STEP 1: CHARACTERIZATION

Purpose

- To identify the dominant physical, biological, and human processes and features of the watershed that affect ecosystem function or condition.
- To relate these features and processes with those occurring in the river basin or province.
- To provide the watershed context for identifying elements that need to be addressed in the analysis.
- To identify, map and describe the most important land allocations, plan objectives, and regulatory constraints that influence resource management in the watershed.

Discussion

The Lower Hayfork Creek landscape is located on the Hayfork Ranger District, Shasta-Trinity National Forests. The legal description is sections 4 thru 9, 16, 17, 20, 21, 28, and 29 of T2N, R8E; sections 6 and 7 of T2N, R12W; sections 1, 12, 13, 24 and 25 of T3N, R6E; sections 1, 4 thru 9, 12 thru 30, and 32 thru 36 of T3N, R7E; sections 4 thru 9, 16 thru 21, and 28 thru 33 of T3N, R8E; sections 3 thru 10, 14 thru 23, 26 thru 34 of T3N, R12W; sections 31, 32, and 36 of T4N, R7E; sections 31 thru 33 of T4N, R8E; and sections 29 thru 33 of T4, R12W, Humboldt Baseline and Meridian and Mount Diablo Baseline and Meridian.

Lower Hayfork Creek landscape assessment area is approximately 48,769 acres in size. It is bounded by Hyampom to the west, Hayfork Creek to the south, Pattison Peak and Hayfork Bally to the north, and Thompson Peak to the east. The Lower Hayfork Creek landscape has been changed by both timber harvesting and wildfires. The northwestern portion of the landscape experienced varied intensities of wildfire in 1987.

The landscape has a variety of geologic and soils characteristics. It generally contains steep slopes with areas of more gentle terrain intermixed. There are several perennial streams running through the landscape. The primary year round streams found within the landscape include; Hayfork Creek, Bear Creek, Olsen Creek, Miner's Creek, Knowles Gulch, Little Creek, Rusch Creek, Jud Creek, and Grassy Flat Creek. There are also several smaller tributaries that are of importance as well.

The wildfires that occurred during 1987 were the result of lightning ignitions. These wildfires were large in size primarily due to the large amount of vegetation and existing fuel ladders that had been created predominately related to fire exclusion within the landscape over the past 60-70 years.

There are several parcels of private property scattered throughout the landscape. Most of the private property contains year around residences.

The area is easily accessible from Hayfork and Hyampom. It is very popular for deer hunting and is used fairly heavily in the fall. The South Fork of the Trinity River is designated as a Wild and Scenic River with the adjacent segment having scenic emphasis. The section of Hayfork Creek from Nine Mile Bridge downstream to Hyampom has been determined to be eligible for consideration as a "scenic" Wild and Scenic River as proposed in the Shasta-Trinity LRMP ROD.

There are seven distinct landscape analysis areas identified within the landscape. The wide variation among these areas is primarily due to varying degrees of disturbance. The seven areas identified are: The Canyonlands (Area C); Hyampom Earthflows (Area D); Halfway Ridgelands (Area E); Burned Area (Area F); Jud-Rusch Creek (Area G); Pattison (Area H); and Little Creek (Area I).

The Canyonlands lie within the lower, steeper portions of the Butter Creek watershed. The area is characterized by closed canopy, late seral, Douglas-fir and mixed conifer forests. Road density is low. Olsen Creek and the communities occupying lower slope positions within the drainage have remained relatively untouched by fire. Northwest aspects exhibit snags as the only striking evidence of the 1987 burn. The matrix is comprised of mid to late seral Douglas-fir, although canyon live oak, jeffrey pine, sugar pine and gray pine form small inclusions, notably on southeastern aspects. Scattered individuals of knobcone pine are also present on southeastern aspects within the upper-third of the Olsen drainage.

The Hyampom Earthflows characterize an area of undulating earthflow-mantled slopes. Vegetation is comprised of mixed conifer and Douglas-fir hardwood plant communities, with poison oak and graminoids in the understory. Ultramafic outcrops and numerous small meadow openings, including Grassy Flats, contribute to floristic diversity. The area is bounded on the North and East by Hayfork Creek, which supports an important anadromous fishery. Walker and Grassy Flat Creeks fall within the Analysis Area.

The Halfway Ridgelands are characterized by steep, highly dissected slopes. Big Canyon Creek is in this Analysis Area as is Hayfork Creek, an important anadromous fish stream. The relatively harsh, steep and rocky sites support Douglas-fir, ponderosa pine and mixed conifer plant communities.

The 1987 Burn area is located in the northwestern portion of the Lower Hayfork Creek watershed. Due to the fires and subsequent salvage activities, extensive plantations with patches of remnant, late and mid-seral Douglas-fir stands are present within the Bear and Gulch burns. Ultramafic soils within the Gulch burn support incense cedar, jeffrey and gray pine, and black oak. Within the lower half of the drainage, madrone, grey pine, buckbrush and manzanita dominate those areas experiencing stand replacement fires and now occupied by pine plantations. Within the upper half, canyon live oak is the dominant hardwood species. Grey pine and incense cedar occur patchily throughout the burns. Northwestern aspects generally experienced lighter burns, leaving most of the mid to late seral stands of mixed conifer and Douglas-fir in the Olsen Creek drainage relatively intact.

When viewed in 1944 and 1990 aerial photos, canopy closure within the Bear burn appears to have been little affected by the 1987 fire. This suggests that the area has either been relatively devoid of overstory cover historically, as is true for the harsher gray pine sites existing within the canyonlands, and/or that it was recovering from fire in the 1940s much as it is today.

The Jud-Rusch Area is characterized by the moderate to steep slopes surrounding the Jud and Rusch Creek drainages. Low gradient areas, including small ultramafic inclusions dominated by mixed conifer stands, occur at higher elevations within the upper end of the Rusch Creek drainage. The majority of the analysis area is dominated by late to mid-seral Douglas-fir and Douglas-fir canyon live oak communities, with numerous, widely dispersed harvest units and pine plantations scattered in between. Stringers of old growth Douglas-fir are present within the riparian zone up through mid-elevation reaches of the Jud and Rusch Creek drainages.

The Pattison Area is the largest of the analysis areas and is characterized by steep, highly dissected south-facing slopes and shallow, droughty metavolcanic soils. Extensive, undisturbed stands of Douglas-fir and canyon live oak are interspersed with pure hardwood stands on the upper slopes and ridgelines. Although these communities are doubtless maintained by fire, there is relatively little evidence that the area has burned within the last 100 years. Miner's Creek, West Fork Miner's Creek, and Bear Creek are the major drainages within the area. Because the Pattison Area has not been surveyed, little is known about the area botanically.

The Little Creek Area extends from Hayfork Bally south to Hayfork Creek. Approximately 60% of the analysis area burned in 1955, leaving a matrix of mid to late seral Douglas-fir and plantations. Road density in the area is relatively high.

Core Topics and Questions

Erosion Processes

- What erosion processes are the dominant within the watershed? Where have they occurred or are they likely to occur?

Mass Movement and Surface Erosion - Over the entire analysis area, mass wasting processes are the dominant erosion processes. These include translational-rotational landslides, debris slides, debris avalanches, debris torrents, internested translational-rotational slides, and slump earthflows. These mass wasting processes are most common at the valley inner gorges along the lower reaches of Hayfork Creek, and at the area south of Hayfork Creek between Hyampom and Halfway Ridge.

REGIONAL GEOLOGY AND GEOMORPHOLOGY

The Lower Hayfork Creek watershed is located within the Klamath Mountain geologic province. The Klamath Mountain geomorphic province is one of the more complex provinces in North America. It is a west-facing arcuate form region which extends from northwestern California into southwestern Oregon. It consists predominantly of marine volcanic arc-related volcanic and sedimentary rocks of Paleozoic and Mesozoic ages. Ultramafic and associated ophiolitic rocks are also important components. Granitic plutons intruded many parts of the province during Jurassic time. Structurally, the province consists of a series of north to northwest trending slices of tectonically acreted ancient crust that form an imbricate eastward dipping sequence.

The province has been subdivided into four major lithotectonic units that from east to west are called the Eastern Klamath belt, the Central Metamorphic belt, the Western Paleozoic and Triassic belt, and the Western Jurassic belt. The Lower Hayfork Creek Watershed lies within the Western Paleozoic and Triassic belt.

The regional geomorphology of the Klamath Mountains is also quite diverse. Geomorphic types which are actively occurring or occurred within the Pleistocene include glaciation, mass wasting, fluvial and tectonic processes including relatively rapid uplift and faulting.

During the Paleocene epoch (65-53 Million Years Before Present), the Klamath Mountains were sufficiently high to shed sediment to adjacent basins, and to block transport of sediment from the interior of the continent to the Pacific Coast. By the middle of the Eocene Epoch (45 MYBP), topography had been reduced by erosional processes to a relatively subdued landscape. This condition allowed rivers to cut across the province from the east, and transport sediment to the Pacific basins of Oregon and California. During the Oligocene Epoch (37-24 MYBP), rapid uplift occurred. During the Neogene Period (23-1.6 MYBP), much of the topographic relief was again reduced by erosion, creating a gentle landscape. From the middle of the Miocene to early Pleistocene Epochs (@4-5 MYBP), topographic relief in the Klamath Mountains was low. Rapid uplift began in the early to middle Pleistocene (1.6-1 MYBP), and has continued through the Holocene, elevating the Klamath Mountains to their present elevation.

The Klamath and Trinity Rivers once flowed across a landscape of low relief with broad valley floors and a meandering river system. It probably resembled a modern day low to moderate relief coastal plain. However, there is little conclusive evidence on how long ago, or how many times this condition existed. Regardless of the timing of uplift, the climate which coincided with the gentle landscape was probably humid. When the gentle landscape of the ancestral valleys of the major river systems flowing through or within the Klamath Mountains were rapidly uplifted, the rivers cut deeply into the valley floors. As downcutting progressed, erosional and depositional terraces were left stranded on valley walls hundreds to several thousands of feet above modern day river elevations. Early studies of the Klamath Mountains have suggested that a succession of erosional surfaces exist above the highest river gravels, with the oldest of these surfaces occupying the modern mountain crests. This surface has been referred to as the "Klamath Peneplain."

Mass wasting is the dominant geomorphic process which has operated within the Quaternary, in the Klamath Mountains. Primary processes include rotational and translational slides, debris slides, flows, including earthflows and debris flows, and complex mass wasting types including slump-earthflows, internested translational-rotational slides and valley inner gorges. Mass wasting features cover approximately 70 percent of the landscape. Many of the mass wasting features remain active or susceptible to activation as a consequence of inappropriate land management activities, intense seasonal storms, a series of wet weather years, and seismic events, acting individually, or in conjunction.

Glaciation was a significant geomorphic process during the Pleistocene. In general, glaciation occurred above an elevation of 6500 feet, with classic glacial features such as cirques, aretes and tarns eroded out of the landscape. Glacial moraines and outwash features were deposited at lower elevations. They are generally confined to elevations above 4,000 feet in elevation.

BEDROCK GEOLOGY

The Lower Hayfork Creek watershed lies entirely within the Western Paleozoic and Triassic Belt. The Western Paleozoic and Triassic belt is the most extensive of the concentric lithic belts. The southern part of the Western Paleozoic and Triassic belt has been divided into three parallel subunits called terranes. From east to west these are the North Fork, Hayfork, and Rattlesnake Creek terranes. The term "terrane" refers to an association of geologic features, such as stratigraphic formations, intrusive rocks, mineral deposits, and tectonic history, some or all of which lend a distinguishing character to a particular tract of rocks and which differ from those of an adjacent terrane.

Two terranes are exposed in the watershed; the Rattlesnake Creek terrane in the west and the Western Hayfork Terrane in the central and eastern portions of the watershed.

Rattlesnake Creek Terrane

The Rattlesnake Creek Terrane crops out for a length of 140 km and a width that ranges commonly between 10 to 15km. For most of its length it is bordered to the east by the Hayfork Terrane and to the west by the Galice Formation of the Western Jurassic Belt. The terrane consists of a wide variety of rocks, including abundant ultramafic rock, gabbro, diabase, pillow basalts, chert, various metamorphosed mafic volcanic rocks, granite, diorite, limestone, phyllite, sandstone, and conglomerate. Plutons of diorite are scattered throughout the terrane. The rocks are greatly disrupted by folding and faulting, and their original relations are further obscured by widespread slope failure and landsliding. Lithologies suggest that much of the terrane is a dismembered ophiolite. Intermixing of the various rocks indicates that the terrane is a melange. The Rattlesnake Creek Terrane is considered Early Jurassic in age (200 MYBP) (Wright, 1981).

A melange is characteristically composed of allochthonous blocks of widely ranging bedrock lithologies, ranging in size from a few acres to hundreds of acres, juxtaposed and separated from one another by highly sheared serpentinite. In a sense, these blocks are floating in this serpentinite matrix.

When mapping within melanges, a scheme has to be applied which not only identifies the boundaries of the large blocks, but also the boundary of the highly sheared melange zones containing only small blocks of lesser size. A block larger than 200 acres is considered a large block and is thus mapped as such, while areas containing smaller blocks are collectively mapped as small block melange.

Hayfork Terrane

The Hayfork Terrane is similar in extensiveness as the Rattlesnake Creek Terrane. It has been subdivided in this area by Irwin (1985b) into the Eastern Hayfork Subterrane and the Western Hayfork Subterrane. Only the western Subterrane is exposed in the watershed. Irwin (1985) has subdivided the Western Hayfork Subterrane into three units: The Chert and Argillite Unit, Hayfork Bally Meta-Andesite and the Ironside Mtn. Batholith. All are of Middle Jurassic age (170 MYBP). The Chert and Argillite Unit is not exposed in the watershed. The Hayfork Bally Meta-Andesite is exposed along Big Canyon Creek and Little Creek. It consists of layered mafic volcaniclastic rocks ranging from coarse-textured to fine-grained tuff. The Ironside Mtn. Batholith underlies the majority of the central and eastern portions of the watershed. It consists mainly of a medium-grained monzodiorite, but includes minor areas of quartz diorite, gabbro and pyroxenite.

The Hayfork Terrane is separated from the Rattlesnake Creek Terrane By the Salt Creek Fault, which is regional in nature.

Weaverville Formation

The Weaverville Formation is a superjacent formation, not related to the Klamath Mountain bedrock formations. It consists of generally weakly consolidated continental and estuarian sedimentary rocks which were deposited in the fault bounded Hayfork, Hyampom and Weaverville basins in the Miocene or Oligocene (37-20 MYBP). The sediments consist of sandstone, conglomerate and thinly laminated light-colored clay and tuff. Fossil plants are abundant in some beds and lignitic coal beds are locally present. The Weaverville Formation outcrops along the Hyampom road as you climb out of Hyampom and in the Olson Creek area.

GEOMORPHOLOGY

As previously described, the Klamath Mountains have been uplifted and eroded at least several times in their most recent history. There are many remnants of the old eroded surface throughout the Klamath Mountains. Lower Hayfork Creek watershed contains a canyon which has incised itself into the upland area, now serving to separate the uplands of Indian Valley from the uplands of Corral Bottom to the north. A small portion of the upland area lies within the upper portions of Jud and Rusch Creek watersheds.

In looking at the general geomorphology of the analysis area it is apparent that mass wasting features cover nearly 90 percent of the landscape. Fluvial and human-caused features cover the remaining portion of the watershed.

Mass Wasting Features

Each of the three major bedrock units has a characteristic mass wasting character, due to the difference in the lithologies of each unit. The following mass wasting features are well represented within the Lower Hayfork Creek Watershed.

Translational-Rotational Landslides

This type of slide is defined as one which moves as a coherent or semi-coherent mass along a concave (rotational) or planar (translational) failure plane. This type of slide is not restricted to the zone of weathering, but can have deeply lying failure planes.

Translational-rotational landslides are morphologically divisible into four parts: 1) the crown scarp which is the headward zone of detachment, (2) lateral scarps (the lateral zone of detachment) (3) slide bench (the relatively flat lying portion of the displaced slide mass) and (4) the toe zone (the steep area at the base of the slide mass which extends down to where the failure plane intersects or "daylights" the slope). The slide mass characteristically moves as a coherent body, and generally has relatively low movement rates. Movements generally occur in the winter and spring when moisture content is high.

Rotational slides occur primarily within both the Rattlesnake Creek Terrane and the Weaverville formation. Most slides occur in association with at least one of the following: serpentinized shear zones, faults, lithologic contacts and wet steep zones such as inner gorges.

Debris Slides and Debris Avalanches

These types of landslide generally is confined to the shallow soil or colluvium zone. The failure surface generally corresponds to the bedrock/soil interface and usually is no deeper than fifteen feet. There is a complete gradation from debris slide to debris avalanche depending on water content, cohesion of material and slope steepness. Generally, debris slides have slump blocks at their head, with the slide mass becoming more broken toward the foot of the slope. Movement rates are slow to moderate. Debris avalanches, however, commonly fail rapidly, with the slide mass liquefying in part as its mass moves down slope. Failures often occur within low-order stream reaches or adjacent to higher order stream channels. The preponderance of debris avalanches occur near the head of natural first order drainages (hollows) sometimes represented only by subtle inflection on the slope. Thusly, it is the more subtle features which can be the most hazardous. The scars characteristically are long and narrow in shape. Debris slides and avalanches generally occur in response to significant precipitation events.

These mass wasting features are extremely common within the Ironside Mtn. Batholith. They are the primary slope forming processes in the Pattison area.

Debris Torrents

Debris torrents are a type of debris flow common in low-order mountain channels. They are defined as a rapid movement of water-charged soil, rock and organic material down high gradient stream channels. They are generally initiated during extreme discharge events when a streamside debris avalanche enters a channel and entrains organic debris and sediment through scouring as it moves downstream. The torrent continues to flow and scour until it reaches a lower gradient stream reach or meets a significant obstruction. When its momentum is lost, the slide material is deposited within the channel. The torrent deposit is usually downcut and slowly winnowed of its fine-grained silt, sand, gravel and organic component which is transported further down channel. The coarser-grained cobbles, boulders, and organic material remain as a lag deposit within and along the channel. This material can stabilize, revegetate or be re-entrained by later torrents. Debris torrents have occurred within the past 20 years in the Jud Creek watershed.

Internested Translational-Rotational Slides

Internested translational-rotational slide areas are commonly found in areas overlain by cohesive soils. Typically they consist of individual slides having volumes ranging from 1,000 to 50,000 cubic yards which occur side by side, above, below and on top of one another over a broad area. Creep indicators such as "pistol-butted" and "jackstrawed" trees are commonplace. In the higher hazard types, springs and bogs occur.

Bedrock and structural properties such as downslope oriented bedding or foliation, shear and fault zones or melange areas are often responsible for the occurrence of widespread internested areas. Small block serpentine melange zones within the Rattlesnake Creek Terrane and the unconsolidated Weaverville Formation are most noted for these features.

Slump Earthflows

Slump earthflows are a complex mass wasting feature. They are comprised of various components which have varied processes at work. Slump earthflows generally have a well developed head scarp and lateral scarp which are generally steep and prone to debris slide or internested translational rotational slide processes. The slide mass itself is often highly complex in form and generally broken into many smaller blocks; separated from one another by secondary scarps. Commonly, there are sag ponds, wet areas and floating bedrock blocks on the slide mass. Finally, there is often a well defined toe zone at the lower portion of the slide which is often steep and hummocky. Generally, slump-earthflows are relatively slow moving masses of clay-rich materials. These failures are complex, involving many components of different types of mass movement. In general, earthflow movement occurs during the winter and spring where under fully saturated conditions pore water pressures are elevated and intergranular resistance is reduced. High clay content increases the cohesiveness of the material. Failure planes are generally deep (greater than 50 feet) with movement rates ranging from gradual to periodic pulses of rapid movement.

Sediment is usually transferred to the fluvial system near the distal end of the earthflow where channels have developed. Channel stability in the form of bank failure, active headcuts, and lateral gullies is common at the distal portion of most earthflows. Earthflow movement rates are sometimes rapid enough to cause channel abandonment and migration on an annual basis.

Slump-earthflows are well developed in the southwestern portion of the watershed. They are primarily located at the Lower portion of the Hayfork Canyon within serpentine melange terrane of the Rattlesnake Creek Terrane. Many extend from the ridgetop to the canyon bottom, encompassing thousands of acres.

Valley Inner Gorges

A valley inner gorge is defined as the slope adjacent to a streamcourse having a slope gradient greater than sixty-five percent which is separated from the upslope area by a pronounced break in slope. Valley inner gorges are formed through channel downcutting which produces an oversteepened slope which periodically fails through debris slides, avalanches or translational-rotational slides which "toe out" in the inner gorge. Active slides are commonly present in these areas.

Although inner gorges are found throughout the project area, proportionately, they are present within only a small percentage of the land area. Nevertheless, due to their location directly adjacent to stream channels, active slides within the inner gorge can contribute significant quantities of sediment directly to the fluvial system. The depth of the inner gorge can range from 25 up to 400 feet along the Hayfork Creek Canyon. Sideslopes vary from 60 to 110 percent.

GEOLOGIC HAZARDS

There are two types of Geologic Hazards present within the Analysis Area; Seismic hazards and slope stability hazards.

Slope Stability Hazards

Slope Stability Hazard, as defined by the U.S. Forest Service (Haskins and Chatoian, 1993) is the division of the land surface into areas and the relative ranking of these areas according to degrees of actual or potential natural hazard from landslides or other mass movement on slopes. Natural hazard means the probability of occurrence within a specified period of time, and within a given area of a potentially damaging phenomenon.

This type of hazard analysis considers the relative hazard of the landform component, such as the valley inner gorge, toe zone of a translational slide, debris slide prone slope and crown scarp, in conjunction with material characteristics, slope steepness, local groundwater conditions, and other local factors including seismicity and climate. Features are given a hazard rating on a scale of 1 to 10, with 1 being stable and 10 being extremely unstable. Slope stability hazards within a major portion of the project area are considered to range from none to highly unstable, according to the geologic and topographic conditions previously characterized.

The slope stability hazards for the Lower Hayfork Creek watershed were ascertained through photo-interpretation and mapping of all mass wasting features, use of existing bedrock mapping, and reconnaissance field study. Through studying the pattern and occurrence of past and present mass wasting, patterns emerged. Mass wasting in the Rattlesnake Creek is complex, due to its lithologic and structural diversity. However, it is apparent that large active slump-earthflows are developed within the serpentine melange within the Lower Hayfork Creek Canyon and within the upper portions of Jud Creek. Varied mass wasting processes are occurring within these complex features and movement varies from slow to rapid. Toe zones are extremely active, as are some axial zones. The majority of the large blocks within the terrane are relatively stable, exhibiting dormant mass wasting features, except where slope steepness exceeds 75 percent, where varied activity exists.

Debris slides and debris avalanches are the primary slope forming process within the Ironside Mtn Batholith. Within the Pattison area, the features are well expressed. Hazards range from moderate to extreme within the batholith, and can be strongly influenced by management activities since they rely heavily on root support for stability. Loss of root support due to management activities or mortality can contribute to debris avalanches being triggered by intense storm events.

The Hayfork Bally Meta-Andesite is not very prone to mass wasting. It appears to be modified by gradual colluvial flow and surface erosion.

The Weaverville Formation dominantly has internested rotational-translational slide activity, which varies from a moderate hazard to extreme, generally related to the presence or absence of groundwater.

Seismic Hazards

Seismic hazards for the Lower Hayfork Creek watershed are tectonically related to the subduction of the Pacific plate beneath the North American plate, and the northern-most extension of "San Andreas" right lateral slip. Relatively deep epicenters of seismic events have been located in the vicinity of the watershed which are related to plate subduction. Recent investigations have revealed that significant events have occurred, and that there remains a threat of large magnitude deep seated earthquakes. The Grogan fault lies 6 miles northwest of the mouth of the watershed. It is believed to be an active northern splay of the San Andreas Fault (Wallace, 1990). It trends north northwest, which is typical of faults in the Klamath and Coast ranges. In addition, the South Fork Mountain Fault, which separates the Coast Range from the Klamaths lies 1/2 mile west of the watershed. Although evidence is lacking for recent seismic activity on the fault, it parallels the Grogan Fault, so may be a more inland splay of "San Andreas" tectonics.

MINERAL RESOURCES

Mineral resources in the Lower Hayfork Creek watershed include gold, platinum group metals, chromite, manganese and coal. There has been no significant production of any of these commodities from the analysis area and surface disturbances resulting from mining related activities have been minimal. Placer deposits of gold and platinum group metals occur in Quaternary terrace and landslide deposits along Hayfork Creek and its tributaries. Presently, the only mining activity is for placer gold in the east half of the analysis area along Hayfork Creek, in deposits associated with the Hayfork Terrane.

There is a remote potential for additional small subeconomic podiform chromite deposits being identified in serpentine and serpentine melange units in the Rattlesnake Creek terrane within the area.

Manganese occurs as manganese coatings on chert surrounded by serpentine in the Rattlesnake Creek terrane. Five manganese prospects have been identified within the boundaries of the analysis area with no reported production coming from any of the sites. American Manganese No.1 and 2 claims in section 23 of T.3 N., R.7 E. reported a massive green chert containing 3% to 5% manganese stains with a unit thickness of 400 feet (121.9 meters), but this was considered too low grade to be of economic value as a manganese source. There is a moderate potential for additional small subeconomic manganese-bearing bedded chert deposits being identified in the melange units of the Rattlesnake Creek terrane within the analysis area.

Coal has been identified in the extreme western section of the analysis area near the community of Hyampom. It occurs as a deposit of lignite interbedded with shale and fine-grained sandstone in the Weaverville Formation. Although there are no records of production for this commodity, the area has been designated by the U.S. Bureau of Land Management as being "prospectively valuable" for coal although there is a low potential for development.

Soils formed from the metasedimentary and metavolcanic rocks of the Rattlesnake and the Western Hayfork Terranes are some of the major soils in the Pattison area, the Olsen Creek and Butter Creek Canyonlands, the Hyampom Earthflows, the 1987 Burn, Jud-Rusch Creek, and the Little Creek area from Hayfork Bally south to Hayfork Creek.

Moderately steep and steeply sloping sideslopes in these analysis areas have soils which are very gravelly. Soils with high gravel contents are classified as being skeletal soils. Skeletal soils in the Lower Hayfork Watershed analysis area include Kindig, Deadwood and Clover of the metasedimentary or metavolcanic parent materials, and Dubakella and Wietchpec of the serpentinitic derived soils. Skeletal soils with greater than 35 percent rock fragment component affects soil manageability in two basic ways: potential limiting factors associated with rock fragments themselves, and the reduction in fine soil volumes within the solum. Rarely does rock fragment type affect soil functions or limits in forest soils as does the serpentine content of Dubakella and Weitchpec, for instance. Perhaps the most common impacts might be their influence on bulk density and on heat transfer. Typically, rock fragments will increase the soils weight per unit area, or bulk densities. On the other hand, rock content has potentially significant affects on thermal transfer in soils, on how rapid, how deep, and for how long heat is held by soil. Thermal transfer increases progressively faster with increased rock fragment content, penetrates deeper into the soil profile, and holds heat longer. Although there are some benefits from these characteristics (such as earlier spring warming, allowing vegetation to exploit available soil water early in the growing season), the implications of these characteristics for management include reduced soil productivity and planting difficulties.

More significant are the influence rock fragments have on available water holding capacity and porosity of soil. Steinbrenner (1979) found the dominant effect of increased rock fragment content on forest soils was a reduction in fine soil volumes for the vegetation to exploit, leading to lower site index. This effect has potentially significant management ramifications with regard to seedling survival, appropriate species to be planted, nutrient and water supplies, and heat transfers (Childs, 1981). However, it appears that coarse textured soils will recover more quickly from compacted conditions than do fine textured soils (Earth Resource Note #6).

The main limitations for these soils are the seasonal wetness, steepness of slope and the hazard of erosion. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and can damage the roots of trees. Disturbance of the protective layer of duff can be reduced by the careful use of wheeled and tracked equipment. Steepness of slope limits the use of wheeled and tracked equipment in skidding. Cable yarding systems generally disturb the soil less. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

If seed trees are present, natural reforestation of cutover areas occurs infrequently. The high soil temperature and limited soil moisture during the growing season cause mortality of seedlings, especially on south and south-west facing slopes.

These soils are subject to debris flows, which are common in gravelly soils (more than 50% rock fragments) that are less than 60 inches deep and are underlain by an impermeable layer. Debris flows frequently occur along natural channels in steep forested areas and generally are triggered by high rainfall during intense storms in the winter. The extra weight of water from rainfall and the buoyant effect of sand grains generally reduce the ability of the soil to resist sliding, and gravity pulls the soil mass down slope. Internal stresses break the soil block up into a flowing mixture of rock, soil material, and organic debris. (Soil Survey of Mendocino County, Eastern Part, and Trinity County, Southwestern Part, California; USDA-SCS; p. 151, Jan., 1991)

The units that are most susceptible to debris flow are those that have slopes of more than 50 percent. Forest vegetation adds stability to steep slopes by anchoring the soil to bedrock with living root systems and by reducing the soil water content through transpiration. Revegetation of cuts on this soil is very difficult because of the large amount of the coarse fragments in the soil. Droughtiness of the surface layer reduces the survival rate of seedlings, especially on the southwest facing slopes. Care should be taken in forest regeneration, roadbuilding, and drainage design to reduce the occurrence of this type of slope failure. (Soil Survey of Mendocino County, Eastern Part, and Trinity County, Southwestern Part, California; USDA-SCS; p. 152, Jan., 1991)

The Deadwood soil is a shallow (<20 inches in depth) soil that tends to occupy gentle to very steep, convex surfaces on mountain sideslopes and headwall areas. They are generally associated with crown scarps of deep-seated mass wasting features. These soils have significant limitations in productivity related to low available water holding capacity, amount of coarse fragments in the profile, position on the landscape and available rooting depths. The Deadwood soil may also reflect an influence of adjacent serpentinitic derived soils.

