected. However, low to moderate sediment levels may be partially due to an adequate large wood supply in areas of the upper watershed.

Loss of large wood in perennial streams also is contributing to loss of pool habitat.

7. Stream Bank Condition

Natural surface erosion outside of the stream channel and erosion of stream banks occur over a prolonged period but, under natural conditions, are usually in balance with the bank rebuilding process. Land management activities (i.e. livestock grazing, timber harvest and road construction) can alter this equilibrium resulting in significant increases in bank erosion and channel instability (Platts 1991). Bank instability reduces rearing habitat for younger fish by eliminating undercut banks that provide cover. Adult habitat also is affected by loss of undercut banks which provide pockets of cooler water during the heat of the day for fish to occupy.

Bank stability has not been measured on forest stream reaches except for South and Middle Forks of Deep Creek. However, Lower Deep Creek , Parsnip and Camas Creeks on BLM exceed the recommended threshold of 20% bank instability.

8. Shade

Streamside vegetation provides shade to the stream channel which is a significant factor in the regulation of water temperatures (Platt 1991). The ability of vegetation to shade a stream is dependent upon the general morphology of the channel, channel orientation to the sun, and the condition and type of streamside vegetation. For example, the amount of shading a stream receives is often greater in narrow steep sided canyons or those streams which flow east or west as compared to those in wider unconstrained channels or which flow north or south. Larger streams require higher adjacent streamside vegetation to obtain adequate shade. Platts (1991) found trees provided nearly all of the stream shading on large streams (6th and 7th order) and shrubs and trees on small to medium sized streams. The condition and type of vegetation also affects shade levels. Both canopy density and closure are important factors affecting stream shade (Adams and Sullivan 1990). On forested streams, the effective buffer width varies based upon ecotype but most shade is provided by vegetation within one potential tree height of the stream channel (FEMAT 1993).

Excessive herbivory by livestock and other ungulates has lowered the water table along stream channels, particularly in the lower gradient deeper soil riparian sites. This primarily occurred from overgrazing in the late 1800s and early 1900s. Channels on the upper reaches of streams and canyons were less affected by grazing because of greater rock content and inaccessibility to stock. The greater quantity of rock material resists downcutting. Downcutting alters streamside riparian vegetation, which is now dominated by sagebrush and xeric species. In many cases, the stream width to depth ratios have changed from narrow deep channels to wider shallower channels.

Stream temperatures have a strong influence on redband trout populations (Synthesis and Interpretation-32). Redband trout that have evolved in the closed basins of eastern Oregon generally have higher temperature tolerances than rainbow trout elsewhere in the United States. Stream water temperatures within the Deep Creek watershed have exceeded the 70oF (21.1oC) threshold for rainbow trout on perennial streams as shown in Table 29. Approximately 77% of the streams monitored exceeded 70oF.

9. Interspecific Competition

The level of stress on native redband trout from the stocked brook trout is not known. However, competition is assumed to be an important factor that is limiting redband trout populations.

Human Uses

A. Timber

Timber harvesting conducted by Fremont Sawmill on private lands and the Forest Service's increased harvesting of big ponderosa pine following the end of World War II has left a visible impact on the forest landscape throughout the watershed. Besides the removal of the big trees, road building and other timber related ground disturbances can be seen.

Up until World War II, timber harvest had been limited and most of the timber had gone to local markets. The style of cutting was more of a "PICK and PLUCK" than anything else and left a natural appearing forest when harvesting was completed. After World War II, the increased demand for wood products caused a more accelerated harvest situation which slowly began to change the appearance of the natural landscape.

Harvest levels on National Forest System lands held steady and increased to a peak in the 1980s. After this, harvest levels dropped off to about one-tenth of this peak level.

B. Grazing

As the nineteenth century came to an end, homesteaders who built at lower elevations of the watershed would move their cattle, sheep and horses seasonally up into the higher reaches of the drainage basin. During the early part of this century, sheep and cattle grazed heavily throughout the watershed. It wasn't just their vast numbers, but the fact that they grazed year-round that had such an effect on the watershed's vegetation. After the Taylor Grazing Act of 1934 and World War II, domestic livestock grazing declined. Gradually, sheepherding gave way to cattle production and today the cow is the dominant commercial grazing animal within the watershed.

The impacts of grazing management on BLM-administered lands in the watershed are addressed in the following allotment discussions.

Vinyard Individual Allotment (0201)

This allotment encompasses portions of Lower Deep Creek and Gibson Canyon subsheds. There is a detached pasture in Drake Creek subshed. Management is a three pasture rest rotation grazing system that has been in place for 25 years. The allotment is currently undergoing an evaluation to determine what changes if any should be made in the grazing management.

In the past 10 years, major changes in allotment management have resulted in watershed improvements. About 8.1 miles of the 8.5 miles of Deep Creek have been excluded from grazing except for four small watergaps along the creek. This significantly reduced the impacts from grazing on Deep Creek and should continue to improve the riparian vegetation for several years. Only 0.4 miles of public land and 0.75 miles of private land along Deep Creek remain open to cattle grazing and these portions are only grazed for part of the year. In addition, the 1.7 miles of Camas Creek and 0.5 miles of Drake Creek are excluded from grazing.

The areas of concern on this allotment continue to be Sweeny Canyon and Squaw Creek which are intermittent but heavily used when cattle are in these pastures. These drainages are in separate pastures that are grazed early in the spring and summer every other year. The new grazing plan is to graze these areas a little later in the season thereby reducing the grazing period and utilization levels.

There are significant areas of big sagebrush-grass in the Gibson Canyon subshed that have become juniper-big sagebrush with juniper encroachment from the rims above. Juniper control should become a major component of future management to maintain a diversity of plant communities.

Hickey Individual Allotment (0202)

This allotment encompasses portions of Drake and Peddlers Creeks, Big Lake and Gibson Canyon subsheds. The allotment has a five pasture rest rotation grazing system in which two of the pastures are riparian pastures. These riparian pastures are Camas Creek and Parsnip Seeding. The schedule for both pastures is spring grazing (April-May) for two to six weeks every other year with rest during the other year. This system has been in place since 1994 and conditions along the 1.9 miles of Camas Creek and the 1.0 mile reach of Parsnip Creek have been improving steadily. Utilization levels have reached 70% along the creek when it is grazed, but moving livestock off before June has allowed for plenty of regrowth. The stubble height has been a minimum 8-10 inches by fall. This grazing schedule has eliminated cattle grazing on willows and young willows are starting to establish. There is also a 0.5 mile of Drake Creek and 1.4 miles of Parsnip Creek that are excluded from grazing except for two small watergaps. This exclusion has helped improve these riparian areas significantly.

The other three pastures are upland pastures grazed in a rotation pattern designed to rest one pasture a year. The primary vegetation in these pastures is low sagebrush-grass in late and mid-seral condition. There is some big sagebrush-grass in early seral condition and some with cheatgrass in the understory. Under the current grazing system, these communities have been improving. However, young junipers have invaded some of the big sagebrush-grass from sources on the rocky rims. Some control of these junipers may be necessary in the future.

Crump Individual Allotment (0204)

This allotment is within the Gibson Canyon subshed. Only the southern tip of the allotment (600 acres) is in the watershed. The public land is grazed every year early in the spring to utilize the cheatgrass and then rested to allow perennial grasses to maximize growth.

Lane Plan II Allotment (0206)

Most of this allotment is in the Big Lake subshed. The allotment is a three pasture rest rotation system with one of the pastures being a crested wheatgrass seeding. Each spring one of the native pastures, either Thompson or Crump Lake, is grazed and the other one rested. Then, the Parsnip Seeding pasture is grazed for two to three weeks in June. Drake Creek forms the boundary between Thompson and Crump lake pastures, but Drake Creek is excluded when the cattle are in Crump Lake pasture. When the cattle are in the Thompson pasture, about 1.5 miles of Drake Creek can be grazed and about 1.25 miles is inaccessible. The grazing system allows for grazing during April and May when the water is high and the canyon bottom is cold. This limits the amount of the creek area the cattle can access and the time they spend there. By removing the cattle before June there is adequate time and water for grazed vegetation to regrow and stubble heights have exceeded the required six inches by fall. Grazing use on willows also is minimal this early in the spring. Riparian conditions are improving on Drake Creek. The Roaring Springs Fork which runs from Roaring Springs for 0.75 miles into Drake Creek is managed the same as Drake Creek.