Soils on gentler slopes tend to be finer textured, have less coarse-fragment content, reflect more weathering, and generally are more productive forest soils. The moderately deep (20 to 40 inches in depth) Marpa and Nuens soils occupy concave or convex positions on gently sloping to very steep hillslopes. They are often associated with the colluvial ridges and hillslopes in the uplands. These soils tend to be moderately productive due to coarse gravel contents in surface horizons, soil depth and droughthiness. The Marpa soil typically has finer textures, occurs on gentler surfaces, and has fewer limitations for management than the Neuns soil, but does not appear to be significantly more productive.

The serpentine melange bedrock intrusions in the Rattlesnake and Western Hayfork Terranes are rich in serpentine as well as small blocks of a variety of other lithologies. Soils derived from these rocks tend to be found on "softer" landscapes, yet are not limited to gently sloping areas. They often have less coarse fragment content in the surface horizons than those of metasedimentary or metavolcanic origins. Soils of this type include the deep (40 to 60 inches to bedrock) Dunsmuir soil, the moderately deep (20 to 40 inches) Dubakella and Weitchpec, and the shallow (10 to 20 inches) Grell. Nutrient imbalances significantly limit the vegetative communities that can occur on these soil types. The four soils all are of low to moderate productivity, and are limited by drouthiness.

The main limitations for these soils are the seasonal wetness, soil depth, very low AWC, and the low soil fertility because of the ratio of calcium to magnesium. Serpentine weathers into acidic soils that are high in magnesium, iron, and montmorillinitic clays and low in calcium, sodium, potassium and phosphorus. In particular, the uncommonly low ratio (about 1 to 50) between exchangeable calcium and magnesium (USDA-SCS, 1987a) places significant limits on soil productivity. Only specialized plants which have adapted to these conditions can populate these soils. Many of these populations are endemic to serpentine soils.

Soils derived from serpentine weathers to smectite clay which become weaker as they absorb large amounts of water. This causes the soil to slump in areas where the soils, commonly underlain by shattered bedrock, have been disturbed. (Soil Survey of Mendocino County, Eastern Part, and Trinity County, Southwestern Part, California; USDA-SCS; p. 151, Jan., 1991). These serpentine derived soils make up a large portion of the Lower Olsen analysis area, a moderate portion of the Grassy Flat Creek and Grassy Mountain areas, and are a minor inclusion in the West Middle Fork, Bear, Pattison, West Middle Rusch, and Rusch 2,3, and 4, analysis areas.

Soils formed in moderately to deeply decomposed granite and diorite intrusions in the Rattlesnake Terrane, the Western Hayfork Terrane, and the Iron Mountain Batholith are extremely erodible. These soils include the deep (greater than 60 inches) Holland, the moderately deep (40 to 60 inches) Chaix and Hotaw, and the shallow (10 to 20 inches) Chawanakee. These soils are found in large areas of the Pattison area, Jud-Rusch Creek, the Halfway Ridgelands area, and the south-west portion of Little Creek for Hayfork Bally south to Hayfork Creek.

Productivity for these soils range from the productive Holland and Chaix soils to the shallow unproductive Chawanakee. However, soils developed in decomposed granitic materials are among those with the highest erosion hazard ratings. (EHR) Textures in these soils are dominated by sand sized particles. They have very low clay and silt content. Typically they contain greater than 70 percent sand, with most of this being medium sand, coarse sand, or very coarse sand. These soils also contain varying but significant amounts of fine gravel. These sand and fine gravel particles are primarily individual mineral grains that result when the granitic rock decomposes.

When these single grained sandy soils without a litter layer are exposed to rainfall and runoff there is very little to hold them in place. The individual soil particles do not have to be detached from aggragetes an are easily transported by water. On the typically steep slopes even the very coarse sand and the fine gravel are easily eroded by raindrop impact or fast moving water. During storms it is easy to observe the movement of these particles carried in surface runoff. Downslope this runoff concentrates and may form large gullies. Within several days or weeks after the storm, the sand particles settle and roll down the slopes and cover any signs of sheet and rill erosion on the upper slopes. The gullies contribute large amounts of sediment to streams and remain clearly visible for years.

Without significant clay content to bind the sand particles together, these soils are generally single grained or only weakly aggregated. Surface erosion is removing material nearly as fast as it is being weathered, and consequently, soil development is slight. The main aggregating agent is organic matter. These soils can lose organic matter by disturbance or removal of the surface soil and forest litter layer, or by removal of vegetation which would have dropped needles, twigs, and leaves to sustain the litter layer. It has become apparent that the duff layer is the most important component of ground cover since it serves as a "sponge" to hold moisture and is actually the binding agent just below the soil surface. (Monitoring Erosion on Granitic Soils; J. Holcomb, S. Miles, J. Anderson, K. Lanspa, and C. Lukacic; p. 6.) Surface organic matter also buffers the weight of large machinery passing over the soil profile. Its removal imparts the compactive force directly to the soil. This allows greater increases in soil density with less compactive force. Other factors being equal, compaction risk is inversely related to soil organic matter content (Alexander and Poff, 1985).

Soils derived from granodiorite are some of the most sensitive soil types to ground-disturbing activities due to their coarse granular textures, droughthiness, non-cohesive nature and generally limited productivity. Granodiorite soils that are greatly disturbed by management activities such as timber yarding, road and skid trail construction, tractor piling, and broadcast burning may take decades to recover from the cycle of soil erosion that is initiated by these types of disturbance.

Within local subwatersheds, there are soils with a high to very high potential for surface soil erosion. These watersheds are the Jud Creek, Rusch Creek, Olsen Creek, Little Creek, and Bear Creek waterheds. Of these, Jud Creek, Rusch Creek, Olsen Creek, and Little Creek have soil mapping units with a high to very high potential for roadbed damage. These are the surface erosion processes of greatest concern. The vast majority of soils within the Lower Hayfork Watershed Analysis area have only a low to moderate potential for surface soil erosion at the organic horizons.

Transportation - The Lower Hayfork Creek area was accessed first with trails and later with roads for mining purposes. In more recent years, the need for access to timber reserves and private lands accelerated the development of the road system. With this expansion of the road network throughout the basin, nearly all drainages of Hayfork Creek, outside of the Pattison area, were entered and timber harvest conducted.

Hayfork Creek drainages were entered extensively for both the timber and mineral resources. Some early road building techniques were not to current standards, and road placement was sometimes poor, leading to road failures from mass wasting, which contributed sediment to streams. Today a majority of the problems have been corrected, but to the lack of road maintenance there remain isolated problem areas. The transportation system in the Lower Hayfork Creek Analysis Area is currently used extensively for recreation and resource management projects.

The 176 miles of road that lie within the Lower Hayfork Creek watershed are comprised of 124.27 miles of Forest Service, 20.41 miles of jeep roads, 21.67 miles of County and 9.96 miles of private roads.

The average road density is 2.31 miles per square mile for the entire watershed, and up to 7.24 miles per square mile in one of the subwatersheds. A list of all roads within each subwatershed and the road density for each of the subwatersheds are listed in Step 3.

The transportation system was surveyed for road surface. 62 percent of the system within the Lower Hayfork Creek watershed is native surfaced, nearly 36 percent has aggregate surface, and 1.7 percent is chip sealed.

Hydrology

- What are the dominant hydrologic characteristics and other notable hydrologic features and processes in the watershed?

Acreage for the entire watershed is 247,133 acres (386.2 square miles). The total area includes the Corral Creek and Salt Creek watersheds, and the entire drainage area of Middle Hayfork and Upper Hayfork Creek. There are 48,769 acres within the Lower Hayfork Watershed Analysis area.

CLIMATE

The Lower Hayfork Watershed Analysis area has a Mediterranean type climate with warm to hot summers; the winters are moderately wet. Average annual precipitation ranges from 40 inches at Hyampom to about 60 inches at the highest elevations. Elevations range from 1,250 feet at Hyampom to about 6,300 feet at Hayfork Bally (Forest LMP). Most of the annual rainfall occurs between October and April. Winter storms come in as cold or warm fronts and bring precipitation across a large area for days at a time. Most of the analysis area is in a transition zone between the rain zone and the snow zone. This transition zone is especially susceptible to rain-on-snow events.

CUMULATIVE WATERSHED EFFECTS

The Lower Hayfork Watershed Analysis area was divided into 24 subwatersheds. The following subwatersheds have a Threshold of Concern estimated to be 16%: Bear, Bear Creek, Confluence, Halfway, Headwaters Little, Headwaters Olsen, Headwaters Rusch, Lower Little, Lower Olsen, Pattison, Rusch1, Rusch2, Rusch3, Rusch4, West Fork Rusch, West Middle Rusch, and Lower Rusch. The following subwatersheds have a Threshold of Concern estimated to be 14%: Big Canyon, East Hyampom, East Middle Rusch, Grassy Flat Creek, Grassy Mountain, Jud, and East Jud. Threshold of Concern (TOC) is a measure of the sensitivity of a subwatershed to management activities and wildfires; it is based primarily on the geology, soil erodibility, and mass wasting processes within a subwatershed. It is standard within the methodology known as Equivalent Roaded Area (E.R.A.), which is used to quantify the cumulative impacts of management activities and wildfires on a subwatershed. Threshold of Concern is usually estimated to be between 12% and 18% for a given subwatershed.

The percent equivalent roaded area for the entire analysis area is estimated to be 4.9%, or less than 40% of a generalized Threshold of Concern of 16%.

Explanation on Cumulative Watershed Effects Assessment - Lower Hayfork Watershed Analysis

We performed a general assessment of the cumulative watershed effects for subwatersheds within the Lower Hayfork Creek Watershed using the following assumptions and methods:

- To evaluate cumulative watershed effects from past harvest activities, we compiled plantation acres for each subwatersheds. We used an average disturbance coefficient of 0.18 which was an estimate of what the coefficient would be based on harvest method, site prep intensity and recovery. Plantation acres were multiplied by 0.18 to generate harvest ERAs.
- Road lengths were measured by subwatershed and multiplied by an average with of 75 feet, then converted to road acres.
- Threshold of Concern values were assigned to each subwatershed based on our working knowledge of the relative sensitivities of each. TOC values ranged from 14 to 16 percent ERA.
- ERA values for each of the watersheds were calculated by adding the harvest ERAs to the road ERAs, and converted to percent ERA by dividing total ERA by acres in each subwatershed.
- Plantation percent was calculated by dividing the total acres of plantations by the total acres in the watershed. This is an indicator of potential changes in winter snow pack and rain on snow flood risk.
- Road density was calculated for each subwatershed. This is also an indicator of changes in peak runoff regime.

Modeling was performed to evaluate where, from a watershed management perspective, future ground disturbance activities could be best absorbed without contributing to cumulative watershed effects. This analysis used a management ceiling of 60 percent of the TOC for each subwatershed. This translates to 9.6 percent ERA for 16 percent TOC watersheds and 8.4 percent ERA for 14 percent ERA TOC watersheds. The rationale for this was that in the Forest Plan we define Condition Class I watersheds as those with management levels less than 40 percent TOC, condition Class II watersheds as those with management levels between 40 and 80 percent TOC, and Class III as those over 80 percent TOC. Sixty percent TOC seemed a reasonable number to use. Following discussion with various team members, we assumed that future harvest activities will be performed based on the following percentages by method: 25 percent tractor systems, 40 percent cable systems and 35 percent helicopter systems. An average coefficient of 0.18 was used, which included roading. Calculations were performed and the output was total acres which could be treated within each subwatershed without pushing the ERA level over 60 percent TOC.

This analysis is not meant to be used for precise scheduling of activities, it is only meant to be used as one indicator of where future activities can be proposed. NEPA analysis will be performed after projects are proposed, and a far more detailed cumulative watershed effects analysis will be performed.

Wtrshed	Acres	TOC	Plntn Acres	Road ERA	Road Miles	Sq. Miles	M/Sq mi	Veg ERA	Total ERA	% ERA	% Plntn	CAS Acres	Acres available for treatment 60% TOC	Acres available for treatment 40% TOC	% CAS Acres Treated
Bear	2948	16	117	6.91	0.76	4.61	0.16	21.06	27.97	0.95	3.97	452	1416.88	892.79	25.88
Bear Ck.	5680	16	39	56.18	6.18	8.87	0.7	7.02	63.20	1.11	0.69	1688	2678.21	1668.43	2.31
Big Canyon	1298	14	187	82.00	9.02	2.09	4.44	33.66	115.65	8.91	14.41	936	-36.82	-238.73	19.98
Confluence	174	16	0.4	15.00	1.65	0.27	6.11	0.072	15.07	8.66	0.23	22	9.07	-21.87	1.82
East Hyampom	3520	14	445	207.64	22.84	5.5	4.15	80.1	287.74	8.17	12.64	2319	44.13	-503.42	19.19
E. Middle Rusch	863	14	185	58.45	6.43	1.35	4.76	33.3	91.75	10.63	21.44	669	-107.01	-241.26	27.65
Grassy Flat Ck.	1660	14	167	72.27	7.95	2.59	3.07	30.06	102.33	6.16	10.06	1179	206.15	-52.07	14.16
Grassy Mtn.	1619	14	237	81.00	8.91	2.53	3.52	42.66	123.66	7.64	14.64	1204	68.53	-183.31	19.68
Halfway	2427	16	226	133.09	14.64	3.79	3.86	40.68	173.77	7.16	9.31	1588	329.01	-102.46	14.23
Headwaters Little	1005	16	125	50.91	5.6	1.57	3.57	22.5	73.41	7.30	12.44	472	128.17	-50.49	26.48
Headwaters Olsen	2138	16	460	106.64	11.73	3.34	3.51	82.8	189.44	8.86	21.52	1402	87.84	-292.25	32.81
Headwaters Rusch	437	16	99	30.36	3.34	0.68	4.91	17.82	48.18	11.03	22.65	340	-34.62	-112.31	29.12
Lower Little	4804	16	591	168.36	18.52	7.51	2.47	106.38	274.74	5.72	12.30	3187	1035.78	181.74	18.54
Lower Olsen	2032	16	545	123.55	13.59	3.17	4.29	98.1	221.65	10.91	26.82	1310	-147.63	-508.87	41.60
Pattison	12017	16	52	81.27	8.94	18.78	0.48	9.36	90.63	0.75	0.43				
Rusch 1	382	16	40	7.45	0.82	0.6	1.37	7.2	14.65	3.84	10.47	297	122.32	54.41	13.47
Rusch 2	350	16	20	14.45	1.59	0.55	2.89	3.6	18.05	5.16	5.71	229	86.36	24.14	8.73
Rusch 3	181	16	41	10.91	1.2	0.28	4.29	7.38	18.29	10.10	22.65	136	-5.07	-37.25	30.15
Rusch 4	377	16	64	38.82	4.27	0.59	7.24	11.52	50.34	13.35	16.98	308	-78.59	-145.61	20.78
West Fk. Rusch	385	16	101	26.45	2.91	0.6	4.85	18.18	44.63	11.59	26.23	319	-42.64	-111.08	31.66
W. Middle Rusch	942	16	133	71.82	7.9	1.47	5.37	23.94	95.76	10.17	14.12	674	-29.59	-197.06	19.73
Jud	1705	14	218	100.64	11.07	2.67	4.16	39.24	139.88	8.20	12.79	1226	18.58	-246.65	17.78
East Jud	552	14	58	33.09	3.64	0.86	4.21	10.44	43.53	7.89	10.51	375	15.76	-70.11	15.47
Lower Rusch	1319	16	38	25.91	2.85	2.06	1.38	6.84	32.75	2.48	2.88	870	521.63	287.04	4.37
			4188.4										6286.35	-442.16	

STREAMFLOW

Hayfork Creek near Hyampom

Some of the dominant hydrologic characteristics discussed in Step 1 are for the entire Hayfork Creek Watershed; they can be inserted into a Basin Analysis. The raw data presented is primarily from a discontinued (1953 to 1974) stream gaging station at Hayfork Creek near Hyampom. The watershed upstream of this station contains 378 square miles.

The maximum flood flows for Hayfork Creek near Hyampom are calculated to be 29,400 cubic feet per second (cfs) on January 16, 1974. The highest daily mean discharges usually occurred in January with peaks as high as 24,100 cubic feet per second (cfs) and as low as 1,940 cfs recorded. The annual maximum peak flow for most years ranges between 4,000 and 8,000 cfs. The highest peak flows of the year usually occur between December 1 and the end of February. These are usually in response to either higher intensity rain storms, or rain-on-snow events. High peak flows of lesser magnitude can occur between March and April.

The average streamflow is 548 cfs, or an average of 397,000 acre-feet per year. Average water yield is 1.45 cfs per square mile of watershed, or 1,050.3 acre-feet per year per square mile of watershed.

Base flows consistently begin on about August 1, and usually return to higher flows between September 15 and October 15 of each year. The lowest flows occurred most commonly in September. Over the 20 years of records, streamflows in September have ranged from 16 to 39 cfs. Base flows range from about 60 cfs to the lowest minimum streamfow, which is estimated at 7 cfs (late August, 1977). This data does not account for water diversions upstream of the discontinued stream gaging station.

Hayfork Creek near Hayfork

A second stream gaging station at Hayfork Creek near Hayfork was also a source of data for some of the dominant hydrologic characteristics discussed in this step. The station is located upstream of the Lower Hayfork Watershed Analysis area, and is 5.8 miles southeast of Hayfork. It is no longer maintained as a continuous-record station (1956 to 1965). The station number is 115284. The watershed upstream of this station contains 86.7 square miles.

The maximum flood flows for Hayfork Creek near Hayfork are calculated to be 7,500 cfs on December 22, 1964. Peak flow patterns are similar to what occurs downstream, but with cresting at an earlier time for most peak flows. The average streamflow is 117 cfs, for an average water yield of 84,700 acre-feet per year. Water yield per square mile of watershed is calculated to be 1.35 cfs/square mile, or 977 acre-feet/yar/square mile.

At this gaging station, base flows begin on about July 1 of each year and extend to about October 15. Baseflow values range from about 25 cfs (on about July 1) to about 1.5 cfs (in September or October). This is data without any water diversions upstream.

Other Hayfork Creek Data

Flow measurements recorded in 1995 represent the only other quantifiable flow data available for Hayfork Creek (Natural Resource Conservation Service, unpublished data). These measurements were recorded on four different dates at the Mercill Bridge. Flows of 76.0, 21.5, 12.3, and 18.0 cfs were recorded on July 11, August 10, September 9, and November 1 respectively. Anecdotal information regarding lower Hayfork Creek includes 1988 flow estimates of 4 cfs at the 9 mile bridge and 6 cfs above the confluence with the South Fork Trinity at 6 cfs as well as the 1994 observation that Hayfork Creek was flowing intermittently in September of that year (Kearney, 1994).

South Fork Trinity River Gaging Stations

There are records for three other stream gaging stations, all at the South Fork Trinity River. The only station that is still kept as a continuous-record station is below Hyampom, 3.5 miles downstream of Hayfork Creek. The area drained contains 764 square miles. 386 square miles are within the Hayfork Creek Watershed; the remaining 378 square miles are in other tributary subwatersheds and slopes draining directly into the South Fork Trinity River. The station number is 11528700. The other stations were at Forest Glen and near Hyampom. The station number for the station at Forest Glen is 115281. The station number for the station near Hyampom is 115282; this station was located upstream of Hayfork Creek.

The average streamflow for the South Fork station below Hyampom is 1,375 cfs or an average of 1.80 cfs/square mile of watershed. In comparison, at the other two South Fork stations, the average cfs/square mile of watershed is greater.

Springs, Seeps, and Wetlands

There are a number of springs, seeps, and wetlands less than an acre in size within the Lower Hayfork Watershed Analysis area. These appear to be most concentrated south of Hayfork Creek from its mouth to Halfway Ridge.

There are 21 known wetland sites within the analysis area. Nine of these wetlands are south of Hayfork Creek and between its mouth and Halfway Ridge. Two sites are in the Olsen Creek Watershed; two sites are in the Bear Creek Watershed. Two sites are west of Miners Creek. There is no data available for the remaining 6 sites. Only three of these sites are registered as being more than an acre in size: one at the Olsen Creek Watershed and two adjacent to the Indian Valley (10) Road.

VEGETATION

- What is the array and landscape pattern of plant communities and seral stages in the watershed? What processes causes these patterns?

Terrestrial Vegetation

Existing vegetation conditions within the Lower Hayfork watershed have been primarily identified using available resources including 1990 LMP timber stratum, EUI data from the Thompson Peak and Butter Creek surveys, 1990 aerial photographs, 1993 Wetland Inventory of the Trinity River Basin Restoration Program and field visits.

The most abundant and connected vegetation type of the watershed is Douglas-fir. The Douglas-fir type occupies 70 percent of the watershed in early to late seral stages. Composition of the Douglas-fir plant associations include moist Douglas-fir, mesic Douglas-fir and dry Douglas-fir. The moist Douglas-fir type characterized by Douglas-fir-bigleaf maple (*Acer macrophyllum*) is found consistently in the lower reaches of several of the major tributaries, including Grassy Flats Creek and Big Canyon Creek. The mesic Douglas-fir series characterized by Douglas-fir -canyon live oak (*Quercus chrysolepis*) occur on shallow, metavolcanic soils on steep, south and south westerly aspects. Douglas-fir-canyon live oak forests are found extensively in the Pattison roadless area where it has been historically maintained by fire and to lesser degrees in the remainder of the watershed. The dry Douglas-fir series, characterized by white oak occur in the Canyonlands, Hyampom Earthflows and Halfway Ridgelands on lower hillslopes surrounding Fir Root Springs and the Walker Creek drainage. Other hardwoods that can occur in these Douglas-fir hardwood types are black oak (*Quercus kelloggii*), madrone (*Arbutus menzeisii*) and giant chinquapin (*Castanopsis chrysophylla*).

Mixed Conifer is the second most abundant vegetation type found in the watershed. Common components of mixed conifer include Douglas-fir, white fir, ponderosa pine, sugar pine (*Pinus lambertiana*) and incense cedar (*Calocedrus decurrens*). Mixed conifer can be subdivided into mixed conifer/riparian and mesic, mixed conifer/dry and mixed conifer-canyon live oak. The mixed conifer/riparian-mesic type is found in the Canyonlands, Hyampom Earthflows and Halfway Ridgelands along tributaries forming the headwaters of Big Canyon Creek and are most common on east and north slopes. The mixed conifer dry associations are relatively uncommon and occur in the Canyonlands, Hyampom Earthflows and Halfway Ridgelands on west and south slopes of low productivity.

White fir is found above 2800 feet elevation and occur as dense stands with little understory. A moist white fir type is associated with stream courses such as the headwaters near Grassy Flats Creek. Moister white fir types have huckleberry oak as an indicator species and are found on northwest slopes. The mesic white fir type is found between 3000 and 4000 feet elevation with giant chinquapin as a common hardwood component. White fir types are located in Hyampom Earthflows and Little Creek with relict stands occurring on Hayfork Bally.

Jeffrey pine dominates in areas with ultramafic soil and serpentine outcrops. These areas occur in Hyampom Earthflows, 1987 Burned and Jud-Rusch. Jeffrey pine stands may also include small amounts of ponderosa pine, Douglas-fir, incense cedar, sugar pine and gray pine.

Gray pine represents some of the least productive and most environmentally sensitive sites in the watershed. Small patches of gray pine are found in the Canyonlands, Olsen Creek, 1987 Burned and Pattison roadless areas. Canyon live oak is characteristically an abundant component in gray pine stands.

Non-forested sites include shrub dominated and herb dominated areas. The shrub dominated sites are common in Canyonlands, Olsen Creek, Pattison roadless and Little Creek. A large extensive shrub field occurs on the upper, southern slope of Hayfork Bally and is likely maintained by frequent fire. The herb dominated community occurs as small meadows throughout the watershed. Grassy Flats is an example of a larger stringer type meadow, comprising about 2% of Hyampom earthflows analysis area.

Wetland and Riparian Vegetation

The Trinity River Basin Restoration Program 1993 Wetland Inventory (Bardolf, 1193) conducted on the Hayfork Ranger District, identified 21 wetland sites within the Lower Hayfork watershed and described 15 of those sites. The wetland sites consisted primarily of permanently and semi-permanently flooded, palustrine emergent meadows dominated by sedges (*Carex* spp.) and willows (*Salix* spp.). Meadow areas ranged from 3000 square feet to 80,000 square feet and totaled approximately 9.3 acres.

Channel verification work in conjunction with the 1994 aquatic EUI (USDA Forest Service) described the riparian plant communities. Riparian communities range from white

alder/Indian rhubarb-sedge (*Alnus rhombifolia*/*Darmera peltata*-*Carex nudata*) along much of Hayfork Creek, to pacific yew (*Taxus brevifolia*), bigleaf maple and white alder with California hazel (*Corylus cornuta* var. *californica*), dogwood (*Cornus sessilis*) and/or spikenard (*Aralia californica*) in the constrained, higher order tributaries, to bigleaf maple and/or California hazel in some drier first and second order channels.

Natural Disturbance Regimes

Fire is an important natural disturbance agent in the Lower Hayfork watershed. Fire has a significant affect on the structure and function of forested ecosystems. Recurring fire disturbance on the landscape is described by fire regimes that describe the frequency, intensity and severity of fire and its biological impacts. Initial data samples of a fire history study collected by PSW and Pennsylvania State University in 1995, identify the majority of the watershed (prior to organized fire suppression) having evolved through a frequent low-intensity fire regime. Fire return intervals from five to ten years were the norm prior to organized fire suppression.

Plant Species of Concern Known to Occur in the Lower Hayfork Creek Watershed

Plant species of concern known to occur in the Lower Hayfork Creek Watershed fall into four categories: 1) sensitive plants, 2) vascular plant old-growth associates (survey and manage species), 3) watch list plants, and 4) noxious weeds and other exotic pest plants.

Sensitive plants are those which are considered candidates for listing under the Endangered Species Act of 1973 and that are known or highly suspected to occur on National Forest System lands. Two Region 5 Forest Service listed sensitive plants, Niles' madia (*Madia doris-nilesiae*) and Canyon Creek stonecrop (*Sedum paradisum*) are known to occur in the Lower Hayfork Creek watershed.

There are two known occurrences of Niles' madia within the watershed. The first is located near Grassy Flats in Hyampom Earth Flows Analysis Area (D) and covers approximately ten acres with individual plants estimated at over 1000 in 1994. The second occurrence is located on along County Route 301 bordering the Jud-Rusch Creek (G) and Pattison (H) Analysis Areas and is less than 1/4 acre with individual plants estimated at 250 in 1995.

Approximately 25 occurrences total are known for Niles' madia which is only known from the Shasta-Trinity National Forest in Shasta, Tehama, and Trinity Counties. This annual herb is typically found on rocky to gravelly serpentine slopes and openings in association with gray pine or Jeffrey pine and chaparral at elevations ranging from 2100 to 5200 feet. The one notable deviation from this habitat type is seen in the occurrence along County Road 301 in Analysis Area G/H. This occurrence is on diorite soils and with vegetation typical of openings in mixed conifer/oak forest.

There is at least one and possibly four occurrences of Canyon Creek stonecrop in the watershed. Species distinction has not yet been positively determined for three of the occurrences due to lack of flowering parts at the time of discovery. The one confirmed occurrence is on Hayfork Bally near the lookout in the Little Creek Analysis Area (I) and is approximately 2 acres in size with an estimated 200 individuals. Unsurveyed habitat is present in the area and is likely to support additional individuals. The three unconfirmed occurrences are in the Little Creek (I), Pattison (H) and Jud-Rusch Creek (G) Analysis Areas and are all less than 1/2 acre with approximately 10 to 50 individuals each.

Canyon Creek stonecrop is a succulent perennial herb found on rock outcrops, gravelly slopes, and scree from 960 to 6500 feet in elevation. All but two of the eleven known occurrences (including the three unconfirmed) are on the Shasta-Trinity National Forest in Trinity County. The other two occurrences are in Shasta County north of Whiskeytown Lake and in Trinity County on the Six Rivers National Forest at Gray Falls. One occurrence along the boundary of the Shasta-Trinity and Six Rivers National Forests was reported to have been extirpated, a casualty of extended drought.

Suitable habitat for these two sensitive species has not been thoroughly surveyed for in the Lower Hayfork Creek Watershed. Additional sites are likely to be present.

One vascular plant old-growth associate, mountain lady's slipper (*Cypripedium montanum*), occurs in the Jud-Rusch Creek Analysis Area (G). This plant is included on a list of species to be protected through survey and management standards and guidelines in the Shasta-Trinity National Forests Land and Resource Management Plan (LMP), Appendix R (USDA Forest Service, 1995). Known sites of survey and manage species must be protected from project impacts. Project level surveys for this and other survey and manage species must be done for all projects to be implemented in 1999 or after. Therefore, projects resulting from this watershed analysis are likely to need surveys for survey and manage species in order to comply with LMP Standards and Guidelines.

Mountain lady's slipper, a showy orchid, is widespread but infrequent throughout its range from Southern Alaska down through western Canada and the western United States at elevations from

656 to 6561 feet. It occurs within a rather broad spectrum of habitats over its range from moist sites near riparian areas to dry hillsides. Specific moisture and temperature regimes may be less critical than the presence of symbiotic fungi. Although sites over the entire range may vary, they are consistent locally. Known sites on the Shasta-Trinity National Forest are relatively moist and shady, frequently north-facing, and with overstory tree cover mostly ranging from 80 to 100%. Topographic positions range from ridgelines and benches to alluvial bottom land and riparian areas. The known site within the Lower Hayfork Creek Watershed is on a north-facing spur ridge and is more or less dry but may be seasonally moist. One individual was found at the site. All but one of the sixteen known occurrences of mountain lady's slipper on the Shasta-Trinity National Forest occur in Trinity County.

One "watch list" plant, Tracy's lomatium (*Lomatium tracyi*), occurs in the watershed. Watch list plants are those on List 4 of the California Native Plant Society's (CNPS) Inventory of Rare and Endangered Vascular Plants of California (1994). They are defined as "of limited distribution or infrequent throughout a broader area in California, and their vulnerability or susceptibility appears low at this time". While they cannot be called "rare" from a statewide perspective, they are uncommon enough that their status should be monitored regularly. Should their status change, they will be moved to a more appropriate list. A few of these plants are on the Shasta-Trinity National Forests Sensitive and Endemic Plant List but most are not.

The one known occurrence of Tracy's lomatium in the watershed, in the Olsen Analysis Area (C2), was reported by an individual not employed with the Forest Service. No population data was included in the report and the location was approximate. Suitable habitat for Tracy's lomatium is open pine forests on serpentine soils from 1600-5000 feet. This perennial herb is found in the Cascade, Klamath, and northern North Coast Ranges from Tehama County through Humboldt and Siskiyou Counties and into Oregon. The Oregon Natural Heritage Program lists this plant as "rare, threatened, or endangered in Oregon but more common elsewhere".

Noxious weeds and exotic pest plants of concern in the Lower Hayfork Creek Watershed include yellow star thistle (*Centaurea solstitialis*), bull thistle (*Cirsium vulgare*) and cheat grass (*Bromus tectorum*). These plants tend to be found in disturbed areas, generally along roads, on landings, and in plantations. Star thistle is particularly invasive in pastures.

Species of Concern Suspected to Occur in the Lower Hayfork Creek Watershed

Plant species of concern suspected to occur in the Lower Hayfork Creek Watershed include those found in nearby or adjacent areas for which potential habitat exists in the watershed. This group includes sensitive and endemic plants, vascular plant old-growth associates (survey and manage species), watch list plants (includes all plants listed for Trinity County with potential habitat in the watershed), CNPS List 2 plants, and noxious weeds. Endemic plants are those that occur only on or mostly on the Shasta-Trinity National Forests. The endemic plants currently listed by the Shasta-Trinity National Forests are also CNPS List 4 (watch list) plants. Management for endemic plants is the same as for sensitive plants. No federally-listed threatened or endangered plants or state-listed plants are suspected to occur in the watershed.

Those plants known to occur within ten miles of the Lower Hayfork Creek Watershed are indicated by an asterisk (*).

Sensitive, Endemic Plants

- *Eriogonum libertini**, Dubakella Mountain buckwheat (endemic); serpentine endemic.
- *Lewisia cotyledon* var. *heckneri**, Heckner's lewisia (sensitive), rock outcrops.
- *Lewisia cotyledon* var. *howellii**, Howells's lewisia (sensitive), rock outcrops.
- *Sedum laxum* ssp. *flavidum**, pale yellow stonecrop (sensitive); rock outcrops.

Vascular Plant Old-growth Associates (Survey and Manage)

- *Allotropa virgata*, sugar stick; dry soils with abundant course woody debris.
- *Cypripedium fasciculatum*, clustered lady's slipper*; dry or damp, rocky to loamy sites, 60-100% shade.

Watch List Plants

- *Allium hoffmanii**, Beegum onion; serpentine endemic.
- *Allium siskiyouense**, Siskiyou onion; rocky slopes including serpentine.
- *Arabis modesta*, modest rock cress; deep soil on steep slopes, cliffs, shaded canyon ledges (Note: As of 1983, all Shasta-Trinity National Forests populations were redetermined to be *A. breweri*).
- *Arabis oregana**, Oregon rock cress; rocky hillsides, steep banks, north-facing slopes, often on serpentine.
- *Arabis rigidissima*, var. *rigidissima*, "Trinity Mtns. rock cress; open gravelly or rocky soil.
- *Arnica spathulata*, Klamath arnica; open, dry disturbed oak/conifer woodland generally on serpentine.
- *Asclepias solanoana**, serpentine milkweed; serpentine barrens to open forest on serpentine soils.
- *Astragalus rattanii* var. *rattanii*, Rattan's milk-vetch; gravelly stream banks, river banks, or sandbars.
- *Balsamorhiza sericea*, silky balsamroot; dry slopes and valleys, lower coniferous forest, often on serpentine.
- *Calyptridium quadripetalum*, four-petaled pussypaws; chaparral, sandy or gravelly, usually serpentine soils.
- *Carex gigas*, Siskiyou sedge; forests, wet meadows, serpentine seeps.
- *Clarkia borealis* ssp. *borealis*; northern clarkia; chaparral, forest margin, foothill woodland.
- *Collomia tracyi**, Tracy's collomia; rocky, gravelly, or sandy areas
- *Cypripedium californicum*, California lady's slipper; seeps, stream banks, and moist slopes in mixed evergreen and coniferous forest, usually on serpentine.
- *Darlingtonia californica*, California pitcherplant; seeps, boggy places with running water, generally on serpentine.
- *Epilobium septentrionale*, Humboldt County fuchsia; dry, sandy or rocky ledges.
- *Erigeron cervinus*, Siskiyou daisy; open, rocky slopes, meadows, pine to fir woods.
- *Erigeron petrophilus* var. *viscidulus*, Klamath daisy; chaparral, meadows, rocky foothills to montane forest, sometimes on serpentine.
- *Eriogonum congdonii*, Congdon's buckwheat; serpentine outcrops.

- *Eriogonum strictum* var. *greenei*, Greene's buckwheat; rocky serpentine slopes and ridges.
- *Erythronium citrinum* var. *citrinum**, lemon colored fawn lily; chaparral, woods, usually on serpentine.
- *Fritillaria purdyi*, Purdy's fritillary; dry ridges, chaparral, valley and foothill grasslands, generally on serpentine.
- *Hackelia amethystina*, amethyst stickseed; meadows, forest clearings, stream banks, roadsides.
- *Helianthus exilis**, serpentine sunflower; grassy areas, serpentine seeps chaparral, woodland.
- *Lilium rubescens**, redwood lily; chaparral, gaps in conifer forest
- *Lilium washingtonianum* ssp. *purpurascens*, purple-flowered Washington lily; dry areas in brush or open conifer forest, often on serpentine, also on granitic, or loamy soils.
- *Lomatium engelmannii*, Engelmann's lomatium; serpentine slopes in conifer forest.
- *Lupinus croceus* var. *pilosellus*, saffron-flowered lupine; rocky, dry places.
- *Lupinus lapidicola*, Mt. Eddy lupine; dry granite gravel or serpentine within conifer forest.
- *Lupinus tracyi*, tracy's lupine; dry, open montane forest.
- *Marsilea oligospora*, Nelson's pepperwort; muddy places in creek beds, flood basins, vernal pools.
- *Oenothera wolfii*, Wolf's evening-primrose; roadsides, generally moist, sandy places within lower coniferous forest.
- *Penstemon purpusii*, Snow Mountain beardtongue; rocky areas, open slopes within conifer forest, often on serpentine.
- *Piperia candida*, white-flowered rein orchid; open to shaded sites, generally in conifer forest, sometimes on serpentine.
- *Poa rhizomata*, timber bluegrass; shady, moist soils in lower coniferous forest in rich, loose soils over granitics and serpentine.
- *Sanicula tracyi*, Tracy's sanicle; openings in conifer forest, woodlands.
- *Sedum laxum* ssp. *heckneri*, Heckner's stonecrop; serpentine or gabbro rock outcrops.
- *Senecio clevelandii* var. *clevelandii*, Cleveland's ragwort; drying serpentine soils, especially among shrubs.
- *Streptanthus drepanoides*, sickle-fruit jewel flower; open chaparral or Jeffrey pine woodland on serpentine.
- *Tauschia glauca*, glaucous tauschia; gravelly, often serpentine flats in conifer forest.
- *Thelypodium brachycarpum*, short-podded thelypodium; alkaline soils, adobe flats, pond margins, alluvial clays of river plains and lake basins, sometimes on serpentine.
- *Thermopsis gracilis* (=*T. macrophylla* var. *venosa*), slender false lupine; open, generally dry sites, meadows, conifer forest, disturbed woodlands.
- *Triteleia crocea* var. *crocea**, yellow triteleia; open conifer forest and dry slopes, serpentine or granitic soils.
- *Triteleia crocea* var. *modesta*, Trinity Mtns. triteleia; open conifer forest and dry slopes on serpentine soils.
- *Veratrum insolitum*, Siskiyou false-hellebore, chaparral, openings in thickets and lower coniferous forest on red clay soils.

- *Wyethia longicaulis**, Humboldt County wyethia; grasslands, open woodlands to lower coniferous forest.

CNPS List 2 Plants

These plants are on List 2 of the CNPS Inventory--plants rare, threatened, or endangered in California but more common elsewhere.

- *Carex hystricina*, bottlebrush sedge; wet places, streambanks.
- *Carex leptalea*, flaccid sedge; wet meadows, swamps.
- *Carex vulpinoidea*, fox sedge; wet places.
- *Juncus dudleyi*, Dudley's rush; wet areas in conifer forest.
- *Juncus regelii*, Regel's rush; mountain meadows.

Noxious Weeds

These are state-listed A Rated plants--those required to be eradicated or kept in controlled areas.

- *Centaurea diffusa*, diffuse knapweed*; fields, roadsides, <2300 meters in elevation. Closest occurrence is on South Fork Mountain.
- *Centaurea maculosa*, spotted knapweed*; disturbed areas, <2000 meters in elevation. Closest occurrences are in Hayfork near Big Creek Road and on South Fork Mountain.
- *Linaria genistifolia* ssp. *dalmatica**, Dalmatian toadflax; disturbed places, pastures, fields, generally <1000 meters. Closest occurrence is between Hayfork and Hayfork Summit along Summit Creek Road (County Road 329).

Distribution and Character of Habitat for Plant Species of Concern

The habitat types for plant species of concern in the Lower Hayfork Creek watershed are 1) ultramafic ("serpentine") soils and outcrops, 2) rock outcrops, gravelly slopes, and scree 3) Closed-canopy and old-growth forest. Habitat types for suspected species of concern that are different from the above include wet areas, gravelly areas, forest/woodland openings, meadows, grasslands, roadsides, alkaline soils, disturbed sites, and granitic soils.

Ultramafic (often referred to as serpentine) substrates are abundant in the southern and western portion of the watershed. These areas occur as isolated patches in a larger matrix of more common substrates. Open, sparse, or nearly barren vegetative cover is typical on soils derived from ultramafic substrates. Factors limiting plant growth are thought to include low soil fertility, a calcium/magnesium imbalance, possible toxicity from heavy metals, and a harsh environment due to the often residual nature of ultramafics (rocky, steep, with unstable talus) combined with high heat resulting from lack of vegetation. Plants that have adapted to these unfavorable conditions and are found exclusively (or almost exclusively) on ultramafic soils or outcrops are commonly referred to as "serpentine endemics". Although they can grow on non-serpentine soils, they are unable to maintain themselves in the more rigorous competition of non-serpentine communities (Kruckeberg 1954, 1984). This effectively restricts them to the small and discontinuous geographic areas where ultramafics are present. Ultramafic substrates in the Lower Hayfork Creek Watershed are concentrated in the Jud Rusch Creek (G), Hyampom Earthflows

(D), Olsen (C2), and 1987 Burned (F1) Analysis Areas. There are also two patches in the extreme southwest portion of the Pattison (H) Analysis Area bordering Hayfork Creek.

Rock outcrops are mapped on Hayfork Bally; and along the north side of Hayfork Creek near James Creek and the southern portions of Olsen/1987 Burned Analysis Areas. There are undoubtedly many other outcrops as well as gravelly slopes and scree in the watershed that are not mapped or detectable on aerial photographs. Many of these are noted in the soil survey inventory as inclusions within described soil families. Most of the outcrops in the watershed are of metamorphic or ultramafic rock types.

Closed canopy and old-growth forest habitat (greater than 60% canopy cover) is found throughout the watershed. It is currently unclear why much of the suitable habitat is not occupied by mountain lady's slipper, the old-growth associated species of concern in the watershed. Biological requirements may play more of a role in limiting this species than habitat. Fire is also thought to be important in maintaining the species.

Wet areas, gravelly areas, forest/woodland openings, roadsides, and disturbed sites are present throughout the watershed. Meadows and grasslands are mostly located on private lands within the watershed with the exception is Grassy Flats in the Hyampom Earth Flows (D) Analysis Area. Granitic soils are mapped in the Little Creek (I), Halfway Ridgelands (E), northwestern Jud Rusch Creek (G), and southeastern Pattison (H) Analysis areas. No alkaline soils other than ultramafics are mapped within the watershed.

The Lower Hayfork Creek Watershed and the ecosystems within have evolved in response to disturbance-recovery regimes that have recurred over millions of years. Disturbances often occur as a normal and essential part of ecosystem dynamics and are not always catastrophic events that cause damage. Disturbance type includes but is not limited to fire, wind, ice and freeze damage, water, landslides, insect and disease outbreaks, and those human caused (White and Pickett, 1985). Historically, fire has been the major disturbance factor within the watershed. The scale of a disturbance has a major effect on the composition of vegetation species and associated animal species. Recurrence of fire and recovery is an important mechanism for energy flow and nutrient cycling, and has historically maintained the structural diversity and overall health of the ecosystems within the watershed.

Since ecosystem management means maintaining the interactions between disturbance processes and ecosystem functions, it is necessary to know the historic frequency, intensity and extent of such disturbances. The historic range of variability of fire as a disturbance process has been classified into fire regimes. Fire regimes are defined in terms of fire type and intensity, typical fire sizes and patterns, and fire frequency, or length of return intervals in years. Fire regimes of the Pacific Northwest have been broadly categorized by Agee (1981) into three separate severity categories; high, moderate, and low. High-severity fire regimes are characterized by very infrequent (100 years or more between fires) high-intensity fires, generally stand-replacing, resulting in major vegetation changes on site. Moderate-severity fire regimes are characterized by infrequent (25 to 100 years between fires) fires that are partial stand-replacement, having significant areas of high and low severity. Low-severity fire regimes have frequent (1 to 25 years between fires) low-intensity fires with few overstory effects. Fire regimes are described by the frequency, intensity, and severity of fire and its biological impacts. Frequency of fire is largely determined by the ignition source(s) and the duration and character of weather favoring the spread of fire; intensity is determined by the quantity of fuel available and the combustion rate; severity is determined by the duration of burning time. The fire regime of an area will be primarily determined by regional climate and vegetation combined with local microclimate and topography (Agee, 1993).

Historically the Lower Hayfork Creek Watershed developed under a low-severity fire regime. Through 80 years of fire suppression we have altered the historic fire regime to one of infrequent, high severity, stand replacing fires. Currently stand density, species composition, fire return intervals, fuels levels (living & dead), insect and disease levels, as well as tree mortality levels fall outside the natural range of variability, contributing to the declining health of ecosystems within the watershed. The cumulative effects of altering the historic fire regime in the watershed will result in the occurrence of large, high intensity, stand replacement fires, that will also fall outside of the natural range of variability.

Regulated Harvest Opportunities - The Forest Plan provides the overall direction, including goals and objectives, standards and guidelines, and desired future condition, for regulated timber harvest, including regeneration cutting. Some key references from the Forest Plan are attached.

One of the Forest Goals from the Forest Plan is to..."provide a sustained yield of timber and other wood products to help support the economic structure of local communities and to supply regional and national needs" (Timber #35, page 4-5).

Regulation is the organization and control of the Forests' growing stock to achieve a sustained yield of wood products over time. The Forests' goal is to approach regulation through scheduled regeneration harvests over a period of time called the conversion period. The expected result at the end of the conversion period (or desired future condition) is an equal distribution of age/size classes (Appendix C, page C-3).

To reach regulation, the Plan calls for regenerating 3,500 acres per year in the first decade (2,000 acres of green tree retention and 1,500 acres of selection cutting). The Plan also identifies the timber strata which are priority for regeneration harvests (Appendix C, page C-1).

Determining the Number of Acres to Regenerate

1. Determine the total suitable timber acres for the watershed: for Lower Hayfork Creek, there are an estimated 16,200 acres of CAS land available.
2. Determine the average rotation age for the watershed. The average rotation age for the whole Forest, and for the Lower Hayfork Creek analysis area, is about 150 years.
3. Determine the average annual acres of regeneration harvest within the watershed by dividing the total acres by the rotation age.
4. 16,200 (16,210.7) CAS acres/ 150 years = 100 acres per year.

Determining the Type of Stands to Regenerate

1. Determine of number of acres in each size/age class or timber strata.
2. All stands/strata which have reached culmination of mean annual increment (CMAI) are candidates for regeneration. Typically, priority should be given to stands/strata which are not fully productive, such as understocked or poorly-growing stands, or insect or diseased infected stands.

Other Situations Which May Result in Regeneration Harvest Opportunities:

1. Diversity - To provide a mix and distribution of seral stages and size/age classes of timber stands.
2. Social/Economic - To provide for community stability.
3. Productivity - To provide for healthy forest ecosystems.
4. Research (AMA) - To study new regeneration harvest systems.
5. Wildlife Habitat (Rx VI) - To provide for early seral stages and proper forage/cover ratios.

Conclusion/Summary - Regeneration harvest is the primary activity on regulated timber lands (matrix/AMA) to move the Forests toward regulation and a sustained yield of timber over time.

Stream Channels

- What are the basic morphological characteristics of stream valleys and segments and the general sediment transport and deposition processes in the watershed?

The stream reaches of lower Hayfork Creek from the South Fork Trinity River to Little Creek merit the major discussion under this core topic. Hayfork Creek is the largest free flowing tributary of the South Fork Trinity River, which is itself the largest free flowing tributary of the Trinity River.

11 major tributaries of Hayfork Creek are included in the analysis area. Olsen Creek, Little Bear Creek, Bear Creek, Miners Creek, and Little Creek are major streams flowing into Hayfork Creek from the north. Walker Creek, Grassy Flat Creek, Big Canyon, Dinner Gulch, Jud Creek, and Rusch Creek are major tributaries south of Hayfork Creek. Corral Creek, the largest tributary of lower Hayfork Creek, is excluded from the Lower Hayfork Watershed Analysis.

The Rosgen Stream Classification System is used to classify streams in this Watershed Analysis. The use of the word "disturbance" as used in the context of "sensitivity to disturbance" will be in reference to increases in sediment transport and/or streamflow, and changes in the timing of streamflows.

The Lower Hayfork Watershed Analysis area has channel types that are characteristic of higher elevation, interior coastal mountains in northern California. The most common channel types are A, B, and C channels. D and E channel types are present at very few stream reaches.

A and AA+ channel types are common at first and second order streams; and at steeper landforms, including canyonlands - often at the midslope positions. They are often bedrock-confined channels. Sediment is both transported into the channels from the adjacent uplands and riparian zones, and also generated within the channels - primarily by downcutting , and then efficiently transported on downstream. Woody debris has an important role in storing sediment and controlling the rates of downcutting. A channel types have stream gradients ranging from 4% to <10%; in contrast, AA+ channel types have gradients of at least 10%.

B channel types are common at the lower reaches of tributaries of Hayfork Creek, and can be common at sideslopes of <35%, such as at rounded ridgetops. B Channel types are found at Grassy Flat Creek, the tributaries of Hayfork Creek to the east of Grassy Flat Creek, and the upper reaches of Rusch Creek. They are also found at bedrock gorges and bedrock confined reaches of Hayfork Creek, such as at the confluence with Miners Creek. Sediment from the adjacent riparian zones and/or upstream reaches is efficiently transported on downstream. Stream gradients are between 2% and <4%.

C channel types are found within the lower reaches of Hayfork Creek. These channels are usually wider than A or B channel. These channels typically have a moderate to large amount of sediment transported from mass wasting inner gorges and upstream reaches; they can also generate sediment through channel erosion processes, predominantly through streambank erosion. The deposition of sediment can occurs at pools, the inside of bends, and ripples. These stream types are generally more sensitive to disturbances in comparison to either A or B stream types. Stream gradients are <2%.

D channel types are found at a very few, short stream reaches of Hayfork Creek and may possibly be found at other streams within the analysis area. They have channels abraided with very high rate of depositions of bedload sediment; D channel types are inherently unstable. D stream types are more sensitive to disturbances in comparison to A, B, C stream types. Channel gradients are <2%.

E channel types are common at meadows and wetlands. They tend to have deep and narrow channels. They may be present at the subwatersheds south of Hayfork Creek and just west of its mouth, but east of Halfway Ridge. E stream types are more sensitive to disturbances when compared to A, B, or C stream types. Channel gradients are <2%.

The Riparian Reserves at perennial streams make up 23% (11,346 acres) of the total acreage within the analysis area. Values range from 11% at the Confluence subwatershed to a high of 32.7% at the Lower Rusch Creek subwatershed. Other subwatersheds with a percentage greater than 25% are East Jud, Jud Creek, Halfway, Headwaters Olsen Creek, Pattison, and West Middle Rusch.

The same range of channel types can be found at the Corral Creek Watershed, and at channels upstream of the Lower Hayfork Watershed Analysis area. The landforms, habitats, and elevation positions at which they can be found are similar to what is common for the Lower Hayfork Watershed Analysis area.

Water Quality

- What beneficial uses dependent on aquatic resources occur in the watershed? Which water quality parameters are critical to these uses?

Fish and other aquatic species such as amphibians are entirely dependent upon the water resources within the analysis area. Temperature, flow volume, sediment, as well as organic and inorganic pollutants all have the potential to alter productivity within lower Hayfork Creek and it's tributaries. Elevated water temperatures are known to be a limiting factor for both the resident and anadromous fishery in lower Hayfork Creek. Temperatures in excess of 70 F are typical during the summer months with a high temperature of 85 f recorded in July of 1990. Base flows during these periods are extremely low and are largely responsible for the documented high temperatures. A report from 1994 stated that in September of that year Hayfork Creek flowing intermittently. (Kearney, 1994)

Within the Lower Hayfork Analysis area water is used for both commercial and residential purposes. A vineyard, which draws water from Olsen Creek, represents the only commercial use of water in the Lower Hayfork analysis area. Residential use is also mainly for irrigation purposes. Recreational water use such as swimming, although not prevalent does occur in lower Hayfork Creek.

Residential water use in the analysis area is considered inconsequential to the severe water quality conditions which occur in lower Hayfork Creek. Low flow conditions naturally occur in the tributaries found within the analysis area during summer months. However, water quality, including temperature has been characterized as "good" in all of the tributaries. The vineyard is known to draw a substantial portion of the flow from Olsen Creek during certain times of the year (McCaslin, personal communication). However, the entire volume of flow in Olsen Creek represents only a small portion of the potential flow in lower Hayfork Creek.

Species and Habitats

- What is the relative abundance and distribution of species of concern that are important in the watershed? What is the distribution and character of their habitats?

Wildlife - A query of the California Wildlife Habitat Relationship database [Timossi, 1993], based upon species association with habitat types within the Lower Hayfork Watershed, suggests that up to 228 wildlife species possibly occur in this watershed (13 amphibians, 18 reptiles, 140 birds, and 57 mammals). Of these, 126 wildlife species are strongly associated with habitat types available within the watershed (12 amphibians, 11 reptiles, 79 birds, and 24 mammals). A detailed discussion of each of these species would be tediously cumbersome. Therefore, this section will deal only with those species of major concern; that is to say federally listed endangered, threatened, or proposed species and Forest Service Sensitive species (TE&S species). The following discussion will include a brief description of each TE&S species relative abundance, distribution, and the distribution and character of their habitat.

NOTE: This discussion is based solely upon existing information. No systematic surveys were conducted for either species occurrence or habitats in relation to this Watershed Analysis.

American Peregrine Falcon (Endangered)

No peregrine falcon eyries lie within the watershed. The nearest active eyrie lies about 1/2 mile outside the watershed in the Butter Creek Watershed. The falcons from this eyrie forage within the watershed in the general area of Grassy Flats. Peregrine falcons occasionally frequent the cliffs in the general area of Corral and Gates Creeks just north of Hayfork Creek within the watershed but no nesting activity has occurred.

Potential nest sites may occur within the watershed on the steep cliffs north of Hayfork Creek. Peregrine falcons nest almost exclusively on cliffs and feed primarily on birds in riparian forest habitat. The relationship between the Butter Creek Caves eyrie or the potential nest sites in the watershed and the availability and suitability of foraging habitat within the area was not analyzed.

Bald Eagle (Threatened)

No occupied bald eagle activity areas (i.e., nesting, foraging, winter roosts, or concentration areas) lie within the watershed. The nearest bald eagle nest site lies approximately four miles west of the watershed along the South Fork Trinity River. Occasionally, individual bald eagle are seen, presumably foraging, along Hayfork Creek. However this creek does not represent a major foraging area. Bald eagles are a fairly conspicuous species and are routinely reported by District personnel and area residents when seen, especially pairs, young or nesting activity. While no systematic surveys exclusive to locating bald eagles have been conducted within the watershed, the level of human activity in the area makes the possibility of nesting bald eagles or winter roosts remaining undetected unlikely.

Potential bald eagle nesting habitat and winter roosting habitat occurs in scattered late-successional and old-growth forest stands within the watershed. However, prey populations in the general area are likely too low to support an eagle pair with young or attract and support a concentration of wintering eagles (Butter Creek WA citation).

Northern Spotted Owl (Threatened)

Forest records reveal eight spotted owl activity centers within the watershed. Additionally, nine owl activity centers lie outside the watershed but within 1.3 miles of the boundary. This suggests that these owls may be using habitat within the watershed (i.e., 1.3 miles is the accepted owl "home range" radius around the activity center). The current status of each activity center is largely unknown. That is to say, a number of these activity centers may no longer be occupied.

Spotted owl habitat in the watershed is relatively limited in quantity and is highly fragmented. The spotted owl is associated with late-successional and old growth conifer forest. Suitable owl dispersal habitat is also highly fragmented in certain areas in the watershed. Dispersal habitat typically includes forest stands that average 11 inches DBH and 40 percent canopy cover with adequate space beneath the canopy to allow owl movement.

Pacific Fisher (Sensitive)

Forest records include 10 sightings of this secretive species between 1982 and 1994 scattered throughout the watershed. The fisher is associated with late-successional and old-growth conifer forests and thus current habitat conditions are similar to those for the spotted owl.

American Marten (Sensitive)

Forest records include two sightings of this secretive species between 1988 and 1990 within the watershed. The marten is associated with late-successional and old-growth true fir forest but is also found in lower elevation conifer types. True fir occurs in the watershed in small scattered stands. Otherwise, current habitat conditions are similar to those for the spotted owl.

Northern Goshawk (Sensitive)

This hawk is uncommon on the Trinity portion of the STNF. Forest records include 5 sightings of individual goshawks within the area between 1972 and 1992. One nest was found in the Rusch Creek drainage and was last confirmed as active in 1992. Goshawks are associated with late-successional and old-growth conifer forests on slopes generally less than 35 percent [Hall, 19**]. Suitable goshawk habitat in the watershed is limited and highly fragmented.

Great Gray Owl (Sensitive)

The chances of this species occurring within the area are remote. The Lower Hayfork Watershed lies outside the current range of this species and may lie outside the historic range. The great gray owl is associated with late-successional conifer forest adjacent to large meadow complexes [Winters, 1980]. Within the range of the northern spotted owl, the great gray owl is most common in lodgepole pine forests adjacent to meadows. This vegetation type does not occur within the assessment area. However, this owl is occasionally found in other forest types. The meadow/forest complexes in areas D and E may represent potential great gray owl habitat.

Willow Flycatcher (Sensitive)

While no surveys for this species or habitat have been conducted in the watershed, its presence, in modest numbers, is suspected. This species has been detected on adjacent ranger districts. Willow flycatcher habitat has not been surveyed or mapped but does occur throughout the project area in relatively small, narrow, fragmented patches. The willow flycatcher occupies relatively large wet meadows adjacent to large streams, and tend to nest in large clumps of willows separated by openings [Marcot, 1979]. Willow flycatchers have been detected in more linear willow habitat (some alder) along the mainstem of the Trinity River, however no nest sites were located [Lind et al., 1992].

Northern Red-legged Frog (Sensitive)

While systematic surveys specific to the northern red-legged frog have not been conducted within the watershed, personnel responsible for past stream and wetland surveys looked for this species. No sightings of this species have been reported within the area. Red-legged frogs have been seen in the East Fork Hayfork Creek approximately 10 miles east of the Lower Hayfork Watershed. Red-legged frog habitat has not been surveyed or mapped, however it does occur scattered throughout the watershed. This frog inhabits cool, deep, still to slow moving water such as lakes, ponds, ditches, or slow streams [California Department of Fish and Game, 1988]. Associated dense shrubby or emergent vegetation is required, and well vegetated terrestrial areas within the riparian corridor may provide important sheltering habitat during the winter [USDI, 1994].