There is a short reach of Parsnip Creek within the Parsnip Seeding pasture but it is excluded from grazing except for a small watergap.

The uplands sites in the Thompson and Crump Lake pastures are a mixture of low sagebrush-grass and big sagebrush-grass with some significant areas of juniper invading the big sagebrush. The Thompson pasture especially has a lot of young (less than 100 years old) juniper present and a prescribed fire may be necessary to prevent this area from becoming a solid juniper stand.

Lane Plan I Allotment (0207)

There are portions of five pastures within the Lower Deep and Cressler Creek, Big Valley and Gibson Canyon subsheds. This allotment operates under a rest rotation grazing system that rests two pastures each year.

There are no perennial streams within the allotment though Squaw Creek, an intermittent stream, is a tributary of Deep Creek. Under this grazing system, Squaw Creek has been grazed for a few weeks and has been rested three of the last five years.

The grazing system is well suited for the upland vegetation present as most of it is low sagebrush-grass and juniper-low sagebrush-grass.

Sagehen Allotment (0208)

Most of the allotment is within the Lower Deep Creek subshed with some in Crane Lake and Drake Creek subsheds. There is only the Deep Creek riparian pasture and the Sagehen pasture in this allotment. Grazing management is flexible as this allotment is used in conjunction with the Hickey 0202 allotment. The plan is to graze the Deep Creek riparian pasture as early in the season as possible and be off during July. In addition, there is a 5" stubble height requirement along Deep Creek. This plan has worked well since 1994 and the riparian vegetation along Deep Creek has been steadily improving. The amount of herbaceous vegetation has increased and there are new willows establishing.

The upland vegetation in this allotment is in an upward trend and much of it is already in late seral condition.

Schadler Allotment (0209)

This allotment is almost entirely within the Crane Lake subshed. About half of the BLM-administered land, which is mostly low sagebrush-grass, is in late seral condition and half is in mid-seral condition. Grazing occurs in the spring and fall on the way to and from Forest Service allotments.

Lynch-Flynn Allotment (0520)

A portion of two pastures from this allotment are in the Big Lake subshed. There are no perennial streams flowing through the allotment. The allotment is grazed spring and summer under a rest rotation grazing system. This system is effective for the low-sagebrush-grass and scattered big sagebrush-vegetation found here.

National Forest

The present grazing program on the Lakeview Ranger District within the boundaries of the Deep Creek watershed show 2,336 cattle permitted to graze eight allotments during a general season of 7/1 to 9/30. As a comparison, between 1909 and 1915 on one allotment alone, there were 6,510 head of sheep permitted for four months 6/15 to 10/15. At the same time, there were 572 head of cattle and 61 head of horses permitted for seven months 4/15 to 11/15. At this time, there were no grazing systems and the stock was moved when the area was grazed out. The impacts of this intense historic livestock grazing are described by Deputy Forest Supervisor Bradley in Synthesis and Interpretation-4. Now, of the eight allotments, five are grazed under a deferred rotation system, one is under a rest rotation system and two are season long. Of the two season long systems, one allotment has 75 head for 60 days and the other allotment is under on-off and private land permits.

Riparian areas that currently are or recently have been degraded due to livestock grazing activities have been fenced into riparian pastures for protection and controlled use by livestock. At this time there are six such pastures. They are: a 498-acre pasture on Dismal Creek; two pastures on Deep Creek, totaling 152 acres; a 40-acre pasture on Willow Creek; a 480-acre pasture on Camas Creek; and a 80-acre pasture on Burnt Creek. In 1996, sites photographed 30 to 50 years ago were rephotographed to record any change. The main change is new willow growth in riparian areas.

Since 1995, the grazing monitoring program to assure compliance with the biological opinion for the protection of the federally listed Warner sucker has shown few incidences of noncompliance. There were three such incidences in 1997. For the most part, forage utilization in key areas of the allotments did not approach the maximum utilization standard. Presently, all allotments in the Warner Mountains, including those in the Deep Creek watershed, are being evaluated for grazing activities. Any recommendations from this process to improve watershed condition will be considered for implementation.