Western Pond Turtle (Sensitive)

While systematic surveys specific to this turtle have not been conducted within the assessment area, personnel responsible for past stream and wetland surveys looked for this species. This species has been seen in the area but population levels remain unknown. Hayfork Creek contains an important population of pond turtles. Pond turtles occur in at least three ponds in the western portion of the watershed. Suitable pond turtle habitat exists scattered throughout the watershed but has not been surveyed or mapped other than Hayfork Creek. This species is found in a variety of habitat types associated with permanent or nearly permanent water [Holland, 1991; CDFG, 1988]. These turtles are often concentrated in low flow regions of rivers and creeks, such as side channels and backwater areas [Lind et al., 1992]. They prefer creeks that have deep, still water and sunny banks. Hatchlings are small and require shallow edgewater areas with minimal currents. This species depends on basking to regulate their body temperature. Basking sites include logs and other woody material, rocks, emergent vegetation, overhanging vegetation that touches the water, and sloping banks. Studies conducted on the main stem of the Trinity River indicate this turtle prefers slow moving water (e.g. pools) where basking sites exist [Lind et al., 1992].

TRENDS

As indicated above, TE&S species known or expected to occur within the watershed are associated with two general habitat types: 1) riparian, and 20 late-successional and old-growth conifer forest. Late-successional and old-growth forest habitat within the watershed have been greatly reduced and fragmented by relatively intense past timber harvesting (mainly clearcutting), road building, and large-scale stand-replacing fires. Past timber harvesting typically targeted older forests. Few large logs and snags (important habitat components for many late-successional and old-growth related species) occur within areas replanted after harvesting. Riparian habitat has also been negatively affected to a lesser degree. These two habitat types are generally improving as harvested and burned areas recover from these disturbances.

Fisheries - Two federally proposed fish species, Klamath Mountain Province Steelhead and Northern California Coastal Coho Salmon are known to occur within the South Fork Trinity Basin. While coho salmon are not known to occur within the Lower Hayfork watershed analysis area, steelhead are present throughout the analysis area. Spring chinook, which have recently been petitioned for Federal listing also occur within the watershed analysis area.

Suitable salmonid habitat is present in both lower Hayfork Creek and eight tributaries which lie within the lower Hayfork Analysis Area. The habitat and water quality conditions in the eight tributaries has generally been reported as "good, with resident rainbow trout and anadromous steelhead populations present in all of the tributaries except Jud Creek. Jud Creek is barriered to upstream migration of anadromous fish and therefore contains only resident rainbow trout. Fish inventories have shown that the tributaries support moderate densities of juvenile rainbow trout/steelhead. High stream gradient, shallow pool depths and low summer flows are considered to be the primary factors which limit fish production in the tributaries. Chinook salmon are not found in any of the tributaries.

Habitat conditions in lower Hayfork Creek are poor and fish abundance is quite low. Only occasional sightings of summer steelhead have been made in recent years and spring Chinook spawning activity has been sporadic in only the past six years. Although elevated levels of fine sediment have been identified as a problem in lower Hayfork Creek, water quality and water yield are the factors limiting fish production in lower Hayfork Creek. Extremely low flows and water temperatures as high as 85 F have been documented in recent years. Heavy water use and poor riparian canopy condition upstream of the Lower Hayfork analysis area are believed to be the major cause of these intolerable water quality conditions.

Despite the severity of the water quality problem, other habitat conditions such as pool depth and cover are not nearly as limiting. It appears that salmonid use and abundance in lower Hayfork Creek might be able to rebound toward historic numbers, if the water quality and water yield problems were corrected. Historic use, particularly by spring chinook was concentrated in the lower two miles of Hayfork Creek where the channel is less confined but also more sensitive to low flows and high temperatures.

Human Uses

- What are major human uses, including tribal uses and treaty rights? Where do they generally occur in the watershed?

Humans and Private Property - This flow is generally confined to private properties located within the landscape and road systems used to access them. This flow is also dependent upon water from the landscape for domestic use. This water is retrieved from the springs and creeks found within the watershed. This flow is dependent upon the transportation systems that access their holdings. Movement by this flow is generally confined to the access routes and occurs both into and out of the landscape. This flow occurs year around in the landscape.

Humans and Recreation - Within the landscape, the flow of humans engaged in recreational opportunities are reliant upon three primary uses. One use involves fishing along the major streams. Another recreational use, hunting, can occur anywhere within the landscape. The third primary use is mining which occurs along the Hayfork Creek. Fishing and mining use activities are primarily dependent upon water flows. Hunting use is more concentrated to those areas containing early seral vegetation that is in close proximity to cover. Most of the human recreation use is confined to the road systems found within and adjacent to the landscape and is heaviest in and around Indian Valley. It is seasonal in nature with this use occurring during the regulated fishing and hunting seasons.

Commercial Uses - The primary types of commodity use that occur within the landscape involves Forest based activities. This involves both commodity use and the jobs associated with all the activities that may occur within the landscape. Examples of these Forest based activities include: timber harvesting, timber stand improvement work, watershed restoration, wildlife habitat improvement, and reforestation. The human commodity flow is not dependant upon a particular landscape element, as activities can occur within any of the identified elements. This flow is usually tied to the existing transportation system in the landscape. Timing of this flow is generally from spring to late fall.

Tribal Cultural Resources - Within the Lower Hayfork Watershed Analysis area we have an estimated 5,000 years of recorded human history. American Indians were the first humans to flow through this landscape. Settlement and subsistence was focused in the late fall, winter, and early spring along the streams and valley bottoms in the landscape area. Into the late spring, summer, and late fall the flow of human use moved up out of the canyons and valleys toward upland ridgelines and watersheds. Resources attracting the flow of human use were anadromous fisheries and game mammals. In addition, gathering and collection of plant material was done for food and utilitarian use.

In the 1850s American Indian pattern of landscape use was first modified by Euro-American culture. As time progressed into the 20th-century Euro-American cultural concept of private/public property, agriculture, industrial, and transportation became dominant, which changed human flows within the landscape.

Heritage/archaeological sites do not have any current interaction with the various elements other than the need for legally mandated protection. Archaeological sites such as those in the Olsen Creek 87 Burn area F1 are representative of a past human flow. This can be compared to the present, however does not interact with the present.

Within Lower Hayfork there is American Indian traditional gathering of red bud, bear grass, and other materials for basketry and medicinal purposes. In addition, certain locations, especially along Hayfork Creek, may have traditional spiritual use.

Humans and Roads - This landscape element development can be traced back to trail routes used by Chamariko and Wintu American Indian groups in Lower Hayfork. These early trails were later used by Euro-American settlers to access Hayfork Creek, the surrounding high country, and Hyampom and Hayfork Valleys. Later on the Forest Service used many of these prehistoric trail routes and expanded this system for range management, Forest inventory, and fire protection. From these trails the current Forest Service and County road systems developed.

The County road system now in place is used to access the community of Hyampom with Hayfork and various parcels of private property. Off the main County Highway (Hyampom Road) Forest Service system roads were put in to carry out timber management, fire protection, range management, and recreation.

STEP 2: ISSUES AND KEY QUESTIONS

Purpose

- To focus the analysis on the key elements of the ecosystem that are most relevant to the management question, human values, or resource conditions within the watershed.
- To determine which core questions are applicable, establish the level of detail needed to address applicable core question, and to document rationale for determining that a core question is not applicable.
- To identify additional relevant topics and questions based on issues in the watershed.
- To formulate key analysis questions for the watershed based on indicators commonly used to measure or interpret the key ecosystem elements.

Discussion

Preliminary analysis of the Lower Hayfork Creek Watershed indicates a high need to enter this watershed for the purpose of fuels hazard reduction, watershed restoration, and the maintenance of forest health, which provides for commodity outputs including commercial forest products. The Lower Hayfork Watershed assessment area lies primarily within Management Areas 17 and 19, with a lesser portion in Management Area 18. The assessment area is comprised of four LMP land allocations, including adaptive management area (AMA), late-successional reserve (LSR), administatively withdrawn, and unmapped riparian reserves; and seven management prescriptions, including Prescription I (Unroaded Non-motorized Recreation), Prescription III (Roaded Recreation), Prescription VI (Wildlife Habitat Management), Prescription VII (Late-successional Reserves/Threatened, Endangered, Sensitive Species), Prescription VIII (Commercial Wood Products Emphasis), Prescription IX (Riparian Management), and Prescription XI (Heritage Resource Management). The desired future condition (DFC) for this watershed, as described in the Forest Plan, is primarily a function of land allocation. Within the AMA (matrix), suitable lands are to be managed on a sustained yield basis. Silvicultural systems, including commercial thinning, green tree retention/regeneration, and sanitation/salvage opportunities are to be considered toward moving these lands toward a regulated condition. Fuels hazard reduction opportunities, including the prescribed use of fire, are also appropriate. Within the LSR, forest stands are managed to maintain health and diversity components, and to provide for late-successional habitat. Proposals which include providing for the maintenance and development of late-successional habitat, such as thinning and fuels hazard reduction opportunities are appropriate. Within the administratively withdrawn area, which is primarily Pattison, the emphasis is to provide for semi-primitive, non-motorized recreation opportunities. Proposals which include trail maintenance/development, and fuels hazard reduction opportunities are appropriate. Within the riparian reserves, the emphasis is to provide for the maintenance or development of riparian areas, wildlife habitat, fisheries habitat, and water quality. Proposals which include riparian habitat maintenance/enhancement, the restoration of degraded habitat, and habitat connectivity opportunities are appropriate. Additionally, within the riparian reserves, integrated resource management proposals consistent with the Aquatic Conservation Strategy are appropriate.

Core Topics and Questions

Erosion Processes

- What are the landslide hazards for the entire watershed? [Scale]
- What non-natural or human-induced conditions exist or have the potential to exist that jeopardize the long-term sustainability of the soil resource and all of its functions? [AMA]
- What might be the expected rates of recovery of the soil environment (physical, chemical, biological) following disturbance? [AMA]
- What erosion processes are the dominant within the watershed? Where have they occurred or are they likely to occur?

Three major forms of slope movement occur in the analysis area. These are Slump-earthflow, debris flow, and soil creep.

Creep is slow, downslope movement of the soil mantle in response to gravitational forces. Movement occurs under shear stresses sufficient to produce deformation but too small to result in discrete failure. Interstitial and absorbed water contribute to creep movement by opening the structure within and between mineral grains and clay minerals, thereby reducing friction within a soil mass. Therefore, creep is mainly a function of gravitational forces but is facilitated by saturation with water and by frost action. Root strength, weight of vegetation, and wind stress on the soil mantle are also factors affecting soil creep.

Creep is the most persistent of all mass erosion processes. It operates at varying rates, dominantly in clayey soils, that occur even on relatively flat slopes. It can be recognized by the displacement of boulders, tilted poles and fences, and curved tree trunks. Some land management practices can modify the root strength, bydrology, and shear strength relationships of a site and thereby accelerate the rate of creep. Creep activity can result in a continuing supply of soil material to streams in the form of encroaching banks and small-scale slope failures and thereby contribute to sediment load in streams. Creep can also damage structures and roads. In areas where shear stresses are great enough, creep movement can accelerate into faster moving types of slope failure, mainly slump-earthflow.

High erosion hazards can almost exclusively be linked to slopes in excess of 65%, or as a secondary process of localized landsliding. High coarse gravel contents within the matrix of fine-grained, not readily detachable clayey soils also reduce the erosion hazard rating on some soil types occurring on moderately steep to steep surfaces.

Transportation - The transportation system in the Lower Hayfork Analysis area will meet all needs for the three objectives provided to enter this area: watershed restoration, fuels hazard reduction, and forest health.

Watershed Restoration - Since the decline of timber production in the last few years due to the listing of the Spotted Owl to the Threatened, Endangered, Sensitive Species Act many of our roads in the area have not received proper maintenance from associated timber operations and also with the decline of the Forest Service Maintenance budget, the lack of routine maintenance has caused some roads to deteriorate and are causing some local surface damage. Also with the high amount of open level 1 roads in the area which were suppose to be closed after use, there would be an opportunity to close these roads which would reduce the open road density and prevent travel during wet weather periods which could cause rutting and surface erosion.

Fuels Hazard Reduction and Maintenance of Forest Health - The existing transportation system in the analysis area would provide access to most areas identified for projects. Some new road construction will be proposed if feasible in areas where projects planned that are not roaded at present time excluding the released Pattison Area.

Hydrology

- What are the primary water and sediment routing mechanisms in the watershed? [Basin]
- What is the sensitivity on a subwatershed basis? [AMA]
- What is the history of rain-on-snow events in the watershed? [Basin]
- What is the climate for the Lower Hayfork Creek watershed? [Basin]
- What are the streamflow characteristics (flow regimes) of the watershed, including peak streamflows, baseflow, etc? [Basin]
- What effect did the 1964 flood have on the watershed? [Basin]

Hydrology includes cumulative watershed effects, which is a highly important factor in determining the limitations in roading, vegetation manipulation, and fuels treatments at all 24 subwatersheds delineated within the Lower Hayfork Watershed Analysis area. Cumulative watershed effects are also a major factor determining priorities for watershed restoration.

Vegetation

- Where does connectivity need to be maintained? [Scale]
- What are the forest health conditions? [Scale]
- What harvest levels are thought to be ecologically and environmentally sustainable from the watershed? [AMA]
- What products are currently being harvested. [AMA]
- What were/are the historic patterns of harvesting in the area? [AMA]
- What products have potential for harvest in future (anticipate demand)? [Basin]
- What is the transportation plan? [AMA]
- What is the historical fire regime and the timing of historic events in the Lower Hayfork Creek Watershed? [AMA]
- What are the current fire regimes? [AMA]
- What is the natural range of fuel characteristics in the Lower Hayfork Creek Watershed? [AMA]
- What is the DFC for fuel characteristics within the Lower Hayfork Creek watershed? [AMA]
- What is the wildfire hazard potential and associated risk to loss of resources in areas where fuel characteristics are outside the natural range of variability? [AMA]

Fire has had a significant impact on the Pacific Northwest forests long before the appearance of any element of civilization. Fire shaped the composition and structure of North American forest, woodland, shrubland and grassland ecosystems (Pyne 1982) and is a significant component of ecosystem functioning. Fire, because of the climate of the Klamath Mountains, has created stands and controlled stocking and stand density. Historically, prior to the fire suppression era, the dominant fire regime of this landscape consisted of frequent low-intensity ground fires. Suppressing fires has, in effect, changed the historic role of fire, resulting in unhealthy overstocked stands encroached heavily by fire intolerant vegetation.

Plant adaptations, like thick bark, enable a species to withstand or resist recurrent low-intensity fire while less adapted species perish. In the absence of periodic low-intensity surface fires stands undergo relatively rapid changes in species composition and structure which often facilitates epidemic insect and disease attacks, setting the stage for catastrophic stand replacement wildfires (Agee, 1990).

Weather patterns in the Lower Hayfork Creek Watershed are such that long, dry periods in summer are often accompanied by lightning storms. These storms result in frequent ground strikes with minimum precipitation. Thus, lightning has historically been a significant ignition source. Prior to human intervention, lightning fires could burn from days to months with periods of increased intensity during hot, dry, windy conditions, and decreased activity and intensity at night and during periods of wetter weather.

The Nor-El-Muk tribe of Wintu used fire in the Lower Hayfork Creek Watershed, but to what extent and where still remains to be determined. Native American burning practices within the watershed and their future burning needs require further research. (See Heritage Resource Portion of this Analysis for additional information).

Is the Lower Hayfork Watershed capable of contributing to the Allowable Sale Quantity (ASQ) assigned to the Forest? An estimate of Capable, Available, and Suitable (CAS) lands within the Lower Hayfork Creek analysis area, stratified by size and density classes provided by available LMP90 database information would indicate the number of acres to harvest per year to move the area toward regulated forest conditions.

Stream Channels

- What are the sensitive channel types and how are they distributed? [AMA]
- What factors contribute to stream channel sensitivity? [Basin]

We have conflicting information on the distribution and streambed composition of C channels at Hayfork Creek. We lack information on the distribution of D channels at Hayfork Creek and possibly other streams in the analysis area; we lack verification of the channel conditions at meadows and wetlands: do they have sensitive channel types?

Species and Habitats

- Is the Lower Hayfork Watershed currently fulfilling its assigned biological role in the overall strategy for maintaining viable populations of species associated with late-successional and old-growth forest ecosystems as described in the FSEIS, the subsequent ROD, and the Shasta-Trinity National Forest Land and Resource Management Plan?

Specifically; is this watershed providing adequate connectivity between LSRs RC-330 and RC-332? Connectivity is a measure of the extent to which the landscape pattern of the late-successional and old-growth ecosystem provides for biological and ecological flows that sustain late-successional and old-growth associated animal and plant species across the range of the northern spotted owl.

The rationale for focusing this analysis on the issue of connectivity is presented. This focus does not imply that other wildlife issues are henceforth dropped from consideration. Rather, many wildlife concerns (e.g., possible impacts to red-legged frog, western pond turtle, or willow flycatcher habitat) are best dealt with at the project (i.e., site specific) level.

Riparian species (e.g., western pond turtle, northern red-legged frog, or willow flycatcher) are not likely to have significant impacts to their habitats due to management requirements imposed by the Forest Plan within Riparian Reserves to assure consistency with the Aquatic Conservation Strategy. In addition, the important population of pond turtles in Hayfork Creek lies within a corridor that is likely to receive little if any management activity. Further, any concerns with riparian dependant wildlife species are largely addressed by the issues and questions dealing with erosion processes, hydrology, stream channels, and water quality.

No bald eagle or peregrine falcon nest sites are known to occur within the watershed. The potential falcon nest sites north of Hayfork Creek would not be affected by probable future management activities. Probable future management activities within the watershed would not likely affect foraging opportunities for these two species.

Current conditions within the Lower Hayfork Watershed strongly suggest that wildlife species associated with early seral stage forest conditions or shrub habitat are not limited by the amount of these habitats currently available in the watershed. Further, these habitats recover much faster after disturbance events (e.g., stand replacing fire or timber harvesting) than do mature, late-successional, or old-growth forest habitats.

The Lower Hayfork Watershed lies between two large LSRs and thus must provide adequate connectivity to fulfill its function in the overall strategy to maintain viable populations of species associated with late-successional and old-growth forest ecosystems (e.g., northern spotted owl, northern goshawk, American marten, and fisher). Connectivity is a measure of the extent to which the landscape pattern of the late-successional and old-growth ecosystem provides for biological and ecological flows that sustain late-successional and old-growth associated animal and plant species across the range of the northern spotted owl. Further, suitable habitat for maintaining connectivity (typically mature or older forest) can take long periods of time to recover after disturbance events (e.g., stand replacing fire or timber harvest).

Fisheries

Step one of the watershed analysis process (characterization) for the Lower Hayfork Watershed analysis area indicates that the majority of tributaries within the the analysis area are characterized as being in "good" condition with moderate fish abundance. In contrast, lower Hayfork Creek is in very poor condition with very low numbers of salmon and steelhead. Characterization has also shown that the condition in lower Hayfork Creek is clearly attributable to water quality and water yield and that these conditions are primarily a result of activities taking place upstream of the analysis area.

In January of 1996, the Lower Hayfork watershed analysis team received direction to focus upon watershed restoration, fuels hazard reduction, and forest health needs within the Lower Hayfork watershed analysis area. Fisheries issues have typically been a primary factor driving watershed restoration issues within the Trinity River basin. As an area of focus, watershed restoration is certainly appropriate for the analysis given the degraded condition of fish habitat in lower Hayfork Creek. Fuels hazard reduction issues/needs may also relate well to the current fish habitat condition in the Lower Hayfork analysis area, since healthy upland and riparian stands that are not endangered by catastrophic fire events benefit both terrestrial and aquatic resources.

Clearly the most degraded habitat within the Lower Hayfork Watershed analysis area is located in lower Hayfork Creek. This deteriorated condition is logically of paramount concern and should be of primary importance for watershed restoration. A key challenge will be to evaluate restoration opportunities within the analysis area in the context of the entire Hayfork basin, since much of this deteriorated condition results from activities which take place upstream of the analysis area.

Because the majority of the tributaries within the analysis area are in "good" condition, restoration activities targeted at improving conditions within the tributaries should be of secondary importance. The analysis should, however, focus on maintaining those current "good" conditions by identifying localized areas of concern that may threaten the condition of the tributaries that are in "good" condition and address conditions in the tributaries. While focusing the analysis on forest health issues, the team will ideally be able to identify activities which will not threaten the good condition of the tributaries and will not exacerbate the degraded conditions in lower Hayfork Creek.

The team has reviewed all of the core topics and key questions identified in the Federal Guide for Watershed Analysis and has chosen to consider all of these topics and questions as part of the Lower Hayfork Watershed analysis. A close association exists between the core topic of fish and fish habitat and the core topics of erosion processes, hydrology, stream channel and water quality. These topics must be integrated to understand and evaluate fish and their habitat in the Lower Hayfork watershed. Based on our characterization of the analysis area in step one, our understanding of water quality issues will be of extremely high importance if fish and their habitat are to be included as a primary beneficiary of any recommended watershed restoration effort.

Water Quality

- Where in the Lower Hayfork Creek watershed are the present sediment production conditions outside the natural range of variability? [Scale]
- What are the processes within the Lower Hayfork Creek watershed that control the natural range of variability of water temperature? [Scale]
- Where in the Lower Hayfork Creek watershed are the present water temperatures outside the natural range of variability? [Scale]

During step one, water quality conditions and specifically elevated temperatures and very low flows, were identified as extremely limiting to fisheries productivity in lower Hayfork Creek. Since watershed restoration has been identified as an issue upon which the team should focus, consideration of the water quality issue is of paramount importance, since water quality instead of stream habitat condition appears to be the clear and primary limiting factor in lower Hayfork Creek. The analysis should thus focus on water quality and how more tolerable conditions could be restored within the drainage. A major challenge will be to determine how best to address this water quality problem since the source of that problem lies outside of the analysis area. Of secondary importance are sediment and bedload issues which are typically of very high concern in other areas of the South Fork Trinity basin.

Human Uses

- What are the dominant social and cultural contexts represented in this area? [Basin]
- What are the significant prehistoric and historic sites in this area? [Scale]
- What are the prehistoric and historic settlement patterns in this area and how have they changed through time? [Basin]
- What landscape elements are impacting prehistoric and historic sites and where is this occurring? [Scale]
- What historic contexts will likely continue into the future? [Basin]
- What are the major economic considerations in the Lower Hayfork CK Watershed? [AMA]
- What are the expectations of the local community for the watershed? [AMA]
- How have prehistoric human settlement and use affected the area's landscape elements from 10,000 ybp to 1850? [Basin]
- What are the expectations of the local community for the watershed? [Scale]

Human Uses - Review of the three focused issues within the framework of Human Uses has generated no additional ones. However, there are management considerations which must be taken into account when implementing proposals generated from these issues. In particular, as it regards Heritage Resource Management.

STEP 3: CURRENT CONDITIONS

Purpose

- To develop information relevant to the issues and key questions from Step 2 that is more detailed than information from the characterization in Step 1.
- To document the current range, distribution, and condition of the core topics and other relevant ecosystem elements.

Core Topics and Questions

Erosion Processes

- What are the current conditions and trends of the dominant erosion processes prevalent in the watershed?

The mass wasting processes occurring at the valley inner gorges and to the south of Hayfork Creek supply a high sediment load that is deposited within a two mile segment of Hayfork Creek from Hyampom on upstream. Translational-rotational landslides within the valley inner gorges present the greatest and most direct hazard to Hayfork Creek. Translational-rotational landslides at road fillslopes generate moderate to high amounts of sediment that impact tributaries such as Jud Creek and Rusch Creek. Debris slides, debris avalanches, and debris torrents are more likely to occur at watersheds to the south of Hayfork Creek, such as Big Canyon and Grassy Flat Creek. Some stream crossings have the potential to initiate debris torrents, if the culverts are plugged.

The surface erosion processes of most concern are those occurring at roads within the Jud Creek, Rusch Creek, and Olsen Creek watersheds. Sediment from active surface at stream crossings and at other culvert locations is transported directly into local streams in these watersheds. Other areas where surface erosion is active include the Big Canyon and Grassy Flat Creek watersheds, and the Grassy Mountain, Halfway, and East Hyampom subwatersheds.

The soils within the Lower Hayfork Watershed Analysis area are derived from four major geologic types: the Weaverville formation, the Rattlesnake Terrane and Western Hayfork Terrane, and the Iron Mountain Batholith.

The Weaverville Formation consists of Oligocene opoch nonmarine material which is weakly consolidated. This formation has several component beds, that have been deformed in places by uplifting. The material ranges from fine-grained sediments deposited by slow moving water to that deposited by fast moving streams that contains many large rounded rock fragments. In some areas this material is influenced by glacial outwash from the Trinity Alps, and the rock fragments are angular. This material fills the Hayfork Valley to depths of as much as 2,000 feet thick and extends at low elevations along the Trinity River and its tributaries. The Weaverville Formation underlies portions of the Olson Creek and Butter Creek Canyonlands areas, as well as the Pattison area.

The Rattlesnake Terrane contains a group of rocks with large blocks of metasedimentary and metavolcanic rocks, serpentine melange, and basic igneous intrusives. Analysis areas which are underlain by the Rattlesnake Terrane include the Olsen Creek and Butter Creek Canyonlands, the Hyampom Earthflows, the 1987 Burn, and Jud-Rusch Creek.

The Western Hayfork Terrane is comprised of metavolcanic rocks and diorites of the Ironside Mountain Batholith. This geology underlies portions of the Pattison Area, Jud-Rusch Creek, the Halfway Ridgelands area, and the Little Creek area from Hayfork Bally south to Hayfork Creek.

Some general properties used to characterize forest soils and their basic patterns of soil evolution in the Lower Hayfork Watershed are soil depth, soil color, gravel content, clay content, particle size distribution, and certain chemical properties (Zinke and Colwell, 1963). External to soil properties are the whole host of spatial and temporal phenomenon, perhaps dominated by a soil's geomorphic position, that play a role in a soils character, function, and productivity.

Soils in the Lower Hayfork analysis area are quite varied, due to the parent material, climate, topography, and vegetation of the area. These soils range from shallow, rocky soils having low productivity to relatively deep, fine textured soils which are relatively productive. Soils of major extent in the area include Casabonne, Kindig, Clover, Nuens, Marpa, Deadwood, Grell, Dubakella, Dunsmuir, Weitchpec, Holland, Hotaw, Chaix, and Chawanakee. These soil series are generally mapped as complexes, which are natural groupings of individual soils as they occur on the landscape. These complexes reflect soil series that are discrete from one another in characteristics, but are not readily delineated because of the intricate mixing of soil types across the landscape. For example, the Deadwood-Marpa Complex, 5 to 35 percent. Here, the Deadwood soil is the dominant member in this complex, followed by the Marpa series.

In the large blocks of metasedimentary and volcanic bedrock derived soils of the Rattlesnake Creek Terrane, as well as the Western Hayfork Terrane, moderately steep and steeply sloping areas have soils which are very gravelly. Soils on gentler slopes tend to be finer textured, have less coarse-fragment content, reflect more weathering, and generally are more productive forest soils.

The deep, (>60 inches) Kindig and Cassabonne soils occur on gentle to very steep mountain sideslopes, the upland area, or in association with mass wasting features in inner gorges. These soils are among the most productive in the watershed, with a range from almost no management limitations to somewhat significant limitations related to very steep sideslopes and high surface gravel content. The deep Clover soil is of little extent in the watershed, but is significant due to the presence of a heavy gravel mulch 6 to 12 inches thick on the soil surface. The gravel mulch, with its coarse nature, has almost no water holding capacity. This characteristic severely limits the plantability, regenerative capacity, and the potential for seedling survival on this soil type.

The moderately deep (20 to 40 inches in depth) Marpa and Nuens soils occupy concave or convex positions on gently sloping to very steep hillslopes. They are often associated with the colluvial ridges and hillslopes in the uplands. These soils tend to be moderately productive due to coarse gravel contents in surface horizons, soil depth and droughthiness. The Marpa soil typically has finer textures, occurs on gentler surfaces, and has fewer limitations for management than the Neuns soil, but does not appear to be significantly more productive.

The Deadwood soil is a shallow (<20 inches in depth) soil that tends to occupy gentle to very steep, convex surfaces on mountain sideslopes and headwall areas. They are generally associated with crown scarps of deep-seated mass wasting features. These soils have significant limitations in productivity related to low available water holding capacity, amount of coarse fragments in the profile, position on the landscape and available rooting depths. The Deadwood soil may also reflect an influence of adjacent serpentinitic derived soils.

The serpentine melange bedrock is rich in serpentine as well as small blocks of a variety of other lithologies. Soils derived from these rocks tend to be found on "softer" landscapes, yet are not limited to gently sloping areas. They often have less coarse fragment content in the surface horizons than those of metasedimentary or metavolcanic origins. Soils of this type include the deep (40 to 60 inches to bedrock) Dunsmuir soil, the moderately deep (20 to 40 inches) Dubakella and Weitchpec, and the shallow (10 t0 20 inches) Grell. Nutrient imbalances significantly limit the vegetative communities that can occur on these soil types. The four soils all are of low to moderate productivity, and are limited by drouthiness.

Soils formed in moderately to deeply decomposed granite and diorite intrusions and the Iron Mountain Batholith are extremely erodible. These soils include the deep (greater than 60 inches) Holland, the moderately deep (40 to 60 inches) Chaix and Hotaw, and the shallow (10 to 20 inches) Chawanakee. Productivity for these soils range from the productive Holland and Chaix soils to the shallow unproductive Chawanakee. However, soils developed in decomposed granitic materials are among those with the highest erosion hazard ratings. (EHR) Textures in these soils are dominated by sand sized particles. They have very low clay and silt content. Typically they contain greater than 70 percent sand, with most of this being medium sand, coarse sand, or very coarse sand. These soils also contain varying but significant amounts of fine gravel. These sand and fine gravel particles are primarily individual mineral grains that result when the granitic rock decomposes.

Without significant clay content to bind the sand particles together, these soils are generally single grained or only weakly aggregated. Surface erosion is removing material nearly as fast as it is being weathered, and consequently, soil development is slight. The main aggregating agent is organic matter. These soils can lose organic matter by disturbance or removal of the surface soil and forest litter layer, or by removal of vegetation which would have dropped needles, twigs, and leaves to sustain the litter layer. It has become apparent that the duff layer is the most important component of ground cover since it serves as a "sponge" to hold moisture and is actually the binding agent just below the soil surface. (Monitoring Erosion on Granitic Soils; J. Holcomb, S. Miles, J. Anderson, K. Lanspa, and C. Lukacic; p. 6.) Surface organic matter also buffers the weight of large machinery passing over the soil profile. Its removal imparts the compactive force directly to the soil. This allows greater increases in soil density with less compactive force. Other factors being equal, compaction risk is inversely related to soil organic matter content (Alexander and Poff, 1985).

Within local subwatersheds, there are soils with a high to very high potential for surface soil erosion. These watersheds include those underlain by decomposed granitic materials such as those of the Ironside Mountain Batholith. This geology underlies portions of the Pattison Area, Jud-Rusch Creek, the Halfway Ridgelands area, and the south-west portion of Little Creek from Hayfork Bally south to Hayfork Creek. These soils include Holland, Hotaw, Chaix and Chawanakee.

Textures in these soils are dominated by sand sized particles. They have very low clay and silt content. Typically they contain greater that 70 percent sand, with most of this being medium sand, coarse sand, or very coarse sand. These soils also contain varying but significant amounts of fine gravel. These sand and fine gravel particles are primarily individual mineral grains that result when the granitic rock decomposes.

When these single grained sandy soils without a litter layer are exposed to rainfall and runoff there is very little to hold them in place. The individual soil particles do not have to be detached from aggregates and are easily transported by water. On the typically steep slopes even the very coarse sand and the fine gravel are easily eroded by raindrop impact or fast moving water. During storms it is easy to observe the movement of these particles carried in surface runoff. Downslope this runoff concentrates and may form large gullies. Within several days or weeks after the storm the sand particles settle and roll down the slopes and cover any signs of sheet and rill erosion on the upper slopes. The gullies contribute large amounts of sediment to streams and remain clearly visible for years.

Transportation - The transportation system in the Lower Hayfork Creek Watershed is used extensively for recreation and resource management projects.

There are 176.32 miles of road in the analysis area which consist of 124.27 miles of Forest Service roads, 20.41 miles of jeep roads, 21.67 miles of County roads, and 9.96 miles of private roads. Of the 124.27 miles of Forest Service roads, 77.05 miles are native surface roads, 44.28 miles of aggregate surface, and 2.94 miles of chip sealed roads. Over half (14 plus miles) of County roads in the area are paved, the rest being native surface with only about 10 percent being aggregate surfaced.

The overall transportation condition is in fairly good shape, even though there has been less maintenance over the past few years due to the decrease in sale activity and the decline in Forest Service maintenance budgets.

There are isolated areas of concern due to surface erosion which could affect water quality. These areas are mainly native surfaced roads that have been rutted by vehicle traffic during wet weather conditions and from the lack of maintenance to correct the problem. Other areas are drainage structures that are not working properly which in turn is diverting water down native surfaced roads and causing surface erosion.

The County roads in the area that are native surfaces like County 316 which lies on the west side of the analysis area and runs north and south has a history of surface erosion problems, fill failures and channeling water long distances in ditch lines which cause ditch erosion. County

Road 310 (Hyampom Road), which is paved all the way from Hayfork to Hyampom, has erosion problems associated with poor drainage structures, side casting of slide material and side casting material from culvert cleaning.

Non-system roads, roads on National Forest that are not jeep roads but temporary roads, built and never closed. There are two non-system roads in the East Hyampom area that when traveled on during wet weather conditions become rutted and caused surface erosion.

Open road density is always a concern in any watershed as in this one. One of the main concerns is the amount of road that can be traveled on even during wet weather conditions which could lead to rutting and surface erosion on native surface roads. Of the 136.18 miles of open road in the analysis area 84.14 miles are Forest Service roads, of these 84.14 miles 29.73 miles are level 1 roads which should have been closed year-long when the projects were completed, or their maintenance changed to level 2 with correspondingly appropriate maintenance.

The following road density charts will show the overall road density for the whole watershed plus each sub watershed for open road, seasonal closure, and year long closure road density. Plus they will show the amount of level 1 roads per sub watershed.

Road Density				
Sub Watershed	**Miles**	**Sq. Miles**	**Road Miles/per Sq. Mile**	**Maintenance Level 1 Road Miles**
Bear	0.76	4.61	0.16	0
Bear Creek	6.18	8.87	0.70	0.31
Big Canyon	9.02	2.03	4.44	3.29
Confluence	1.65	0.27	6.11	0
East Hyampom	22.84	5.50	4.15	4.34
East Jud	3.64	0.86	4.21	1.52
East Middle Rusch	6.43	1.35	4.76	4.34
Grassy Flat Creek	7.95	2.59	3.07	2.37
Grassy Mountain	8.91	2.53	3.52	4.20
Halfway	14.64	3.79	3.86	2.89
Headwaters Little	5.60	1.57	3.57	0.53
Headwaters Olsen	11.73	3.34	3.51	3.21
Headwaters Rusch	3.34	0.68	4.91	2.38

Road Density				
Sub Watershed	**Miles**	**Sq. Miles**	**Road Miles/per Sq. Mile**	**Maintenance Level 1 Road Miles**
Jud Creek	11.07	2.66	4.16	6.24
Lower Little Creek	18.52	7.51	2.47	5.56
Lower Olsen Creek	13.59	3.17	4.29	2.77
Lower Rusch Creek	2.85	2.06	1.38	0.32
Pattison	8.94	18.78	0.48	0
Rusch 1	0.82	0.60	1.37	0.37
Rusch 2	1.59	0.55	2.89	0.46
Rusch 3	1.20	0.28	4.29	0.70
Rusch 4	4.27	0.59	7.24	2.05
West Fork Rusch	2.91	0.60	4.85	0.97
West Middle Rusch	7.90	1.47	5.37	1.67

Open Road Density				
Sub Watershed	**Open Miles**	**Sq. Miles**	**Road Miles/per Sq. Mile**	**Maintenance Level 1 Road Miles**
Bear	0.76	4.61	0.16	0
Bear Creek	4.91	8.87	0.55	0
Big Canyon	3.93	2.03	1.94	2.21
Confluence	1.65	0.27	6.11	0
East Hyampom	18.97	5.50	3.45	2.71
East Jud	0	0	0	0
East Middle Rusch	6.43	1.35	4.76	4.34
Grassy Flat Creek	6.30	2.59	2.69	0.75
Grassy Mountain	4.62	2.53	1.83	0.46
Halfway	14.64	3.79	3.86	2.89
Headwaters Little	4.82	1.57	3.07	0
Headwaters Olsen	10.29	3.34	3.08	1.76
Headwaters Rusch	3.34	0.68	4.91	2.38
Jud Creek	2.57	2.66	0.97	0.36
Lower Little Creek	10.93	7.51	1.46	4.32
Lower Olsen Creek	12.48	3.17	3.91	1.66
Lower Rusch Creek	2.85	2.06	1.38	0.32
Pattison	8.76	18.78	0.48	0
Rusch 1	0.82	0.60	1.37	0.37
Rusch 2	1.59	0.55	2.89	0.46
Rusch 3	0.74	0.28	2.64	0.24
Rusch 4	4.24	0.59	7.19	2.02
West Fork Rusch	2.91	0.60	4.85	0.97
West Middle Rusch	7.74	1.47	5.27	1.51

Seasonal Road Density				
Sub Watershed	**Miles**	**Sq. Miles**	**Road Miles/per Sq. Mile**	**Maintenance Level 1 Road Miles**
Bear	0	0	0	0
Bear Creek	1.27	8.87	0.14	0.31
Big Canyon	5.09	2.03	2.51	0.95
Confluence	0	0	0	0
East Hyampom	1.77	5.50	0.32	0.23
East Jud	3.64	0.86	4.21	1.52
East Middle Rusch	0	0	0	0
Grassy Flat Creek	0.77	2.59	0.30	0.76
Grassy Mountain	0.74	2.53	0.03	0.19
Halfway	0	0	0	0
Headwaters Little	0.26	1.57	0.17	0
Headwaters Olsen	0	0	0	0
Headwaters Rusch	0	0	0	0
Jud Creek	7.91	2.66	2.97	5.29
Lower Little Creek	7.54	7.51	1.00	1.24
Lower Olsen Creek	0	0	0	0
Lower Rusch Creek	0	0	0	0
Pattison	0.18	18.78	0.01	0
Rusch 1	0	0	0	0
Rusch 2	0	0	0	0
Rusch 3	0	0	0	0
Rusch 4	0	0	0	0
West Fork Rusch	0	0	0	0
West Middle Rusch	0	0	0	0

Year Long Closure Road Density				
Sub Watershed	**Miles**	**Sq. Miles**	**Road Miles/per Sq. Mile**	**Maintenance Level 1 Road Miles**
Bear	0	0	0	0
Bear Creek	0	0	0	0
Big Canyon	0.13	2.03	0.06	0.13
Confluence	0	0	0	0
East Hyampom	2.10	5.50	0.38	1.40
East Jud	0	0	0	0
East Middle Rusch	0	0	0	0
Grassy Flat Creek	0.86	2.59	0.33	0.86
Grassy Mountain	3.55	2.53	1.40	3.55
Halfway	0	0	0	0
Headwaters Little	0.53	1.57	0.34	0.53
Headwaters Olsen	1.45	3.34	0.43	1.45

Year Long Closure Road Density				
Sub Watershed	**Miles**	**Sq. Miles**	**Road Miles/per Sq. Mile**	**Maintenance Level 1 Road Miles**
Headwaters Rusch	0	0	0	0
Jud Creek	0.59	2.66	0.22	0.59
Lower Little Creek	0	0	0	0
Lower Olsen Creek	1.11	3.17	0.35	1.11
Lower Rusch Creek	0	0	0	0
Pattison	0	0	0	0
Rusch 1	0	0	0	0
Rusch 2	0	0	0	0
Rusch 3	0.46	0.28	1.64	0.46
Rusch 4	0.03	0.59	0.05	0.03
West Fork Rusch	0	0	0	0
West Middle Rusch	0.16	1.47	0.11	0.16

ROAD DENSITY TOTALS

TOTAL MILES 176.32

TOTAL SQ. MILES 76.27

= 2.31 miles/per sq. mile

TOTAL LEVEL 1
50.49 MILES

OPEN ROAD DENSITY

TOTAL MILES 136.18

TOTAL SQ. MILES 76.27

= 1.79 miles/per sq. mile

TOTAL LEVEL 1
29.73 MILES

SEASONAL CLOSURE

TOTAL MILES 29.17

TOTAL SQ. MILES 76.27

= 0.38 miles/per sq. miles

TOTAL LEVEL 1
10.49 MILES

YEAR LONG CLOSURE

TOTAL MILES 10.97

TOTAL SQ. MILES 76.27

= 0.14 miles/per sq. mile

TOTAL LEVEL 1
10.27 MILES

Hydrology

- What are the current conditions and trends of the dominant hydrologic characteristics and features prevalent in the watershed?

Table 1 shows the estimated cumulative watershed effects at each of the 24 subwatersheds within the Lower Hayfork Watershed Analysis area. Included in the table are:

1. The equivalent roaded area for both roads and timber harvest units;
2. The combined equivalent roaded area for both management activities;
3. The percent equivalent roaded area by subwatershed;
4. The square miles of road per square miles of subwatershed; and
5. Percent of the subwatershed occupied by plantations.

In determining the current conditions of the 24 subwatersheds, the cumulative watershed effects data is utilized by comparing percent of equivalent roaded area (% ERA) is compared to the Threshold of Concern. The following subwatersheds have a percent equivalent roaded area of less than 40% of the Threshold of Concern: Bear, Bear Creek, Lower Little, Pattison, Rusch1, Rusch2, and Lower Rusch. The following subwatersheds have a percent equivalent roaded area that is between 40% and 60% of the Threshold of Concern: Confluence, East Hyampom, Grassy Flat Creek, Grassy Mountain, Halfway, Headwaters Little, Headwaters Olsen, Jud, and East Jud. The following subwatersheds have a percent equivalent roaded area that is between 60% and 80%: Big Canyon, East Middle Rusch, Headwaters Rusch, Lower Olsen, Rusch3, West Fork Rusch, and Middle Fork Rusch. Rusch4 is the only subwatershed with a percent equivalent roaded area that exceeds 80% of the Threshold of Concern.

Road density is high in six watersheds in particular: East Middle Rusch, Headwaters Rusch, Lower Olsen, Rusch 3 and 4, and West Fork Rusch. The southern half of the Jud Creek Watershed also shows a high road density.

The cumulative watershed effects model is a great tool for identifying potential problem areas across the landscape. However, the relationship between thresholds of disturbance activities and their actual impact on the ecosystem needs to be better understood. The cumulative watershed effects model establishes thresholds of concern for erosion related disturbance activities. It does not, however, provide a measure of the actual amount of sediment present within streams or whether sediment is limiting productivity with the aquatic ecosystem.

Although qualitative evaluation of sediment levels has been completed within the Lower Hayfork Analysis Area, quantifiable information regarding sediment levels is lacking. There is only one quantifiable report of sediment levels in lower Hayfork streams, and this work, done within Rusch Creek did not indicate that sediment levels were a problem although "percent threshold of concern values" in portions of Rusch Creek were approaching the established 60% of threshold level. Without additional quantifiable information regarding sediment levels, the relationship between inferred and actual conditions cannot be established. This information should be gathered to evaluate both the strengths and limitations of the model.

Another limitation of the cumulative watershed effects model is that it may not adequately address the full range of cumulative watershed effects. Within Northern California bedload movement and sediment levels as well as water temperature and flow volumes are considered the predominant factors which limit productivity and function of the aquatic ecosystem. Because the model addresses erosion processes, it provides a means to evaluate possible limiting conditions that arise as a result of increased sediment levels. However, to adequately evaluate processes and conditions that affect water temperature and stream flows, additional analyses need to be completed. Thus, the cumulative watershed effects model alone cannot be used to identify limiting factors within the aquatic ecosystem as the model does not address the full range of cumulative watershed effects.

There is a slow, steady decline in total water yield as trees at clearcuts and other harvest units on National Forest lands grow toward maturity. The most notable change is a decrease in the duration of flood and peak flows between December and February. Reductions in total water yield do not appear to decrease baseflows significantly.

The major hydrologic concern is for baseflow quantities between August 1 and September 30 of each year. The following is an estimated range of baseflow values (in cfs) from August 1 to October 1:

August 1 - 20 cfs to 60 cfs.

August 15 & Sept. 1 - 7 cfs to 50 cfs.

Sept. 15 & Oct. 1 - 7 cfs to 35 cfs.

At lower baseflow values, stream temperatures during August and September can reach about 85 degrees Fahrenheit at Hayfork Creek. These lower baseflow values are a lesser, yet still significant concern during the months of June and July, when water temperatures can reach into the upper 70's. Between June 1 and July 30, the streamflow quantities can be more than four times greater.

Springs and Seeps

Some springs and seeps have been impacted by road construction and/or reconstruction.

Stream Channels

- What are the current conditions and trends of stream channel types, and sediment transport and deposition processes prevalent in the watershed?

Throughout the watersheds of the tributaries of Hayfork Creek, A and AA+ channel types tend to downcut into the streambed and transport the resulting sediment supply on downstream to the B channel types. The B channel types at the lower reaches of the tributaries and at bedrock confined channels efficiently transport most of this sediment into Hayfork Creek; they have a low to moderate sensitivity to disturbances and remain stable streams. These are normal processes reflecting the dynamic equilibriums of a healthy ecosystem.

There may be E channel types at meadows and/or wetlands that are undergoing channel dynamics that are converting them into C or G channel types. Channel processes such as accumulation of sediment at streambeds, streambank erosion, and channel widening can convert an E channel type into a C channel type. Channel dynamics such as downcutting, streambank erosion, and destabilization of riparian vegetation can result in a G channel type.

The stream reaches of Hayfork Creek from Little Creek to near the junction of the Hyampom Road and the Indian Valley (10) Road (about 2 miles upstream of the mouth of Hayfork Creek) are predominantly in a good to excellent condition. Photo interpretation, and a review of photographic slides taken during fisheries surveys and of topographic maps gives the impression that there are several reaches of C channel types mixed in with A and B stream types in this segment of Hayfork Creek. Either way, these are channels are in dynamic equilibrium with the upstream portions of the watershed and upper reaches of Hayfork Creek. Stream reaches with a gradient of at least 2% - at bedrock confined sites and gorges, such as at the mouth of Miners Creek - have B channel types. Cascades, steep riffles, and some reaches dominated by boulders are classified as A channel types.

From the junction of the Hyampom Road and the Indian Valley Road on downstream to the mouth of Hayfork Creek, cumulative watershed effects are evident. There is an unstable D bedrock channel type near the road junction; it is abraided with bedload sediment transported from upper stream reaches. This channel type is slowly returning to a C channel type as the deposited bedload sediment is routed on downstream and the channel deepens and regains sinuosity. On downstream, the predominantly C channels are laden with high to very high amounts of sediment transported from upstream and Olsen Creek, and sediment from streambank erosion.

The percentage of perennial Riparian Reserve that is in plantation acreage varies from less than 1% at the Bear Creek and Pattison subwatersheds to an abnormally high 36% at the Headwaters Little Creek subwatershed. Most of the subwatersheds are in the 5% to 12% range.

Vegetation

- What are the current conditions and trends of the prevalent plant communities and seral stages in the watershed, riparian and nonriparian?

Current vegetative conditions were analyzed with the use of timber inventory data collected for the 1990 Land and Resource Management Plan (Shasta-Trinity N.F., 1993), and the 1992-93 Ecological Unit Inventory of existing vegetation for Analysis Areas Canyonlands (C1), Hyampom Earthflows (D), Halfway Rigdelands (E), Jud-Rusch (G) and Little Creek (I). The latter procedure consisted of photo interpretation and vegetation community delineation of aerial photographs taken in 1990. Delineated stands were classified according to the LRMP timber stratification, wildlife habitat stage (Mayer and Laudenslayer, 1988) and seral stage (USDA Forest Service, 1994). Within the Ecological Unit Inventory, the delineations and classification were extensively field verified and additional data collected.

The majority of the watershed is described by LRMP data, and discussions of seral stage and stand condition will be derived from size class and density data for the 1987 Burned (F1 and F2) and Pattison Roadless (H) analysis areas (Tables 1 and 2). An analysis of seral stage distribution based on 1992-93 Ecological Unit Inventory data is provided for the majority of the analysis areas Canyonlands, Hyampom Earthflows, Halfway Ridgelands, Jud-Rusch and Little Creek.

Table 1: 1990 LRMP Timber Size Classes

Seral Stage	Size class	Crown Diameter
sapling	1	0-5 feet; seedlings & saplings
early mature	2	6-12 feet; poles
mid mature	3	13-24 feet; small to medium timber
mid- to late mature	4	25-40 feet; large sawtimber
late mature to old growth	5-6	Greater than 40 feet; two-storied

Crown diameter classes are based on predominant crown size of commercial species stands or components of stands.

Table 2: 1990 LRMP Timber Crown Cover (Density)

Density Code	Crown Cover
S	Less than 20%
P	20-39%
N	40-69%
G	Greater than 70%

Crown cover percentages apply only to commercial component of total stand density. Ratio is total crown area to polygon area.

Landscape Ecology

To adequately describe broad vegetative patterns and disturbance regimes the watershed may be subdivided into seven analysis areas. These were based upon an analysis of landscape elements. These are Olsen Creek (C2) and the Canyonlands (C1), the Hyampom Earthflows (D), the Halfway Ridgelands (E), the 1987 Burn (F1 and F2), Jud-Rusch Creek (G), the Pattison Roadless Area (H) and Little Creek (I).

Olsen Creek and the Canyonlands area (3531 acres) lie within the Rattlesnake Creek terrain and Weaverville formation in lower, steeper portions of the Lower Hayfork Creek watershed. The analysis area as a whole is characterized by medium to high density, mid to late seral Douglas-fir and Douglas-fir hardwood communities. Road density is low within the Canyonlands portion of the analysis area, but is higher within the Olsen Creek portion. Butter Creek and Hayfork Creek join the fourth Scenic Segment of the South Fork Trinity River. Chinook salmon, steelhead and rainbow trout are present. Communities occupying lower slope positions within the Olsen Creek drainage exhibit snags as evidence of the 1987 burn, but otherwise have remained relatively untouched by fire. Mid- to late seral Douglas-fir occupies approximately 65 percent of the analysis area, although canyon live oak, Jeffrey pine, sugar pine and gray pine form small inclusions on southeastern aspects. Scattered individuals of knobcone pine are also present on southeastern aspects within the upper one third of the Olsen Creek drainage. Pine plantations occupy approximately 10 percent of the Olsen Creek portion of the analysis area.

The Hyampom Earthflows area (5388 acres) is included within the Rattlesnake Creek terrain and is characterized by undulating earthflow-mantled slopes. Ultramafic outcrops, springs, and numerous small meadow openings, including Grassy Flats, contribute to floristic diversity. Seventy-five percent of the analysis area is occupied by mid to late seral Douglas-fir communities, many with a white fir, incense cedar, ponderosa and/or sugar pine component. Poison oak and grasses comprise the dominant understory vegetation. Mixed conifer (5 percent), grasslands (2 percent) and hardwood stands dominated by black oak (<1 percent) occur in small patches. Numerous, well dispersed plantations cover approximately 14 percent of the analysis area. The Hyampom Earthflows are bounded to the north by County Road 301 (Hyampom Road) and by Hayfork Creek to the northeast. Hayfork Creek supports an important anadromous fishery. Grassy Flat and Walker Creek also fall within the analysis area. Road density is relatively high.

The Halfway Ridgelands Analysis Area (2200 acres) lies within the Ironside Mountain Batholith, a complex of intrusive diorites and quartz-diorites. It is characterized by steep, highly dissected slopes. Big Canyon Creek is in the analysis area, and Hayfork Creek borders it to the north. Sites are generally of low productivity, having steep slopes and shallow, rocky soils. Greater than eighty percent of the analysis area is occupied by mid-to late seral Douglas-fir and mixed conifer communities, but the matrix is highly fragmented, with approximately 16 percent of the land area occupied by plantations. Road density is high.

The 1987 Burn (4827 acres) is located in the northwestern portion of the Lower Hayfork Creek watershed and, like the Canyonlands, lies primarily within the Rattlesnake Creek terrain. Due to the fire and subsequent salvage activities, extensive plantations occupy the Bear and Gulch burns. Ultramafic soils within the Gulch burn area support stands of mixed conifer, Jeffrey and gray pine, and black oak. At lower elevations within the drainage, madrone, relict grey pine, buckbrush and manzanita dominate areas that experienced stand replacement fires. Northwestern aspects generally experienced light understory burns. Canyon live oak is the dominant hardwood species on moister, high elevation sites. Fifty-two percent of land within the analysis area is in mid-to late seral Douglas-fir and Jeffrey pine, 14 percent is in ponderosa pine plantations and 19 percent is in hardwood or shrub-dominated communities. Stand densities range from predominantly sparse in the Gulch burn, (< 20 percent cover) to good (>70 percent cover) in Douglas-fir dominated communities of the Bear burn. Road density is moderately high.

The Jud-Rusch Creek area (9282 acres) lies within the Ironside Mountain batholith and Rattlesnake Creek terrain, and is characterized by moderate to steep slopes surrounding the Jud and Rusch Creek drainages. It is bounded to the north by Hayfork Creek and partly to the west by Halfway Ridge. Low gradient areas, including small ultramafic inclusions dominated by mixed conifer and Jeffrey pine, occur at higher elevations within the upper end of the Rusch Creek drainage. Seventy-one percent of the analysis area is occupied by mid seral Douglas-fir and Douglas-fir/canyon live oak communities, with ponderosa pine as a subdominant in approximately 25 percent of the stands. Inclusions of older Douglas-fir and mixed conifer stands occupy approximately 14 percent of the analysis area. Stringers of late seral and old-growth

Douglas-fir are present in the riparian zone, up through mid-elevation reaches of the Jud and Rusch Creek drainages. Numerous, widely dispersed harvest units and pine plantations occupy approximately 10 percent of the landscape. Road density is high.

The Pattison area (19,638 acres) is the largest of the analysis areas. It is underlain by the Ironside Mountain batholith and Weaverville formations and is characterized by steep (60-80 percent), highly dissected south-facing slopes and shallow, droughty metavolcanic soils. Gravelly loams and cobbly subsoils support communities that have been maintained historically by fire. Extensive stands of Douglas-fir and canyon live oak are interspersed with pure hardwood stands on the upper slopes and ridgelines. Mid seral Douglas-fir communities occupy 50 percent of the analysis area, hardwood communities 26 percent, gray pine and knobcone pine 3 percent and shrub and other non-forest land 3 percent. Miners Creek, West Fork Miner's Creek, and Bear Creek are the major drainages. Botanical surveys have not been conducted to date within the analysis area.

The Little Creek area (3855 acres) extends from Hayfork Bally south to Hayfork Creek. Approximately 60 percent of the analysis area burned in 1955, leaving a matrix of mid seral Douglas-fir communities (48 percent) and young pine plantations (12 percent). Minor components are hardwood and shrub-dominated communities (11 percent) and relict stands of late seral Douglas-fir and white fir. Road density in the area is relatively high.

Plant Communities

Current vegetation patterns based on the LRMP inventory of vegetation types in the Lower Hayfork Creek Watershed tend toward fragmentation and a movement from mixed conifer and Douglas-fir dominated communities to ponderosa pine over time. Eight vegetation types have been mapped in the Lower Hayfork Creek watershed. The matrix, the most abundant and connected vegetation type, consists of mid- to late seral Douglas-fir forest. With an area of 21,779 acres, the matrix covers just over one third of the landscape. Outside of the roadless areas, approximately 10 percent of the watershed is comprised of plantations with a patchy distribution. The smaller patches are the result of clearcut harvest while the continuous large patches are the result of salvage logging after fire. The majority of these have been replanted to ponderosa pine. Much of this fragmentation has occurred within the mixed conifer and Douglas-fir forested areas of the Halfway Ridgelands, Little Creek and Jud-Rusch, where approximately 16 percent, 12 percent, and 10 percent of each analysis area, respectively, is occupied by plantations. The vegetative patterns of the remaining area reflect highly diverse topographic elements and accompanying disturbance regimes. Topographic elements of most influence are slope and aspect. Fire is the disturbance regime having the greatest effect on the distribution of plant communities in the watershed.

Seral stage information (using a crosswalk of seral stage to LRMP) follows the same trend. For the watershed as a whole less than one percent is in old growth conditions, 10 percent in late seral conditions, 63 percent in mid and early mature stages, and 26 percent in very early mature, plantation, shrub or herb seral stages.

Nearly one tenth of the early seral stage acres recorded in the 1990 LRMP data, however, were in the area burned over in 1987. The 1987 burned area has a seral stage distribution of less than one percent in remnant late seral and old-growth, 52 percent in mid-seral stages and 48 percent in very early, shrub and herb seral stages. Commercial timber stands within Olsen Creek and the Canyonlands have experienced relatively little harvest activity and show a seral stage distribution of approximately one percent in late seral and old-growth, 71 percent in mid-seral stages and 28 percent in very early, shrub and herb seral stages.

Additional plant communities found in the Lower Hayfork Creek watershed that are small in areal extent but that contribute to the overall diversity of the landscape include the white oak communities and dry meadows within the Hyampom Earthflows analysis area, and the Oregon ash and other wetland communities at Deadman's Point and surrounding areas.

Potential Natural Terrestrial Vegetation Communities

The vegetation patterns and community composition and structure of the Lower Hayfork Creek flora are controlled by four environmental gradients. They are elevation, precipitation, soil texture as it determines available water capacity of the soil, and the chemical composition of the soil-forming parent rock.

A standardized, hierarchical classification system for potential natural communities is used by federal agency ecologists as well as academicians and non-governmental organizations (USDA Forest Service, 1993). The plant association is a potential natural plant community of definite floristic composition and uniform appearance. It is the lowest level of potential natural community classification. For analysis at the watershed level, mapped plant associations were aggregated into groups with like environmental indications and responses, also known as sub-series. The series is the next highest level of hierarchical classification. Series level analysis is useful for broad, general regional and provincial questions. The series found in the Lower Hayfork Creek watershed are described here to facilitate an understanding of the environmental conditions that the series indicate.

There are four distinct potential natural vegetative series within analysis areas Canyonlands, Hyampom Earthflows and Halfway Ridgelands of the Lower Hayfork Creek watershed. These are the only analysis areas described for the watershed as they were the only ones mapped under the Ecological Unit Inventory. At higher elevations where temperatures are cooler and soil moisture is not limiting, a few white fir plant associations are found in Grassy Flats Creek. Jeffrey pine is the climax species in frost pockets and on highly serpentinized soils. As soil temperatures and winter air temperatures decrease, Douglas-fir plant associations dominate. Mixed conifer series occur on warmer, drier sites characterized by high plant moisture stress, soil drought and lighter snowpacks. Grey pine and canyon live oak series associations are found on harsh, dry, low elevation sites often having skeletal soils and rock outcrops.

There are approximately 95 acres of white fir series potential natural communities in analysis area D. These stands of white fir potential are found entirely above elevations of 2800 feet. These stands are dominated by white fir with lesser amounts of Douglas-fir, incense cedar and sugar pine.

The moist white fir group is associated with stream courses near the headwaters of Grassy Flats Creek. California hazel and dwarf Oregon grape are the common understory indicators of these types. They are most commonly found on densely forested riparian areas or moist lower slopes. The common species found in the herbaceous layer include Hookers fairybells, rattlesnake plantain, bedstraw, stream yellow violet, one-sided wintergreen and false Solomon's seal.

The Douglas-fir series potential natural communities are the most prevalent in the watershed. The plant associations of the Douglas-fir series can be segregated into three distinct groups indicating variation in environmental conditions within the series. They are - moist/riparian (approximately 60 acres), mesic/canyon live oak (3850 acres) and dry/California fescue (2025 acres).

The conifer canopy for the most part is comprised of Douglas-fir, white fir, sugar pine, ponderosa pine and and incense-cedar. The most common hardwood species are canyon live oak, madrone, giant chinquapin and black oak.

The moist Douglas-fir plant associations are found consistently in the lower reaches of several of the major tributaries, including Grassy Flats Creek and Big Canyon Creek. For the most part, big leaf maple is consistently found on these sites. Common understory associates include California hazel, dwarf Oregon grape, snowberry and poison oak. Common herbaceous species include swordfern, Hooker's fairybells and false Solomon's seal.

The mesic Douglas-fir plant associations are the most common group within analysis areas Canyonlands, Hyampom Earthflows and Halfway Ridgelands and are dominated by the presence of canyon live oak, which can be quite dense. This association is commonly found throughout the steepest portions of the analysis areas, with the exception of the headwaters of Big Canyon Creek. The shrub layer contains wild rose and snowberry. The herb layer in comprised of prince's pine, wintergreen, hawkweed, rattlesnake plantain, wild iris, trail plant, little prince's pine, starflower, twinflower and bedstraw. The grass layer may be diverse, with western fescue, mountain brome, California fescue and oniongrass as the dominant species.

Dry Douglas-fir communities occupy approximately 28 percent of the area encompassed by Canyonlands, Hyampom Earthflows and Halfway Ridgelands and are dominated by an overstory predominately of Douglas-fir with white oak in about 16 percent of the sites. Lower hillslopes surrounding Fir Root Spring and the Walker Creek drainage are typed as dry Douglas-fir potential. The shrub layer is sparse but may include poison oak and wild rose. The herb layer may include mountain sweetroot, yarrow, bedstraw and wild iris. The grass layer is prominent, with California fescue being the dominant species along with smaller amounts of lemon needlegrass and bromes.

The mixed conifer plant associations are the second most common in the watershed. They are the dominant types in the headwater areas of Grassy Flats Creek and Big Canyon Creek. It is useful to subdivide this series into three broad groupings based on climatic indication. These are mixed conifer/riparian-mesic, mixed conifer/dry and the most extensive, mixed conifer/canyon live oak.

There are approximately 350 acres of the mixed conifer/riparian-mesic group in analysis areas C1, D, and E of the Lower Hayfork Creek watershed. The more mesic types are found extensively along tributaries forming the headwaters of Big Canyon Creek. These plant associations are found on all aspects but are most common on east and north slopes. They occur on more productive soils than the other groups in the mixed conifer series. The overstory of this group is usually comprised of various combinations of ponderosa pine, white fir, giant chinquapin, Douglas-fir, incense cedar and smaller amounts of sugar pine. The common understory species include California hazel, dwarf Oregon grape, snowberry, wild iris and prince's pine.

The mixed conifer/dry plant associations cover approximately 350 acres of analysis areas Canyonlands, Hyampom Earthflows and Halfway Ridgelands. The dry plant associations are intermediate in productivity, occurring primarily on west and south slopes. They are most common around Grassy Flats and within the upper portion of the Grassy Flats Creek drainage.

The mixed conifer/dry plant association group is characterized by an overstory comprised of several conifer species including ponderosa pine, white fir, incense cedar, Douglas-fir and sugar pine. The understory is usually shrub poor, except where huckleberry oak or wedgeleaf ceanothus occur in abundance. Common herbaceous species include California fescue, wild iris and white hairy hawkweed.

The most common plant associations in the mixed conifer series are those of the mixed conifer/canyon live oak group, comprising approximately 925 acres, or 11 percent of analysis areas Canyonlands, Hyampom Earthflows and Halfway Ridgelands. These plant associations occur extensively in the canyonlands and in the headwaters of Big Canyon Creek, as well as other steep sites with rocky soils. These are commonly on south or west slopes. These plant associations are characterized by an abundance of canyon live oak in the overstory and understory, accompanied by Douglas-fir, ponderosa pine, incense cedar, madrone and to a lesser extent, white fir.

The gray pine plant associations are less common (220 acres) in analysis areas Canyonlands, Hyampom Earthflows and Halfway Ridgelands but ecologically are quite important. They represent some of the least productive and most sensitive sites in the watershed. They occur in small areas within analysis area E, and within the Canyonlands, especially near the mouth of Grassy Flats Creek. They are found on dry, south-facing slopes having skeletal rocky soils. They are characterized by the presence of large amounts of canyon live oak with scattered individual gray pines.

Riparian Vegetation Communities

Vegetation of riparian areas functions to maintain stream and ecosystem health through controls on local channel morphology (Beschta & Platts, 1986), patterns of sediment, nutrient (e.g. allochonthous inputs), wood routing and deposition, and on the demographics of aquatic and riparian-dependent species. It is estimated that approximately __ percent of these streams support perennial riparian vegetation, most of which falls within higher order channels. Because the density of intermittent streams on federal lands within the range of the northern spotted owl is about 90 percent greater than previously estimated by the agencies (FEMAT Report, 1993) and the variation around this figure is great (M. Furniss, personal communication), the figures quoted in this section must be considered only a first approximation of actual stream density.

Riparian vegetation composition within the Lower Hayfork Watershed appears to be influenced by channel aspect, gradient, geomorphology, and hydrologic regime, as reflected by stream order. Upland plant communities located on the valley bottom floor or toeslope positions contribute shade and large wood to the system, and may be inundated during periods of peak flow. Many riparian areas host relatively high numbers of large trees as compared with the adjacent uplands, presumably due to a favorable topographic position (protected from intense stand replacing fires) and environment. Communities well-adapted to the moister conditions of the riparian zone are present and often consist of species that are tolerant of saturated soils associated with frequent flooding or a high water table. Additionally, opportunistic "pioneer" species may colonize in these areas characterized by repeated disturbance.

The Lower Hayfork Creek watershed may be stratified most simply by geomorphology. The majority of the drainages within the watershed consist of high gradient, bedrock and colluvium-controlled A and Aa type channels (Rosgen 1994) that flow in response to storm events, but that show relatively low flows during summer months. Field checks in July through October of 1994 in the Jud-Rusch Analysis Area showed that none of the first-order streams surveyed carried free flowing water. However, field checks conducted in January 1995 during a storm event showed that approximately 80% of crenulations carried water, and that additional water emerged from subsurface flow in a number of locations, visible notably at roadcuts. Due to the preceding eight years of drought, it is difficult to ascertain the periodicity and intensity of flow in these channels.

When stratified by stream order and fluvial surface, community types generally show a greater affinity to stream order, although the species of which they are comprised (e.g. spikenard) may be more closely associated with a given moisture regime and geomorphic surface than with stream order per se. For example, white alder communities typically appear within second through fifth order drainages, most notably on floodplains and islands. Pacific yew communities show no great fidelity to any one environment, but occur primarily on floodplains and terraces within second through fourth order drainages.

Many of the second, third, and fourth order tributaries to Hayfork Creek are typified by B type channels at the lower end and support late mature conifers and hardwoods on the floodplain and terraces. Poorly confined lower gradient streams, seeps, and sag ponds occur on old earthflows, notably within the northern end of the Jud-Rusch analysis area and within much of the Hyampom Earthflows and Halfway Ridgelands analysis areas. The majority of Hayfork Creek is characterized by C type channel that alternates between bedrock- and alluvium-controlled sections.

Hydrologic regime and stream geomorphology appear to be the most significant factors determining species composition within the riparian area. Soils within much of the watershed are highly erosive, and downcutting is observed within many of the high to moderate gradient, higher order channels. Where the moisture gradient is extremely steep, as in gullied systems (G type channels), riparian vegetation is limited to a narrow band of herbaceous species immediately adjacent to the active channel. Riparian vegetation ranges from absent in the driest ephemerals and intermittents, to bigleaf maple/spikenard in first order channels that are moist enough to support perennial riparian species. Where the channel is an intermittent, sclerophyllous species, including prince's pine, dwarf Oregon grape and chinquapin, frequently co-occur with more hydrophytic species. Refer to Appendix _ for a full description of riparian vegetation communities found within the Jud-Rusch portion of the watershed.

Most lower elevation, first and second order riparian communities are dominated by Douglas-fir or by Douglas-fir and canyon live oak. Vegetation composition along intermittent streams does not vary substantially with elevation. Big leaf maple is ubiquitous, occurring in both perennial and intermittent channels, but white alder, mountain dogwood and Pacific yew appear to be limited to higher-order channels where water availability is greater year-round. Alder occurs most frequently on active channel shelves and floodplains where frequent flooding and high light levels permit establishment, such as in the lower reaches of Jud and Rusch Creeks, along Hayfork Creek and on the banks of perennial streams adjacent to or contained within clearcuts. Pacific yew occurs on floodplains, terraces and stream banks at the moistest sites, and is frequently associated with old-growth Douglas-fir and a well-established shrub component of dogwood and/or California hazel. Spikenard was found on nearly 50% of sites sampled within the Jud-Rusch area (Aquatic Ecological Unit Inventory, Hayfork RD, 1994) and, though it appears occasionally in intermittent channels, it seems to require a perennial water source and is probably indicative of seeps within drier headwater areas.

Higher order (i.e., third, fourth, and fifth order) channels offer a wider range of geomorphic surfaces and moisture regimes, and thus support a greater number of community types than first and second order channels. Forested floodplains and terraces generally support a mix of Pacific yew and hardwoods, including shrubs, while the open bars and bedrock channel shelves of Hayfork Creek host Indian rhubarb, sedges, including *Carex nudata*, white alder, and a variety of shrub species. The degree to which elevation influences the distribution of riparian species is not clear. Within the Lower Hayfork watershed the elevation range is relatively narrow and few higher-order channels are present above 4500 feet. White fir (*Abies concolor*) dominates the overstory at elevations above 5500 feet.

Insolation appears to influence the distribution of riparian plant communities. The degree to which a channel is incised determines to some extent the amount of solar radiation received by, and the relative humidity of, that channel environment. It is clear that there is a certain degree of confluence influence, the increased humidity found near the mouth of tributaries draining into higher order channels. Due to microclimatic factors, riparian vegetation may persist for several hundred feet up a tributary that would otherwise not support hydrophytic species.

Channel verification work conducted between September 1994 and May 1995 showed that 66% and 52% of stream segments identified in Hyampom Earthflows, Halfway Ridgelands and Jud-Rusch, respectively, had not been previously mapped by the U.S.G.S. Of those, approximately 10% to 16% could not have been anticipated from topography alone. Sixty percent of channels verified in Hyampom Earthflows and Halfway Ridgelands exhibited perennial vegetation, and those that did not support vegetation were first order intermittents. A number of seeps supporting spikenard, chain fern, rushes, bigleaf sedge and other obligate hydrophytes were observed along roadcuts.

Riparian Condition

Riparian conditions within the Lower Hayfork Creek watershed generally reflect channel conditions. Changes in stream gradient, velocity, and sediment load are manifested by changes in fluvial surfaces and, ultimately, by changes in the composition and distribution of riparian vegetation.

Mining, livestock grazing, roading and past timber harvest have led to increased sediment loads and bank erosion, apparently as the result of sluice-action flood events. Riparian dependent species estranged by a lowered water table may be confined to a narrow swath flanking the channel, and encroachment of upland species onto abandoned floodplains may be observed. Where extensive gravel deposits are present as a result of dredging activity, willows and exotic herbs often dominate.

In addition, fluvial and hillslope processes, as well as fire, introduce a series of disturbance vectors that shape riparian vegetation. While flooding and channel reworking may be the primary forces acting on many streams, it is also evident that earthflows, landslides and debris flows control channel morphology, especially in small mountain streams (Grant & Swanson, 1995). Late seral and old-growth stringers frequently observed in confined valley bottoms are evidence of the unique fire regime that frequently separates riparian from upland sites.

Within Hyampon Earthflows, Halfway Ridgelands and the Jud-Rusch areas, road crossings and skid trails have altered channel morphology, notably in intermittent drainages. Throughout the watershed, on National Forest System lands, streamside management zones (SMZs) have been applied since 1980 to intermittent and some ephemeral channels. Prior to 1980, only perennial streams were protected. Ephemeral streams have been impacted by harvest activities, piling and burning. Intermittent and perennial streams have generally been impacted by activities associated with selective harvesting.

Special Forest Products

With the decline in the harvest of timber on National Forest Lands there has been a shift in the types of products being extracted from the forest. The extensive transportation system has made it an easy area to access for these special products which include: firewood, mosses, cones, herbs, wildflowers and products for the medicinal herb and floral trade.

The Forest is committed to community stability for the timber dependent communities of northern California. There are many efforts currently underway to diversify the economics of these areas. This includes special forest products and cooperation with local groups working on job re-training and contracting and a community based Geographic Information System. Currently the Watershed Center and PSW are developing proposals for research and monitoring and a contract inventory has been completed for special forest products.

With the dwindling timber harvest on public lands, people in forest dependent rural communities are seeking alternative sources of income. Special forest products are increasingly recognized as underutilized and potentially lucrative resources that may partially help to fill the need. Products ranging from mushrooms, pine cones, lichen-covered sticks and medicinal herbs to value-added wildcrafting products such as floral wreaths, manzanita burls, and madrone furniture, are being gathered from public lands throughout the Pacific Northwest.

The mandate of the USDA Forest Service is shifting to include working with rural people and communities to develop strong, diversified and sustainable rural economies consistent with sustainable ecosystem management principles (Thomas, 1994). Special forest products are recognized as an important component of such efforts and a National Strategy for Special Forest Products is currently under development.

Current permits for special forest product harvest are granted on a ranger district wide basis and it is difficult to specify exactly what the current interest and harvest volumes of special forest products in the Lower Hayfork Creek watershed are. However, the trend on the Hayfork Ranger District may be assumed to be indicative of growing interest in special forest products in the area. In 1990 and 1991 only one use permit was logged on the district. In 1992 there were suddenly 16 permits; in 1993 eighteen, in 1994 twenty-three and in 1995 there were 6 permits issued.

Special Use Permits on the Hayfork Ranger District have been issued to allow collecting rights for pine cones (Jeffrey pine, gray pine, sugar pine and Douglas-fir), mushrooms, beargrass, ferns, conifer seedlings, manzanita, dogwood, prince's pine, boughs, items for the commercial floral trade, yarrow and other miscellaneous products. There is also a consistent demand for Christmas tree cutting permits. There were 400 Christmas tree permits sold on the district in 1993, in 1994 there were 213 and in 1995 280 were sold. In addition, there may be considerable volume of harvesting occurring without permits.

Plant Species of Concern

Current habitat conditions appear to be relatively healthy for Niles' madia and Canyon Creek stonecrop. Some habitat for Niles' madia has probably degraded since 1944 due to fire exclusion and will continue to do so unless fire is reintroduced. Other causes of degradation that will probably continue into the future without management intervention are invasion by exotic pest plants and soil disturbance by heavy equipment. Habitat for Canyon Creek stonecrop is unlikely to be significantly affected in the future unless extensive rock quarrying takes place.

Habitat for the old-growth associate, mountain lady's slipper, appears to be present throughout the watershed. Much of it has has been reduced and degraded through past logging; this trend is likely to continue. This species appears to tolerate little disturbance.

Habitat for the exotic pest plants, yellow star thistle (*Centaurea solstitialis*), bull thistle (*Cirsium vulgare*), and cheat grass (*Bromus tectorum*) is abundant throughout the watershed and will probably increase with future disturbance-related management activities, such as logging and road building.

Fire has played and will continue to play an important role within the Lower Hayfork landscape. Over 80 years of recorded fire history, from 1911 to the present, exempting years 1957 through 1967, (no records can be found for these years) shows a total of 242 fire starts; 171 lightning caused fire starts and 71 human caused. The largest documented catastrophic fire event for the watershed was in August and September of 1987 when dry lightning ignited three separate fires that burned into the watershed: The Trinity Fire burned 1,000 acres within the watershed; the Bear Fire (5,750 acres total) burned in excess of 3,000 acres within the watershed; and the Gulch Fire (6,800 acres total) burned in excess of 2,000 acres within the watershed, fire effects ranged from low to extreme. The Trinity Fire had the least intensity burn and was inside the natural range of variability. The Bear and Gulch Fires had the most intense burns, consuming and/or causing mortality to practically all vegetation on the southern aspects. Cumulative effects from the Bear and Gulch fires are outside the natural range of variability.

During the 1995 field season Carl Skinner, PSW Redding, and Alan Taylor from Penn State University collected data from tree rings to identify the role of fire on the landscape over the past couple of hundred years. Initial data samples indicate a high fire return interval of from 5 to 10 year, with some point samples indicating annual fire scars (Personal communications & documents from Carl Skinner, PSW Research Lab, Redding, Ca. 1995-96).

In the field of fire and fuels management "Risk" is a wildfire causative agent, such as lightning, chainsaws or campfires. Risk management would eliminate or reduce sources of firebrands (intense heat sources). "Hazard" is a rating assigned to a fuel complex that reflects its susceptibility to ignition, the wildfire behavior and severity it would support, and/or the suppression difficulty it represents. A fuel complex is defined by kind, arrangement, volume, conditions, and location. Hazard ratings are generally subjective, ranging from very low (green grasses and conifer litter) to extreme (cured grass and heavy slash) (Deeming, 1990). A fuels reduction program can pursue one or both of two strategies: risk management; or hazard management.

Jon Wideman, Implementation Fuels Specialist S.F.M.U., with input from the Shasta-Trinity N.F. Fuels Committee, completed the South Fork Management Unit "Hazard Risk Analysis". Hazard risk analysis is the process of determining the estimated fire behavior of a given land base. It incorporates into the analysis such features as aspect, slope, fuel model, and weather conditions. The output of the analysis is rated by considering flame length and rate-of-spread. Areas with low rate-of-spread would most likely have a slow burning fire, low rate-of-spread, and short flame lengths. Areas of high ratings would most likely have fast moving fires with flames reaching well into the overstory canopies.

The Hazard and Risk Analysis Map indicates the Lower Hayfork Creek Watershed as having medium and high ratings.

Urban interface areas are present throughout and adjacent to the watershed. The community of Hyampom is partially inside the western portion of the watershed and the community of Hayfork is on the eastern border. All recorded human caused fires have been either in these urban interface areas or along roads and trails, with the majority of human fire starts in the Hyampom area. Lightning fire starts are pretty well distributed throughout the watershed, with the majority occurring in the Pattison Roadless Area, which is the largest portion of the watershed.

Plantations

Plantation is defined as a forest stand raised artificially either by sowing or planting. Over 90% of the plantations within Region 5 were established after 1960. Plantations account for about 500,000 acres within the Region. These plantations were costly to establish, with current cost estimates at approximately $1,000 to $3,000 per acre, protecting these plantations from wildfire is a major management concern (Landram, pers. comm. 1992 - Irwin, et al. 1991).

In 1987 fires burned over 90,000 acres of plantations within Region 5 (Denton, 1991). Assessing factors associated with plantation damage from the 1987 Hayfork Lightning Fires, Weatherspoon and Skinner (In Press), found method of site preparation was among the most significant variables which affected degree of damage. Plantations that were planted without site preparation received the most damage (all plantations surveyed were completely destroyed), sites that were machine piled and burned received less damage and areas which had been previously broadcast burned sustained the least amount of fire damage. The presence and amounts of grass and forbs, understory cover, aspect, and elevation were also noted as significant.

Treating fuels in and adjacent to plantations is a proven method of protection, but also costly (Forbes, 1990). While budgets for fire suppression organizations continue to increase, natural resource and property losses from wildfire have not decreased (Irwin et al. 1991).

There are multiple fuel treatment alternatives which would serve to help protect plantations from fire damage, most involve modification of fuel loadings, arrangement, and continuity.

If the plantations within the watershed are to mature into the forests of the future, protection from wildfires should be one of the primary areas of management focus.

Fire is a natural and primary part of the ecosystems of Lower Hayfork Creek Watershed and fuels management based on an overall watershed approach is essential to reduce the risk to life, property, and resources.

Regulated Forest Opportunities

Forest Goals

- Provide a sustained yield of timber and other wood products to help support the economic structure of local communities and to supply regional and national needs (Timber #35, page 4-5).

Forest-Wide Standards & Guidelines

- Emphasize the regeneration harvest of understocked and poorly-growing stands, whether using even or uneven-aged systems (Timber e., page 4-27).

Matrix Lands (Description)

- Substantial portions of the management direction for the Forest were directed by the NW ROD (Introduction, page 4-1).
- Regulated harvest from Matrix (and AMA) lands (NW ROD, table on page A-4).
- Production of timber and other commodities is an important objective for the Matrix (NW ROD, page B-1).
- Most timber harvest and other silvicultural activities would be conducted in that portion of the Matrix with suitable forest lands, according to standards and guidelines. Most scheduled timber harvest (that contributing to the probable sale quantity [PSQ] not taking place in Adaptive Management Areas) takes place in the Matrix (NW ROD, page C-39).

Management Prescriptions

- Timber yields from Prescriptions III, VI and VIII are regulated harvests and are chargeable to the Allowable Sale Quantity (Appendix L, page L-7).
- Prescription VIII - Intensive (Timber) Management is identified as an Emphasized Management Practice. "This timber management regime assumes a wide range of...silvicultural treatments including...appropriate final harvest methods...including regeneration cutting systems such as clearcutting, green tree retention, and shelterwood cutting" (Appendix L, page L-7).

Tentative Ten-Year Timber Sale Program

- Reasons for Harvest - Stands to be managed intensively-Harvests will be carried out for the following purposes...to regenerate stands to meet regeneration acreage allocations to provide planned future yields (Appendix C, page C-1).
- Harvest Priority - Regeneration is the means by which productivity can be increased and regulation approached. The understocked and poorly-growing strata should receive first consideration (Appendix C, page C-1).
- Timber Management Controls - The Forests' goal is to approach regulation through scheduled regeneration harvests over a period of time called the "conversion period". Regeneration harvests to achieve regulation include 2,000 acres of green tree retention and 1,500 acres of selection cutting per year (Appendix C, page C-3).

Estimated Lower Hayfork Creek CAS Availability

The following tables itemize the estimated number of CAS acres available within the Lower Hayfork Creek analysis area displayed by subwatershed. Information presented is as per the LMP90 database. The following components and assumptions were used in constructing this table: 1). Prescription III, VI, and VIII lands only by subwatershed, minus buffered Riparian Reserve acres; 2). Productivity class High and Low for density S and P; productivity class High, Low, and Null (un-attributed) for density N and G; 3). Plantations are located upon suitable lands only; 4). that an additional 15% of indicated available lands are unmapped Riparian Reserves; 5). Hayfork Creek, from Nine Mile Bridge downstream to Hyampom, which has been nominated in the Shasta-Trinity NF LMP for possible inclusion into the National Wild and Scenic Rivers System as a "scenic" component, has not been classified as Prescription II and subtracted from the indicated CAS component; and 6). regenerability must be determined at the site-specific level to ensure adequate regeneration within five years of final harvest.

Subwatershed: Upper Rusch				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	453.0	385.1	0.0	0.0
2S	0.0	0.0	8.2	0.0
2P	0.0	0.0	8.2	0.0
2N	0.0	0.0	22.4	0.0
2G	13.5	11.5	22.4	257.6
3S	138.5	117.7	16.8	1977.8
3P	525.0	446.3	16.8	7497.0
3N	328.7	279.4	28.9	8074.7
3G	210.3	178.8	28.9	5167.3
4S	0.0	0.0	16.8	0.0
4P	0.0	0.0	16.8	0.0
4N	20.7	17.6	28.9	508.6
4G	90.5	76.9	28.9	2213.7
Sub-Total:	**1780.2**	**1501.8**		**25439.1**

Subwatershed: Lower Rusch				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	181.7	154.4	0.0	129.1
2S	27.3	23.2	8.2	190.3
2P	5.3	4.5	8.2	37.0
2N	45.8	39.0	22.4	872.1
2G	36.9	31.4	22.4	702.6
3S	55.4	47.1	16.8	791.1
3P	310.5	264.0	6.8	1794.7
3N	281.1	239.0	28.9	6905.2
3G	162.9	138.5	28.9	4001.7
4S	0.0	0.0	16.8	0.0
4P	43.9	37.3	16.8	626.9
4N	87.8	74.6	28.9	2154.4
4G	138.8	118.0	28.9	3409.7
Sub-Total:	**1195.6**	**1016.6**		**21614.8**

Subwatershed: Bear				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	43.9	37.3	0.0	0.0
2S	0.0	0.0	8.2	0.0
2P	3.7	3.2	8.2	25.8
2N	0.0	0.0	22.4	0.0
2G	0.0	0.0	22.4	0.0
3S	46.0	39.1	16.8	656.9
3P	65.7	55.9	16.8	938.2
3N	178.1	159.1	28.9	4596.1
3G	119.0	101.2	28.9	2923.3
4S	0.0		16.8	0.0
4P	0.0		16.8	0.0
4N	0.0		28.9	0.0
4G	0.0	0.0	28.9	0.0
Sub-Total:	**412.5**	**358.5**		**9140.3**

Subwatershed: Lower Little Creek				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	508.2	432.0	0.0	0.0
2S	0.0		8.2	0.0
2P	0.0		8.2	0.0
2N	0.0		22.4	0.0
2G	120.1	102.1	22.4	2286.8
3S	477.2	405.6	16.8	6814.4
3P	767.1	652.1	16.8	10954.2
3N	555.9	472.5	28.9	13655.7
3G	572.2	486.4	28.9	14056.1
4S	0.0		16.8	0.0
4P	0.0		16.8	0.0
4N	11.9	10.1	28.9	292.3
4G	156.0	132.6	28.9	3832.2
Sub-Total:	**3168.6**	**2693.4**		**51891.7**

Subwatershed: Headwaters Little				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	74.7	63.5	0.0	0.0
2S	0.0		8.2	0.0
2P	0.0		8.2	0.0
2N	0.0		22.4	0.0
2G	0.1	0.1	22.4	1.9
3S	0.0	0.0	16.8	0.0
3P	75.7	64.4	16.8	1081.0
3N	49.4	42.0	28.9	1213.5
3G	222.1	188.8	28.9	5455.9
4S	0.0		16.8	0.0
4P	0.0		16.8	0.0
4N	0.0		28.9	0.0
4G	28.2	24.0	28.9	692.8
Sub-Total:	**375.4**	**382.8**		**8443.2**

Subwatershed: Bear Creek				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	29.4	25.0		0.0
2S	0.0	0.0	8.2	0.0
2P	0.0	0.0	8.2	0.0
2N	74.0	62.9	22.4	1409.0
2G	57.4	48.8	22.4	1093.1
3S	216.8	184.3	16.8	3096.2
3P	223.9	190.3	16.8	3197.0
3N	145.7	123.8	28.9	3554.7
3G	599.1	509.2	28.9	14715.9
4S	0.0	0.0	16.8	0.0
4P	0.0	0.0	16.8	0.0
4N	0.0	0.0	28.9	0.0
4G	117.9	100.2	28.9	2896.2
Sub-Total:	**1464.2**	**1244.5**		**29962.1**

Subwatershed: Grassy Flat Creek				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	148.5	126.2	0.0	0.0
2S	0.0	0.0	8.2	0.0
2P	0.0	0.0	8.2	0.0
2N	0.0	0.0	22.4	0.0
2G	0.0	0.0	22.4	0.0
3S	114.0	97.0	16.8	1629.6
3P	317.3	269.7	16.8	4531.1
3N	161.3	137.1	28.9	3962.4
3G	30.7	26.1	28.9	754.2
4S	10.3	8.7	16.8	147.1
4P	0.0	0.0	16.8	0.0
4N	81.9	69.6	28.9	2011.9
4G	293.6	249.6	28.9	7212.3
Sub-Total:	**1157.6**	**984.0**		**20248.6**

Subwatershed: Grassy Mountain				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	204.6	173.9		
2S	0.0	0.0	8.2	0.0
2P	0.0	0.0	8.2	0.0
2N	0.0	0.0	22.4	0.0
2G	19.9	16.9	22.4	378.9
3S	89.8	76.4	16.8	1282.4
3P	434.7	369.5	16.8	6207.5
3N	242.2	205.9	28.9	5949.7
3G	144.9	123.2	28.9	3559.5
4S	0.0	0.0	16.8	0.0
4P	0.0	0.0	16.8	0.0
4N	0.0	0.0	28.9	0.0
4G	17.0	14.5	28.9	417.6
Sub-Total:	**1153.1**	**980.3**		**17795.6**

Subwatershed: Halfway				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	210.7	179.1	0.0	0.0
2S	0.0	0.0	8.2	0.0
2P	0.0	0.0	8.2	0.0
2N	11.3	9.6	22.4	215.2
2G	62.4	53.1	22.4	1188.1
3S	43.7	37.2	16.8	624.1
3P	178.4	151.7	16.8	2547.6
3N	400.2	340.2	28.9	9831.0
3G	272.7	231.8	28.9	6698.9
4S	0.0	0.0	16.8	0.0
4P	0.0	0.0	16.8	0.0
4N	0.0	0.0	16.8	0.0
4G	141.0	119.9	28.8	3463.7
Sub-Total:	**1320.4**	**1122.6**		**24568.6**

Subwatershed: Jud Creek				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	195.8	166.4	0.0	0.0
2S	0.0	0.0	8.2	0.0
2P	0.0	0.0	8.2	0.0
2N	28.6	24.3	22.4	544.6
2G	14.1	12.0	22.4	268.5
3S	42.0	35.7	16.8	599.8
3P	329.2	279.8	16.8	4701.0
3N	232.8	197.9	28.9	5718.8
3G	202.2	171.9	28.9	4967.1
4S	0.0	0.0	16.8	0.0
4P	0.0	0.0	16.8	0.0
4N	0.0	0.0	28.9	0.0
4G	375.4	319.1	28.9	9221.7
Sub-Total:	**1420.1**	**1207.1**		**26021.5**

Subwatershed: Big Canyon				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	174.9	148.7	0.0	0.0
2S	0.0	0.0	8.2	0.0
2P	0.0	0.0	8.2	0.0
2N	16.1	13.7	22.4	306.6
2G	9.2	7.9	22.4	175.2
3S	69.4	59.0	16.8	991.1
3P	273.4	232.4	16.8	3904.2
3N	293.4	249.4	28.9	7207.4
3G	29.9	25.4	28.9	734.5
4S	0.0	0.0	16.8	0.0
4P	0.0	0.0	16.8	0.0
4N	0.0	0.0	28.9	0.0
4G	56.2	47.8	28.9	1381.4
Sub-Total:	**922.5**	**784.3**		**14700.4**

Subwatershed: East Hyampom				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	421.4	358.2	0.0	0.0
2S	0.0	0.0	8.2	0.0
2P	0.0	0.0	8.2	0.0
2N	0.0	0.0	22.4	0.0
2G	0.0	0.0	22.4	0.0
3S	349.1	296.8	16.8	4985.2
3P	591.5	502.8	16.8	8446.6
3N	319.5	271.6	28.9	7848.5
3G	93.5	79.5	28.9	2296.8
4S	204.2	173.6	16.8	2916.0
4P	49.2	41.8	16.8	702.6
4N	20.5	17.4	28.9	503.6
4G	273.4	232.4	28.9	6716.1
Sub-Total:	**2322.3**	**1974.1**		**34415.4**

Subwatershed: Lower Olsen				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	498.3	419.7	0.0	0.0
2S	0.0	0.0	8.2	0.0
2P	14.0	12.0	8.2	97.6
2N	45.8	39.0	22.4	872.1
2G	36.9	31.4	22.4	702.6
3S	146.5	124.5	16.8	2092.0
3P	116.3	98.9	16.8	1660.0
3N	281.2	239.0	28.9	6907.7
3G	85.9	73.0	28.9	2110.2
4S	0.0	0.0	16.8	0.0
4P	0.0	0.0	16.8	0.0
4N	0.0	0.0	28.9	0.0
4G	1.5	1.3	28.9	36.9
Sub-Total:	**1221.9**	**1038.8**		**14479.9**

Subwatershed: Headwaters Olsen				
Veg Type	**Gross CAS Acres**	**Net CAS Acres**	**Volume/ Acre**	**Total Volume/ Veg Type**
UX	385.1	327.3	0.0	0.0
2S	0.0	0.0	8.2	0.0
2P	0.0	0.0	8.2	0.0
2N	23.7	20.2	22.4	451.3
2G	0.0	0.0	22.4	0.0
3S	52.0	44.2	16.8	742.6
3P	30.2	25.7	16.8	431.3
3N	260.0	221.0	28.9	6386.9
3G	306.8	260.8	28.9	7536.5
4S	0.0	0.0	16.8	0.0
4P	0.0	0.0	16.8	0.0
4N	0.0	0.0	28.9	0.0
4G	26.7	22.7	28.9	655.9
Sub-Total:	**1084.5**	**921.9**		**16204.5**

Water Quality

- What are the current habitat conditions and trends for the species of concern identified in steps 1 and 2?

Temperature, flow volume, sediment and pollutant levels are typically considered to be primary factors which affect water quality. High stream temperature and low flow volume in lower

Hayfork Creek are extremely limiting to the fishery resource, while agricultural and recreational uses in the Lower Hayfork Creek Analysis Area appear to be unaffected by the high temperatures and low flow conditions. A detailed discussion of the relationship between high stream temperatures, low flows and the fishery resource can be found in the fisheries narrative for step three of the watershed analysis process. Sediment and pollutant levels are considered to be of lesser concern to lower Hayfork Creek.

Water temperature data has been collected in recent years in Hayfork Creek, Miner's Creek, Bear Creek, Rusch Creek, and Olsen Creek (Ranken, unpublished). Using thermographs, temperatures were recorded over a four year period from 1989 to 1992, usually from May through September. Since the salmonid fishery is considered one of the primary beneficiaries of good water quality, the water temperature discussion which follows will focus around the 68 F upper limit considered optimal for salmonids and there 75 F upper limit considered lethal for salmonids (Reiser and Bjornn).

Maximum daily temperatures recorded in lower Hayfork Creek near Hyampom were consistently above 68 F during the months of July, August and September for all four years. Additionally there were numerous days in June when maximum daily temperatures were above 68 F. Minimum daily temperatures were also frequently above 68 F during the months of July, August and September. During those same months there were extensive time periods when maximum daily temperatures exceeded 75 F. In 1992 there were 35 consecutive days (July 8 - August 11) when daily maximum temperature exceeded 75 F and for 18 consecutive days July and August of 1990, maximum daily temperatures exceeded 80 F. Minimum daily temperatures during that eighteen day period ranged form 68.2 to 71.4 F. The highest temperature recorded during the four year period was 84.7 F on July 15, 1990.

While maximum daily temperatures in Hayfork Creek were typically above 68 F during summer months, maximum daily high temperatures even during July, August and September remained below 68 F in all of the tributaries except Olsen Creek. At a lower Olsen Creek site, there were 12 days in 1992 when maximum daily temperature exceeded 68 F. Those temperatures were recorded around peaks in late June, mid July, late July and mid August. The peak temperatures during those periods ranged from 68.2 to 69.4 F. Recorded maximum daily temperatures were lowest in Miners Creek. Maximum daily temperatures above 60 F were recorded only during the summer months of 1992. During 1991 water temperatures never rose above 60 F and in 1989 and 1991 there were only a few days where maximum daily temperatures rose into the low 60's.

The high stream temperatures and low flows which occur in late summer create extremely limiting conditions for salmon, trout, and steelhead in lower Hayfork Creek. The low base flows and high temperatures in lower Hayfork Creek are thought to be a result of heavy water use that occurs upstream of the Lower Hayfork Analysis area. Irrigation diversions, mainly for ranches in the Hayfork Valley appear to account for the majority of this heavy water use. Further discussion of these conditions and their affect on the fishery resource can be found in the fishery narrative for step 3.

The National Resource Conservation Service (unpublished) collected water samples from several locations in the Hayfork valley and one location in the Lower Hayfork Analysis Area (Hayfork

Creek at Bar 717 Ranch). The samples were collected at seven different times throughout 1994 and 1995 and tested for a number of water quality parameters including fecal coliform, total coliform, total dissolved solids, specific conductance, pH, nitrate and nitrogen concentrations. The two coliform tests provide information regarding bacterial concentrations often associated with human and animal wastes and often serve as an indicator of sewage contamination. The nitrate and nitrogen tests provide information regarding nutrient levels and nutrient cycling and often serve as an indicator of contamination resulting from cattle or other livestock. By design, however, all of the test which were run on the Hayfork Creek water samples give a general overview only of water quality conditions. More detailed tests would be required to gain a comprehensive understanding of water quality conditions. Basic Laboratories in Redding California conducted the tests on the water samples. Interpretation of the results and the following discussion were generated through a phone conversation with Jim Holly at Basic Labs.

In general, the test results indicate that no glaring water quality problems exist within the Lower Hayfork Analysis Area for those parameters chosen for study. The results indicate that high fecal coliform concentrations are limited to reaches of Hayfork Creek upstream of the Lower Hayfork Analysis Area, while total coliform concentrations were at times moderately elevated at the lower Hayfork Creek sampling site. Coliform bacteria can create unhealthy conditions for human recreation activities, however, the bacteria by themselves are not toxic to fish. Instead, they affect fish by reducing concentrations of dissolved oxygen in the water. This can be critical if bacterial concentrations are high, particularly during the summer months when dissolved oxygen levels are already low as a result of low stream flows and high water temperatures. Dead and dying fish, which have been observed in reaches of Hayfork Creek in the Hayfork Valley are an indication that a severe oxygen problem may exist. However, no fish kills of this nature have been documented in lower Hayfork Creek. In the absence of dissolved oxygen measurements, the effects of the coliform concentrations in lower Hayfork Creek cannot be determined.

Nitrate and nitrogen concentrations were low throughout all of the test areas, suggesting that cattle, at least from a toxicological standpoint, are having no affect on the Hayfork Creek watershed. The pH was unexplainably high at all survey sites during the June of 1994 sampling period. Water samples collected on that date had pH values above 9.0 while all other water samples collected during the sampling period had pH values between 7.5 and 8.5. Total dissolved solids and specific conductance were also unexplainably high during several of the sampling periods, showing a two-fold increase over all other samples collected. Although perplexing, in the absence of more detailed information nothing conclusive can be determined from the pH, total dissolved solids and specific conductance results.

Sediment conditions in the streams within the Lower Hayfork Analysis Area are described in the fisheries section of step 3. In summary, elevated levels of sediment are thought to be present in lower Hayfork Creek but not in high enough concentrations to be considered limiting to fish production. And tributary streams to lower Hayfork Creek, with only two possible exceptions (Jud and Rusch Creeks) are not known to have elevated levels of sediment.

Species and Habitats

- What are the current habitat conditions and trends for the species of concern identified in steps 1 and 2

CONNECTIVITY: Assuring Successful Dispersal

Three biological principles form the basis of our current strategy for maintaining viable populations of late-successional and old-growth related species (Thomas et al. 1990): 1) Species are more secure from extinction if habitat and local populations are distributed across their entire range. 2) Providing large habitat blocks containing numerous breeding pairs can provide for a population structure that can sustain itself for many generations. With stable or improving habitat conditions within these areas, those local populations can act as sources of "surplus" individuals. 3) Habitat conditions and spacing between local populations must provide for survival and movement of individuals between the large blocks of protected habitat. The range of the northern spotted owl defined "species range" and "large habitat blocks" are Congressionally Reserved Areas augmented by Late-Successional Reserves (LSRs). In this context, the Lower Hayfork Watershed lies in the southern quarter of the range of the northern spotted owl and lies largely between two LSRs. Thus, the main biological principle of concern in the Lower Hayfork Watershed is principle 3 (connectivity).

Connectivity is a measure of the extent to which the landscape pattern of the late-successional and old-growth ecosystem provides for biological and ecological flows that sustain late-successional and old-growth associated animal and plant species across the range of the northern spotted owl. Connectivity does not necessarily mean that late-successional and old-growth areas have to be physically joined in space, because many late-successional species can move (or be carried) across areas that are not in late-successional ecosystem conditions. However, conditions between late-successional and old-growth areas must be compatible with the movement of late-successional and old-growth associated species, such that they are both capable of moving through these habitats and inclined to do so. Although connecting zones need not assure habitat capable of supporting a breeding pair, they do need to provide stopover places where individuals can find suitable cover and, especially, foraging conditions. Landscape features affecting connectivity of late-successional and old-growth ecosystems are (1) distance between late-successional and old-growth areas and (2) forest conditions between these areas.

The Lower Hayfork watershed represents an important link between Late-Successional Reserves RC-330 and RC-332. These two LSRs lie approximately eight miles apart (this distance represents the average distance of measurements of straight-line routes that intersect portions of the Lower Hayfork watershed). Approximately 2,984 acres of RC-332 lie in the northeast portion of the watershed. RC-331 lies approximately 16 miles from the western border of the watershed.

The qualitative description presented in Chapter 1 suggests that current forest conditions related to connectivity within the Lower Hayfork Watershed may inhibit the movement late-successional and old-growth related species. This is due in large part to relatively extensive past timber harvest activity, large stand replacing fires, high road density, and natural site conditions that preclude the production of suitable forest conditions.

ANALYSIS METHOD AND RATIONALE

The only widely accepted scale for analyzing dispersal habitat for late-successional and old-growth related species targets the northern spotted owl and stems from the "50-11-40" rule

(Thomas et al. 1990). To assure that suitable dispersal habitat was well distributed across the landscape, this rule stipulated that suitable dispersal habitat conditions were to be met on at least 50 percent of each quarter township. The "50-11-40" rule has since been dropped but no standardized replacement method currently exists.

This analysis will apply the 50-11-40 rule to the watershed and subwatersheds therein rather than to quarter townships. This analysis in by no means intended to set absolute limits or goals but rather attempts to set a threshold of concern to be addressed at the project or NEPA level analyses. No one "rule" or recipe can address connectivity issues unique to all situations. Using quarter townships as the basis for dispersal habitat (i.e., connectivity) analysis has a number of disadvantages: Connectivity inadequacies within a given watershed may be masked by better habitat conditions outside the watershed. Current management direction specifically calls for connectivity assessments at the watershed analysis scale. Management recommendations (and subsequent projects) that would affect connectivity will normally stem from watershed analysis; thus management recommendations appropriate for deficient quarter townships (i.e., portions outside the watershed) would likely be deferred to future watershed analyses. Quarter township based analysis does not provide an opportunity to identify specific areas where connectivity may be especially important (e.g., headwater and ridgetop areas between adjacent watersheds likely have narrow Riparian Reserves, if any, that can be important connectors for many species with limited ability to cross open habitats). Thus, connectivity analysis for this watershed analysis attempts to avoid some of these disadvantages. Should the analysis prove inadequate during possible future consultations with the U.S. Fish and Wildlife Service, we can conduct quarter township analysis at the NEPA level.

For this watershed analysis connectivity will be analyzed first for the entire Lower Hayfork Creek Watershed and then for each subwatershed (or logical groupings of subwatersheds) within the watershed. The watershed-wide scale analysis will present the general connectivity condition. The subwatershed scale analyses will include more detailed and site specific information. These smaller stratified areas are logical subunits to examine habitat conditions because the criteria for the stratification process was based largely upon the level and type of past disturbance that typically affected wildlife habitat; the areas' general potential to grow habitat; as well as the expected general level of future forest management in the area based upon the Forests Land and Resource Management Plan. Further, any management recommendations stemming from this watershed analysis will likely be based upon these areas. This method avoids analyzing portions of quarter townships that lie only partially within the watershed while meeting the spirit of analyzing dispersal habitat conditions across the landscape.

ASPECTS OF THE ANALYSIS

Maintaining adequate connectivity does not necessarily mean that late-successional and old-growth areas have to be physically joined in space. For example, the lower threshold for suitable spotted owl dispersal habitat has been established as forest stands having an average tree diameter at breast height (DBH) of 11 inches and a 40 percent canopy closure; the "11-40" portion of the "50-11-40" rule (Thomas et al. 1990). However, habitats between late-successional or old-growth areas function better to allow the free movement of late-successional and old-growth related species to move through them the more nearly they resemble late-successional or old-growth ecosystem conditions. Patches of late-successional and old-growth between LSRs are ecologically significant in functioning as refugia for a host of old-growth related species, particularly those with dispersal capabilities that are not able to migrate across large landscapes of younger stands. Our current strategy for maintaining areas of high quality habitat across the landscape depends heavily upon "protected" areas (e.g., Riparian Reserves and 100 acre spotted owl cores).

This analysis will include the following aspects of connectivity at the watershed-wide scale (more general) and the subwatershed (more detailed and site specific) scale:

- **Habitat Quality:** The acres and proportion of at least minimal dispersal habitat (11-40 conditions) and high quality habitat (late-successional or old-growth conditions).
- **Habitat Array:** A discussion of how the dispersal habitat is arrayed in the area; gaps; and important linkages to adjacent watersheds. Specific attention will be paid to dispersal habitat conditions in headwater areas and associated ridgetops (e.g., saddles) where important linkages between adjacent watersheds occur that may not be "protected" by wide Riparian Reserves.
- **Potential Habitat:** acres, proportion, array, and level of "protection" of land currently unsuitable but capable of growing dispersal habitat. This give an indication of the area's ability to provide connectivity through time.

The following LMP strata size class and density class combinations are assumed to be currently suitable owl dispersal habitat: 6G, 6N, 6P, 5G, 5N, 5P, 4G, 4N, 4P, 3G, and 3N. High quality habitat is defined as 4,5, and 6 N and G stands. Potential dispersal habitat is defined as areas that are not currently suitable but lie on Dunning Site Class V or better, current plantations, and all 2N and 2G stands. These definitions are based upon assumptions that are was based on a cursory examination of 1990 aerial photographs of the watershed and three brief field visits by a wildlife biologist and silviculturist.

A further assumption is made that habitat conditions suitable for spotted owl dispersal would likely meet dispersal needs for other late-successional and old-growth related species. For example Freel (1991), after an extensive literature review, concluded that 40 percent canopy closure was an appropriate lower threshold within designated travel corridors for the fisher and marten, both late-successional related mammalian forest carnivores.

RESULTS

The Lower Hayfork Watershed currently includes approximately 21,527 acres of currently suitable dispersal habitat or approximately 47 percent of the federally owned land within the watershed. This suggests that as a whole the watershed is providing connectivity at or near the threshold of concern (i.e., just below 50% is currently suitable dispersal habitat). Of this dispersal habitat approximately 8,637 acres (About 19 percent of the watershed) are currently higher quality habitat. However, when measured at the subwatershed scale, dispersal habitat conditions vary widely across the watershed. For example suitable dispersal habitat currently makes up a low of 21 percent of the Bear subwatershed and a high of 71 percent of the Grassy Flat subwatershed. The proportion of high quality habitat also varies widely between subwatersheds ranging from zero percent to 42 percent of individual subwatersheds.

The general connectivity condition for each subwatershed is briefly discussed below. Each description provides a view of current amounts and proportions of dispersal habitat, habitat quality, the general array of dispersal habitat, unique aspects (or important areas), the subwatershed's potential to provide connectivity in the future, and the results of the major disturbances that are evident:

The Grassy Flat Creek subwatershed currently includes 1,124 acres of dispersal habitat of which 593 acres are higher quality habitat (71 and 37 percent of the subwatershed respectively) and connectivity does not currently appear to be a limiting factor. This watershed has a potential to provide approximately 1,564 acres of dispersal habitat (99 percent of the subwatershed). The headwaters areas (and the associated ridgetop) provide an important connection into the Butter Creek area and LSR RC-330. The northern most portion of this area does not have the potential to grow dispersal habitat so a small "gap" leading to Hayfork Creek will likely continue. Disturbance within the area has been relatively modest and largely related to timber harvest activities reflected by the 152 acres of existing plantations. No known spotted owl activity centers lie within the area.

The East Hyampom subwatershed currently includes 1,950 acres of dispersal habitat of which 773 acres are higher quality habitat (66 and 26 percent of the subwatershed respectively) and connectivity does not currently appear to be a major limiting factor. This watershed has a potential to provide approximately 2,862 acres of dispersal habitat (96 percent of the subwatershed). The headwaters areas (and the associated ridgetop) provide an important connection into the Butter Creek area and LSR RC-330. Disturbance within the area has been moderate and largely related to timber harvest activities reflected by the 434 acres of existing plantations. The private land associated with the community of Hyampom is largely agricultural land or developed for residences and will limit connectivity in the eastern most portion of this subwatershed down to Hayfork Creek and the South Fork of the Trinity River. No known owl activity centers lie within this area.

The Jud Creek subwatershed currently includes 1,381 acres of dispersal habitat of which 938 acres are higher quality habitat (62 and 42 percent of the subwatershed respectively) and connectivity does not currently appear to be a major limiting factor. This watershed has a potential to provide approximately 2,862 acres of dispersal habitat (96 percent of the subwatershed). Disturbance within the area has been relatively modest and largely related to timber harvest activities reflected by the 274 acres of existing plantations. The past harvest activity was largely concentrated along the ridgetop separating this subwatershed from the Rusch and Butter Creek drainages and may somewhat limit connectivity in these areas. Current conditions in the lower portions of this area provide relatively good connectivity down to Hayfork Creek. One spotted owl activity center lies in this subwatershed.

The Halfway subwatershed currently includes 1,431 acres of dispersal habitat of which 594 acres are higher quality habitat (59 and 25 percent of the subwatershed respectively) and connectivity does not appear to be a major limiting factor currently. However, suitable linkages to the north are limited by the lack of potential habitat along large areas abutting Hayfork Creek. This watershed has a potential to provide approximately 2,333 acres of dispersal habitat (97 percent of the subwatershed). Disturbance within the area has been moderate and largely related to timber harvest activities reflected by the 222 acres of existing plantations. Past timber harvesting activities were concentrated along the ridgeline abutting the Big Canyon subwatershed and may somewhat limit connectivity to this drainage. No known spotted owl activity centers lie in this area.

The Lower Little subwatershed currently includes 2,635 acres of dispersal habitat of which 1,515 acres are higher quality habitat (55 and 32 percent of the subwatershed respectively) and connectivity does not currently appear to be a major limiting factor. This watershed has a potential to provide approximately 4,758 acres of dispersal habitat (99 percent of the subwatershed). Disturbance within the area has been moderate and largely related to timber harvest activities and fire in the northern portion of the area (total of 591 acres). The area represents an important connection to LSR RC-332 which lie immediately to the east. The southern portion of the area is much more fragmented than the northern portion with many acres of potential dispersal habitat. One known owl activity center lies in the extreme southern end of the area.

The Lower Rusch subwatershed currently includes 1,374 acres of dispersal habitat of which 739 acres are higher quality habitat (53 and 28 percent of the subwatershed respectively) and connectivity does not currently appear to be a major limiting factor. This watershed has a potential to provide approximately 2,143 acres of dispersal habitat (82 percent of the subwatershed). Disturbance within the area has been moderate and largely related to 100-plus year old fires on the south facing slopes. There are 202 acres of plantations largely concentrated on the ridges between the Butter Creek Watershed to the west and the Middle Hayfork Creek watershed to the west that may somewhat limit connectivity to these watersheds. One known spotted owl activity center lies within this area.

The Big Canyon subwatershed currently includes 648 acres of dispersal habitat of which 468 acres are higher quality habitat (50 and 36 percent of the subwatershed respectively) and connectivity does not currently appear to be a major limiting factor. This watershed has a potential to provide approximately 1,294 acres of dispersal habitat (99 percent of the subwatershed). Disturbance within the area has been moderate and largely related to timber harvest activities reflected by the 166 acres of existing plantations. Past timber harvesting activities were concentrated along the ridgeline abutting the Big Canyon subwatershed and may somewhat limit connectivity to this drainage. No known spotted owl activity centers lie within the area.

The Grassy Mountain subwatershed currently includes 750 acres of dispersal habitat of which 441 acres are higher quality habitat (47 and 27 percent of the subwatershed respectively) and connectivity may be a limiting factor. This watershed has a potential to provide approximately 1,581 acres of dispersal habitat (99 percent of the subwatershed). Disturbance within the area has been moderate and largely related to timber harvest activities reflected by the 233 acres of existing plantations. No known spotted owl activity centers lie within the area.

The Headwaters Olsen subwatershed currently includes 978 acres of dispersal habitat of which 27 acres are higher quality habitat (46 and 1 percent of the subwatershed respectively) and connectivity may currently be a limiting factor, especially the habitat quality aspect. This watershed has a potential to provide approximately 1,597 acres of dispersal habitat (74 percent of the subwatershed). Disturbance within the area has been moderately heavy largely due to fires and harvest activities (totaling 427 acres). This area represents the watershed's main connection to the East Hyampom watershed and the western portion of LSR RC-332. One known spotted owl activity center lies in the area. Current habitat conditions suggest the occupancy of this activity center is unlikely.

The Bear Creek subwatershed currently includes 2,297 acres of dispersal habitat of which 664 acres are higher quality habitat (41 and 12 percent of the subwatershed respectively) and connectivity may currently be a limiting factor. Current conditions largely reflect the harsh growing sites in much of the area. This watershed has a potential to provide approximately 3,388 acres of dispersal habitat (61 percent of the subwatershed). Disturbance within the area has been minimal and largely related to 100-plus year old fire events. Current dispersal habitat lies largely within steep drainages and the ridge bordering the Little Creek subwatershed. The area represents an important link to LSR RC-332 to the north, especially the drainages in the western half of the area. There are no known spotted owl activity centers within the area.

The Pattison subwatershed currently includes 4,446 acres of dispersal habitat of which 1,105 acres are higher quality habitat (38 and 9 percent of the subwatershed respectively) and connectivity, especially in the southern portion, is likely a limiting factor. This watershed has a potential to provide approximately 8,488 acres of dispersal habitat (72 percent of the subwatershed). Disturbance within the area has been moderately heavy due to fires 100-plus years ago. A portion of LSR RC-332 lies in the northeast of this area and connectivity to LSR RC-330 will likely be limited into the future due to harsh south aspect conditions. Three known owl activity centers lie within this area (two in the LSR portion) The activity center outside the LSR is not likely occupied due to current habitat conditions.

The Headwaters Little Creek subwatershed currently includes 368 acres of dispersal habitat of which 27 acres are higher quality habitat (37 and 3 percent of the subwatershed respectively) and connectivity, especially the habitat quality aspect, is likely a limiting factor. This watershed has a potential to provide approximately 720 acres of dispersal habitat (73 percent of the subwatershed). Disturbance within the area has been moderately heavy largely related to timber harvest activities reflected by the 124 acres of existing plantations. Harsh conditions suggest that dispersal habitat may always be lacking in the extreme northern portion of this area to connect with LSR RC-332. No known spotted owl activity centers lie within the area.

The Lower Olsen subwatershed currently includes 628 acres of dispersal habitat of which 13 acres are higher quality habitat (36 and less than one percent of the subwatershed respectively) and connectivity, especially the habitat quality aspect, are likely a limiting factor. This watershed has a potential to provide approximately 1,583 acres of dispersal habitat (90 percent of the subwatershed). Disturbance within the area has been heavy and largely related to fires timber harvest activities (996 acres total, or 55 percent of the area). Private land in the southern portion associated with the community of Hyampom will likely continue to restrict connectivity to the south. No known spotted owl activity centers lie within the area.

The Bear subwatershed currently includes 572 acres of dispersal habitat (21 percent of the subwatershed) of which none are higher quality habitat and connectivity, especially the habitat quality aspect, currently appears to be a major limiting factor. This watershed has a potential to provide approximately 916 acres of dispersal habitat (33 percent of the subwatershed). Disturbance within the area has been heavy due to fires and modest timber harvesting. The harsh growing conditions in this area will not likely provide adequate connectivity into the future. No known spotted owl activity centers lie within the area.

The Headwaters Rusch subwatershed currently includes 945 acres of dispersal habitat of which 740 acres are higher quality habitat (36 and 28 percent of the subwatershed respectively) and connectivity currently appears to be a major limiting factor. This watershed has a potential to provide approximately 2,227 acres of dispersal habitat (85 percent of the subwatershed). Disturbance within the area has been heavy largely related to timber harvest activities reflected by the 510 acres of existing plantations. Past timber harvesting activities were concentrated along the ridgeline abutting the Big Canyon subwatershed and may somewhat limit connectivity to this drainage. No known spotted owl activity centers lie within the area.

Step 3: Connectivity Table

Subwatershed	Tot	Disp	High	Tot Dis	Pot	Tot Poss	Oppor
Grassy Flat Ck.	1582	531	593	1124	440	1564	332
		0.34	0.37	0.71	0.28	0.99	
East Hyampom	2968	1177	773	1950	912	2862	475
		0.40	0.26	0.66	0.31	0.96	
Jud	1705	411	612	1023	507	1530	171
		0.24	0.36	0.60	0.30	0.90	
East Jud	527	32	326	358	169	527	95
		0.06	0.62	0.68	0.32	1.00	
Total	2232	443	938	1381	676	2057	268
		0.20	0.42	0.62	0.30	0.92	
Halfway	2407	837	594	1431	902	2333	217
		0.35	0.25	0.59	0.37	0.97	
Lower Little	4793	1120	1515	2635	2123	4758	240
		0.23	0.32	0.55	0.44	0.99	
Lower Rusch	1319	226	555	781	454	1235	119
		0.17	0.42	0.59	0.34	0.94	
Rusch 1	382	0	108	108	110	218	-84
		0	0.28	0.28	0.28	0.57	
Rusch 2	350	179	3	182	33	215	7
		0.51	0	0.52	0.09	0.61	
Rusch 3	181	46	19	65	102	167	-25
		0.25	0.10	0.36	0.56	0.92	
Rusch 4	377	184	54	238	68	308	49
		0.49	0.14	0.63	0.18	0.81	
Total	2609	635	739	1374	767	2143	78
Big Canyon	1298	180	468	648	646	1294	0

Step 3: Connectivity Table							
Subwatershed	**Tot**	**Disp**	**High**	**Tot Dis**	**Pot**	**Tot Poss**	**Oppor**
Grassy Mtn.	1600	309	441	750	831	1581	-48
Headwaters Olsen	2138	951	27	978	619	1597	-86
		0.44	0.01	0.46	0.29	0.74	
Bear Creek	5518	1635	664	2297	1091	3388	-497
		0.30	0.12	0.41	0.20	0.61	
Pattison	11791	3341	1105	4446	4042	8488	-1415
		0.28	0.09	0.38	0.34	0.72	
Headwaters Little	1005	341	27	368	352	720	-131
		0.34	0.03	0.37	0.35	0.73	
Lower Olsen	1728	614	13	627	922	1549	-242
		0.36	0	0.36	0.53	0.90	
Confluence	34	1	0	1	33	34	-16
		0.03	0	0.03	0.97	1.00	
Total	1762	615	13	628	955	1583	-247
		0.35	0	0.36	0.54	0.90	
Bear	2781	572	0	572	344	916	-806
		0.21	0.00	0.21	0.12	0.33	
Headwaters Rusch	437	62	128	190	240	430	-31
		0.14	0.29	0.43	0.55	0.98	
W Fork Rusch	382	3	204	207	174	381	15
		0	0.53	0.54	0.46	0.99	
W Middle Rusch	942	92	69	161	498	659	-311
		0.10	0.07	0.17	0.53	0.70	
E Middle Rusch	863	48	339	387	370	757	-43
		0.06	0.39	0.45	0.43	0.88	
Total	2624	205	740	945	1282	2227	-367
		0.08	0.28	0.36	0.48	0.85	
WATERSHED TOTAL	46103	12892	8637	21527	15982	37493	-1383
		0.28	0.19	0.47	0.35	0.81	

Tot = Total acres (minus private land)
Disp = Acres that are currently at 11-40 conditions but not at "High" conditions (see below)
High = Acres of higher quality habitat important refugia and foraging sites
Tot Dis = Disp plus High
Pot = Acres that are not currently at least 11-40 conditions but have the potential to grow to those conditions
Tot Poss = Tot Dis plus Pot; represents the total possible dispersal habitat sans disturbance
Oppor. = Opportunity for regeneration harvesting while maintaining 50 percent of the subwatershed in at least 11-40 conditions (positive acres); or the number of acres needed to achieve 50 percent 11-40 conditions (negative numbers)

Note: The numbers included below each acre entry represents the proportion of the entire subwatershed (i.e., Tot acres) not including private property.

SPOTTED OWL ACTIVITY CENTERS

The following analysis of habitat conditions around the spotted owl activity centers associated with the Lower Hayfork Watershed is included for two main reasons. First, this analysis gives a general picture of the watershed's current ability to support late-succession and old-growth associated wildlife species. And, second, this information is valuable for future compliance with the Endangered Species Act requirements.

Comprehensive descriptions of spotted owl natural history are included in the ISC Report (Thomas et al. 1990) and Final Draft Recovery Plan for the Northern Spotted Owl (Unpub. Doc., USDI 1992).

Nesting, Roosting and Foraging Habitat:

Only nesting and roosting habitat has been defined and tracked for the STNF. This habitat is "lumped" and called "suitable". The Shasta-Trinity National Forest define suitable spotted owl habitat as composed of mature timbered stands having multi-layered conditions, a canopy closure of 60% or greater, and displaying obvious signs of decadence. The overstory should be composed primarily of trees 21 inches diameter breast height (DBH) or greater and should comprise at least 40% of the canopy. This habitat definition was developed using Regional definitions combined with local knowledge of where spotted owls commonly occur across the Forests.

The results of habitat analyses around each spotted owl activity center is presented below. Note: The status of the activity centers (e.g., reproductive pair, pair, territorial single, or single) is not included pending updated survey results. These preliminary analyses indicate the general fragmentation of spotted owl habitat in the area.

Spotted Owl Home Range Habitat Analysis

Activity Center	**Acres of Suitable Habitat within 1.3 miles**
410*	537
430*	214
602	195
611	397
614	935
635	1038
636	799
637*	1464
638*	1602

Spotted Owl Home Range Habitat Analysis	
Activity Center	**Acres of Suitable Habitat within 1.3 miles**
710	795
711*	447
712*	673
715	827
716	742
730*	739
733*	769
734*	606

*Activity center lies outside the Lower Hayfork Creek Watershed but within 1.3 miles of the boundary.

Fisheries - Hayfork Creek is the largest free flowing tributary of the South Fork Trinity River, draining an area of 243,000 acres. The Lower Hayfork watershed analysis area includes the lower reach of Hayfork Creek from its confluence with the South Fork to Nine mile Bridge. Included within the analysis area are eleven major tributaries which enter Hayfork Creek (Olsen Creek, Little Bear Creek, Bear Creek, Miners Creek and Little Creek from the North and Walker Creek, Grassy Flat Creek, Big Canyon, Dinner Gulch , Jud Creek and Rusch Creek from the South). Corral Creek, the largest tributary of lower Hayfork Creek, is excluded from the Lower Hayfork analysis area and instead represents an analysis area by itself.

Much of lower Hayfork Creek flows through moderate gradient, fairly well contained channels (Rosgen channel types A and B) in steep mountainous terrain (Arey and Gilroy, 1993). Below this gorge-like area, the channel gradient decreases (Rosgen channel types C and D) and in the very lower reach above the confluence with the South Fork Trinity, Hayfork Creek flows through unconfined channel (Rosgen channel type D) The Rosgen A and B channel types are predominantly transport channels which function to deliver bedload to downstream reaches.

A 1992 survey of Lower Hayfork Creek reported an overall pool:riffle:run ratio of of 1:1:2 (Arey and Gilroy, 1993). Although not disclosed in the report, average pool depth for all pools measured appears to be approximately 1.3 meters. This 1.3 meter estimate indicates that pool depth is not limiting within lower Hayfork Creek (USDA Forest Service, 1994). Instream cover is provided mainly by boulders and whitewater and was visually estimated at 32% during the 1992 survey. Although a "low" cover complexity rating was reported for all surveyed habitat units, this rating appears to have been assigned mainly as a result of the lack of woody debris found during the survey. The low concentrations of wood is completely predictable given the confined channel morphology and moderate gradients that are typical of the majority of lower Hayfork Creek (Rosgen A and B channels). In these types of transport channels wood is rapidly flushed from the system and plays a very minor role in creating fish habitat. Pool depth, boulders, ledges and whitewater/surface turbulents instead serve as the predominant and natural cover components. Although no standard quantitative criteria exists for rating cover, the 32% estimate appears to be fairly good for a stream of this size and this type of channel morphology.

Adult salmon and steelhead monitoring in Lower Hayfork Creek has been sporadic, however, available information suggests that the numbers of adult salmon and steelhead using Lower Hayfork Creek is quite low. In recent years, summer steelhead have been occasionally seen in Lower Hayfork Creek and there are reports of as many as 50 steelhead redds found within the Hayfork drainage (Pacific Watershed Associates, 1994). Most of these redds however, appear to have been seen in the upper portion of the Hayfork watershed and its tributaries. Six spring chinook redds were seen in the lower two miles of Hayfork Creek in 1993 , although no spawning activity was seen in the years 1990-1992 (Aguilar et al. 1995). A total of 29 adult spring salmon and 19 salmon redds were observed during a 1995 survey of Hayfork Creek (Dean, unpublished). All of the redds were found below the town of Hayfork, however the report stated that redds were found further upstream in Hayfork Creek than had ever before been documented. Information regarding recent numbers of fall chinook returning to Hayfork Creek could not be found in the available literature. Present use by coho salmon is also unknown.

A comparison of juvenile steelhead densities in lower Hayfork Creek to densities in other Trinity River basin streams showed that lower Hayfork Creek ranked 13th, 13th and 20th for age 0+, 1+, and 2+ fish respectively (Arey and Gilroy, 1993). The density estimates used for these comparisons were generated during different years. Because of variability between years with respect to flow, temperature, and individual year class strength, the reliability of the comparisons may be questionable. However, the consistent ranking in the lower third of the twenty streams indicates that juvenile densities in lower Hayfork Creek are below average. Other fish species found within lower Hayfork Creek include Pacific lamprey, rainbow trout, speckled dace and Klamath small scale suckers. Two exotic species, Brown bullheads and green sunfish appear to have become fairly well established as a result of low flows and warm water temperatures.

While most of the South Fork Trinity watershed contains highly erodible soils, the Hayfork Creek watershed has been characterized as only moderately sensitive to cumulative erosion and sedimentation effects (Pacific Watershed Associates, 1994). Areas of high and very high instability and erosion hazard ratings do exist. however, within the Lower Hayfork Analysis Area. The 1992 steam inventory of Lower Hayfork Creek identified localized areas of mass wasting and bank instability in Lower Hayfork Creek (Arey and Gilroy, 1993). The report stated that "past and present mining activity is evident in lower hayfork Creek," and that both mining and grazing practices had created unstable bank conditions. Most of the areas of mass wasting identified in the 1992 survey appear to be concentrated along a segment of Hayfork Creek that is 2500 to 4000 meters above the confluence with the South Fork Trinity.

The Action Plan for Restoration of the South Fork Trinity River and its Fisheries (Pacific Watershed Associates, 1994) indicates that high levels of fine sediment have been identified in the in some low gradient reaches of Hayfork Creek below Hayfork valley. The document cites grazing practices in the Hayfork valley and the associated bank erosion problems as being primarily responsible for the elevated levels of fines. The plan suggests however, that total bedload movement within Hayfork Creek is not significant and that sediment sampling in the South Fork Trinity, indicates that there has been relatively low unit input of sediment from the Hayfork Creek sub-drainage. The Action plan also suggests that Hayfork Creek is more susceptible to direct channel impacts and agricultural and domestic water diversion practices than to an overabundance of coarse streambed sediment.

Water quality and water yield appear to be the factors which limit fish production in lower Hayfork Creek. Clearly, the water quality and water yield problem is severe with water temperatures as high as 85 F recorded in lower Hayfork Creek during summer low flow periods (Ranken, unpublished). A Trinity County Planning Department Report (1987) stated that "the water resources in Hayfork Creek Watershed as a whole are over-allocated." And a report written in 1994 stated that in September of that year, the lower portion of Hayfork Creek was not flowing at all (Kearney, 1994). Most of the water use occurs upstream of the lower Hayfork watershed analysis area, in both Hayfork Creek and its major tributaries such as Salt Creek and Big Creek. Flow data collected above and below a diversion in Big Creek in 1995 showed that as much as 75% of the flow from Big Creek was diverted for private land use during certain periods of the year, typically late summer Natural Resource Conservation Service, 1996).

Riparian canopy conditions in the Hayfork valley contribute to the temperature problem in lower Hayfork Creek. Included within the Watershed Project Plan and Environmental Assessment for Hayfork Creek is an evaluation of riparian conditions along private stream miles of Hayfork Creek (USDA Soil Conservation Service, 1994). Within the Hayfork valley, 8.5 of the total 9 miles of stream flow through private land. Nearly 95% (8 miles) of the private stream miles were reported to be in poor to fair condition.

The eutrophic conditions in lower Hayfork created by high temperatures and low flows result in filamentous algal blooms which are both common and extensive in Lower Hayfork Creek. For instance, the 1992 survey of lower Hayfork Creek completed by Arey and Gilroy (1993) reported that "filamentous algal blooms covered greater than 75% of the stream bed in three of the eight reaches surveyed." These conditions which include elevated water temperature and low dissolved oxygen are extremely limiting, if not intolerable for salmonid species. Other factors contributing to the poor water quality condition in the Hayfork drainage are agricultural runoff as well as leaching and runoff from septic tanks and sewage systems.

Fish habitat is present in several of the smaller tributaries within the lower Hayfork analysis area. Many of the tributaries entering Lower Hayfork from the north, including fish bearing and non fishbearing streams alike flow out of the Pattison area. Olsen Creek to the west of Pattison and Little Creek to the east of Pattison are the only fish-bearing streams that fall outside of this roadless area.

Fish bearing tributaries that enter Lower Hayfork Creek from the north include Olsen Creek, Little Bear Creek, Bear Creek and Little Creek. These tributaries are relatively small, ranging from two to seven miles in length. They are characterized as containing good fish habitat (Gilroy and Peak 1993, Kearney 1994, and North State Resources Inc. 1995) and support moderate densities of fish as compared to systems throughout the Trinity River drainage. Fish populations in these streams include anadromous runs of steelhead as well as resident rainbow trout. Stream banks are reported to be fairly stable and pool to riffle ratios appear to be at expected levels given the well contained morphology of the stream channels. The habitat reports for these streams suggest that stream gradient, pool depth and low summer flows may limit fish productivity in these streams. Stream gradient averages approximately 7% in areas where fish habitat exists and mean pool depth for all streams surveyed was in the 0.3 meter range. Riparian areas were generally characterized as healthy with good canopy closure. Water temperatures even during late summer surveys remained within tolerable ranges.

Only a few of the tributaries entering lower Hayfork Creek from the south contain fish habitat. Streams containing fish habitat are Jud Creek, Grassy Flat Creek and Rusch Creek. Rusch Creek and Grassy Flat Creek are known to contain anadromous steelhead as well as resident rainbow trout, while Jud Creek contains only a small resident population of rainbow trout (Mayo, 1992 and Kearney, 1984). A barrier falls near the mouth of Jud Creek prohibits upstream migration of anadromous fish. Stream temperatures in all three of the southern tributaries are considered favorable for salmonids with recorded summer water temperatures falling below 68 F.

Moderate amounts of timber harvest has taken place in the Rusch and Judd Creek drainages. Forest Service habitat inventories in both Judd and Rusch Creeks indicate that excessive fine sediment and channel aggradation may be a problem (Mayo, 1992 and Kearney 1994). The Rusch Creek report indicated that the road system which parallels the Creek may be a major contributor of sediment to the system. The results of fine sediment monitoring conducted in 1994 did not confirm the hypothesis that high levels of instream sediment was a limiting factor within Rusch Creek (Higgins, 1996). Using the V* method, the survey instead demonstrated that fine sediment levels in Rusch Creek compared favorably with other Trinity basin tributaries. Other suggested factors which may limit productivity include low summer flows, high stream gradient, shallow pool depths as well as a poor pool to riffle ratio (Mayo, 1992). Moderate densities of juvenile rainbow trout/steelhead were reported for Rusch Creek as well as Grassy Flat Creek. Fish habitat in Grassy Flat Creek was rated as "good" with pool to riffle ratios of 1:2.

Although run sizes are small in size, the tributaries to lower Hayfork Creek are an important component of the anadromous run of steelhead in the Lower Hayfork Creek watershed analysis area. They also have a positive influence on water quality in lower Hayfork Creek. An August 1994 dive survey by Higgins (unpublished) showed that, although juvenile steelhead densities in lower Hayfork Creek were similar to those reported by Arey and Gilroy (1993), the densities of juvenile steelhead in reaches below tributaries such as Miner Creek were five to ten times greater than a reach immediately below the nine mile bridge. The reach below the bridge was not influenced by nearby tributaries but instead showed the full effects of agricultural and domestic activity in the Hayfork valley. Clearly, the tributaries serve as refugia habitat and a critical element for future salmonid recovery efforts in lower Hayfork Creek.

Human Uses

- What are the current conditions and trends of the prevalent human uses in the watershed?

Heritage - Currently, there are 35 heritage sites recorded within the Lower Hayfork area. The lower Olsen Creek drainage, to the north of Hyampom, has the largest concentration. The majority of these sites have housepit/shelter features associated with them. In addition, many of these sites exhibit cultural deposits over 40 cm, which could provide significant information to further our knowledge of local prehistory.

The remaining Heritage sites are scattered through the 24 identified sub-watershed. The majority of these sites have not been evaluated as to their eligibility to the National Register of Historic Places (NRHP). Consequently, any proposals addressing the three focused issues may adversely effect these sites. Each site which may be impacted (falls within the area of potential effect (APE) for the project) needs to have its historical significance evaluated (36 CFR 800.4 (c)(1)-(5). If the site is considered eligible to the NRHP the criteria of effect needs to be applied and potential management actions proposed (36 CFR 800.5).

Area H, Pattison, and G have had no archaeological inventory done. Under 36 CFR 800.4 (a) and (b) inventory will need to be done on the APE's for those undertakings proposed in these areas.

American Indian Tribal Uses - Currently, areas of Lower Hayfork are being used for traditional gathering. These materials include bear grass, red bud, and black oak to name a few. Basketry and traditional foods are the principal products.

Recreation - At this time, Lower Hayfork area has mainly dispersed recreation use. This use is highest during the fall hunting season. In addition, fishing along Hayfork Creek is another ongoing use. Recreational mining takes place also along Hayfork Creek. Other forms of dispersed recreation take place, but are at much lower levels then those mentioned above.

Economics/Social - The local communities bordering Lower Hayfork have been undergoing an economic downturn in the timber industry. The recent announcement of the Hayfork Sierra Pacific sawmill in Hayfork is evidence of this. This downturn can be traced in part to the reduced levels of timber harvest on public lands. Much of this reduction is in response to management concerns over endangered species, fisheries decline, and watershed quality.

However, this reduction of timber harvest on public lands is only part of the economic picture. The timber industry itself is having to respond to international competition (Canada), reduction in the private land timber base, and the need to make production more efficient.

The local social system/community has been effected. The Hayfork mill closure will result between 50 and 100 jobs leaving the local area. This has secondary effects on local businesses and the school system. These effects continue into other community functions such as little league. Fewer children and adults can limit or curtail community activities dependant on numbers of people participating.

More immediate and long term has been the income decline for families dependant on timber industry jobs. The local communities have been trying over the last few years to create new jobs to fill in for the loss of timber ones, however, success has been limited. Many social and family problems (spousal, child, and substance abuse) have been related to the timber industry downturn. However, this relationship is not cause and effect. An economic downturn can have indirect effects which magnify weaknesses within communities, individuals, and family structures. These problems have deeper roots which must be addressed on the individual, community, economic, and government level. Increased timber production would not solve the problem only mitigate it. The ultimate solution lies at a deeper more personal level.

STEP 4: REFERENCE CONDITIONS

Purpose

- To explain how ecological conditions have changed over time as the result of human influence and natural disturbances.
- To develop a reference for comparison with current conditions and with key management plan objectives.

Core Topics and Questions

Erosion Processes

What are the historical erosion processes within the watershed (e.g., surface erosion processes, mass wasting)? Where have they occurred?

Geology - Chromite and manganese have only been mined in the Klamath Mountains during World Wars I and II and during the Korean War when domestic sources were utilized for the war effort and the U.S. Government provided economic incentives for their production. Chromite is found as small bodies of "float" or clustered podiform masses, on the order of a few tons up to 10,000 tons, in serpentine and peridotite. Two chromite occurrences have been identified in the analysis area south of Hayfork Creek. Production of chromite ore is only reported from the Pallestreau claims in sections 22 and 23 of T.3 N., R.7 E., and produced a total of seven long tons of chromite between the years 1918 to 1920.

Soils -In 1828 the first white men to enter the Lower Hayfork Analysis area were fur trappers in the Smith Party who came to the juncture of the South Fork of the Trinity River and Hayfork Creek. The trails followed by this party had been used by generations of the Wintu and Hoopa, tribes of Native Americans who inhabited this valley. The herds and wagons of farmers who came later to produce for the mining sections followed these same trails. Due to their early beginnings, road placement in the area is poor, with no consideration for erosion hazard, mass movement potential, very steep slopes, or low available water capacity. Early road building techniques were not to current standards, leading to road failures from mass wasting, and sediment contribution to streams. Today many of the problems have been corrected with proper placement, design of road drainage systems, and proper treatment of spoil from excavations, but isolated problems remain.

In the 1930's large scale commercial logging began and accelerated with World War II and the postwar construction boom. As with road placement and construction, early harvest techniques were substandard from modern perspectives. There was little knowledge of the main concerns of erosion hazard, mass movement potential, very steep slopes, and compaction potential in regards to harvest methods, or low available water capacity, competition, % surface gravel, and species diversity in regeneration. Long term sustainability of the soil resource or the ecosystem as a whole was not seen to be a problem until old growth timber had been totally or at least partially harvested.

Historically, fire has been the major disturbance factor within the Lower Hayfork ecosystem. The scale of the disturbance has a major effect on the composition of vegetation species and their contribution to the physical and chemical characteristics of the soils. Recurrence of fire and recovery is an important mechanism for energy flow and nutrient cycling, and has historically maintained the structural and overall health of the ecosystem. Fire plays a critical role in cycling the system's chemical components between vegetation and soil. The most influential factors controlling the release and transport of soil nutrients are: the temperature of the fire, the degree of forest floor consumption, the amount of moisture present in the soil, and the cation exchange capacity of the individual soils.

Modern fire control has been aggressive fire suppression for the purpose of maximum timber production. Instead of removing fires from wildlands, the result has been a gross distortion in the natural fire regimes, removing most fires of low and intermediate severity and size, and increasing the proportion of large, high-severity fires. From a soil resource perspective, the principal negative consequences of fire on soils are the reduction of soil productivity and an increase in erosion. This occurs through the consumption of woody material and duff, which reduces the amount of soil cover to intercept raindrop impact, and represents future contributions to soil organic matter. Erosion can also be increased through damage to surviving root systems, as vegetation removes less moisture through evapotranspiration, runoff increases, and thus do cumulative effects.

Excessively hot fires on certain soils and plant litter types can also increase or induce the natural water repellency of the litter layer. Water repellency may naturally occur in the litter layer, and frequently occurs in the ash dust layer, on top of mineral soil or within a layer at a lower depth. The thickness of the water repellent layer depends on the intensity of the fire, the soil water content at the time of the fire, and the physical properties of the soil. Water repellency can be present without fire and often results from microorganism populations, particularly fungal mycelia. The action of heat on microbial decomposition products and undecomposed plant parts may cause them to coat and chemically bond to the nearby mineral particles causing "hydrophobic" or water repellent layers in the soil.

The 1964 flood left an indelible imprint on the South Fork River and its tributaries. Millions of cubic yards of sediment were mobilized from exposed upland sources and deposited in the active channels resulting in reduced habitat values for anadromous salmonids. The effects of the single storm event are still very evident in the South Fork Trinity River and its tributaries in the form of excessive channel stored sediment, unstable inner gorges and channel banks, and landslides. Much of the area has the potential for ongoing cumulative watershed effects. (AMA Draft Guide)

Geology - As previously described, mass wasting has played a significant role in the geomorphic development of the lower Hayfork Creek watershed. In many of the subwatersheds, mass wasting continues to be the primary geomorphic process today. In those watersheds, mass wasting is the primary erosion process, responsible for the majority of sediment delivered to the fluvial system.

In order to try to get an idea about the natural range of variability for mass wasting, aerial photos spanning the past 52 years were used to evaluate active mass wasting along the main stem of lower Hayfork Creek. The following narrative describes the results of the analysis.

The lower Hayfork Creek channel consists of the canyon section, which is steep, bedrock controlled and generally transporting in nature, and a lower section which is lower in gradient and depositional in nature. In both sections, the channel is deeply incised within the landscape and well defined valley inner gorges bound the channel. Analysis of the lower portion of Hayfork Creek is indicative of slope stability trends for the entire lower channel. The 1944 aerial photos document the presence of 2 large debris slides along outside meanders in the lower 2 1/2 miles of Hayfork Creek. In addition, there is an active earthflow which toes out in Hayfork Creek upstream from the two debris slides. All along the lower reach, small active inner gorge slides are evident. The 1960 aerial photos indicate that the slides remain active, and are unvegetated. The earthflow is more active, with active failure extending well upslope relative to the 1944 photos. The 1970 photos document a new translational slide downstream from the active earthflow, and all of the slides previously described remain unvegetated and interpreted as remaining active.

Analysis of the remaining channel is similar in trend as described above. There are many active debris slides evident on the 1944 photos, which occur within the inner gorge, as well as larger earthflows and translational slides which toe out in the inner gorge. Several more slides are evident on the 1960 and 1970 photos, but nothing very significant.

Hydrology

What are the historic hydrologic characteristics (e.g., total discharge, peak flows, minimum flows and features (e.g., cold water seeps, groundwater recharge areas) in the watershed?

Cumulative Watershed Effects - Past roading, timber harvesting, wildfires, and human settlements have historically been major factors in cumulative watershed effects. The most recent major wildfire occurred in 1987. The upper subwatersheds of Rusch Creek, the Lower Olsen subwatershed, and the southern half of the Jud Creek Watershed show the greatest amount of past roading and timber harvesting.

Effects from upstream areas outside of the Lower Hayfork Watershed Analysis Area have been mainly from urbanization at Hayfork and logging of the Gemmill Gulch and Wilson Point Timber Sales. Approximately 1,000 cubic yards of mostly fine sediments (mostly silts) deposited into Bridge Gulch and Hayfork Creek appear to remain mostly upstream of the Lower Hayfork Watershed Analysis area.

Flood Flows - Historical data for Hayfork Creek and the South Fork Trinity River indicates how the flood of 1964 peaked on December 22, 1964 at all five stream gaging stations. This is displayed as follows:

South Fork Trinity River near Forest Glen - 41,200 cfs
South Fork Trinity River near Hyampom - 57,000 cfs

Hayfork Creek near Hayfork - 7,500 cfs
Hayfork Creek near Hyampom - 28,800 cfs
South Fork Trinity River below Hyampom - 88,000 cfs

Further analysis shows that - at peak flows - the average streamflow per square mile of watershed was 87 cfs/square mile at Hayfork Creek near Hayfork and a lower 76 cfs/square mile at Hayfork Creek near Hyampom.

A comparison of flood flows at Hayfork Creek near Hyampom for 1964 and 1974 hint at the greater potential for damage during the flood of 1964 with its longer duration flood flows of generally higher magnitudes. This appears to be true despite the higher maximum peak flow of 29,400 cfs on January 16, 1974 compared to a maximum peak flow of 28,800 cfs on December 22, 1964.

Flood flows were reported as approximately as high during flooding in 1955 as they were during the flood of 1964. Yet, less damage was recorded in 1955.

Lower Flows-U.S. Geological Survey data for the two discontinued stream gaging stations at Hayfork Creek shows the following range of baseflow data:

Date	Hayfork Creek near Hayfork	Hayfork Creek near Hyampom
July 1	5 to 25 cfs	N.A.
July 15	4 to 20 cfs	N.A.
August 1	3 to 10 cfs	20 to 60 cfs
August 15	3 to 10 cfs	7 to 50 cfs
September 1	2 to 8 cfs	7 to 50 cfs
September 15	2 to 6 cfs	7 to 35 cfs
October 1	2 to 6 cfs	7 to 15 cfs
October 15	3 to 5 cfs at baseflows	15 to 20 cfs at lower flows

Note: cfs = cubic feet per second.

Vegetation

What is the historic array and landscape pattern of plant communities and seral stages in the watershed (riparian and nonriparian) and what processes caused these patterns (e.g., fire, wind, mass wasting)?

Information regarding reference conditions for this watershed is limited. There is some historic information contained in Range reports and a timber inventory from the early 1900's. A single point of reference used for this analysis are a series of black and white aerial photographs at a scale of roughly 1:30,000. The vegetative characteristics considered for the Lower Hayfork watershed include seral stage distribution, plant community and canopy density.

Canyonlands Analysis Area

In 1944, ten percent of the area was in early seral stages. On the west side there were large open cultivated areas in agriculture. In the middle portion of the analysis area there were small patches of early seral vegetation and the east side had a few small scattered patches of open, dry meadows. Thirty-five percent of the area was in mid-seral stages, mostly occurring in the east and middle portions in a continuous matrix. Fifty-five percent of the area was in late seral stage with the majority occurring in the east and middle portions in a contiguous matrix.

Hyampom Earthflows Analysis Area

In 1944 ten percent of the analysis area was in early seral stages. The west portion consisted of large patches of open grasslands on private lands (ranches). There were small scattered openings throughout the area. The east portion had three large openings having scattered conifers. There were also large open stands of ponderosa pine with a grass understory (Grassy Flats). Mid-seral stages encompass 15 percent of the analysis area, with small scattered patches throughout. These are possibly the result of fire. There was 75 percent in late seral stages. A large contiguous matrix of late seral stands of mixed conifer and Douglas-fir was predominant in the eastern half of the analysis area.

Halfway Ridgelands Analysis Area

In 1944 there was 10 percent in early seral stage. Large patches of early seral vegetation appear in a north-east trend and on south slopes. Mid-seral stages encompass 10 percent of the analysis area and is scattered throughout in small patches, possibly the result of fire. Eighty percent of the area is in late seral. The east side has dense stands of mixed conifer and Douglas-fir with obvious hardwood components in late seral stage.

1987 Burned Area and Olsen Creek Analysis Area

In 1944 vegetation consisted of mixed conifer and hardwoods in open patchy stands, interspersed with meadows. Southern aspects were likely dominated by gray pine, knobcone pine and canyon live oak. Canopy closure was most dense on north aspects and near ridgelines. Site potential within the area appears to be low and fire frequency was probably high due to south and southwest orientation and adjacency to a population center. Native American burning may also have been frequent here. Archaeological evidence (house pit sites that were unknown until the 1987 fires burned off shrubfields) indicate heavy Native American use, inferring there was probably decreased vegetation cover in the area.

Jud-Rusch Analysis Area

In 1944 there was 5 percent in an early seral stage. Twenty-five percent was in the mid-seral stage, mostly occurring on south facing slopes. The late seral stands, totalling 70 percent of the area occur on north and northeast slopes.

Little Creek Analysis Area

In 1944 twenty percent of the area was in early seral stages, the major portion occurring on the upper, south-side of Hayfork Bally. There was 20 percent in mid-seral stages in small, scattered patches. The 60 percent in late seral stage was in large patches on north and northeast aspects.

Pattison Area

In 1944 about 10 percent wqs in early seral stage (with 1% in grassland). The remaining 90 percent is in mid-seral stage throughout the analysis area.

Fire Regimes

It is believed that fires were important in maintaining the heterogeneity of vegetation mosaics across the landscape. Localized fire history for the area combined with research findings in adjacent areas suggest a pattern of vegetative arrangement for this landscape. Wills (1991) hypothesized that the pre-settlement landscape was probably exceptionally patchy, containing a complex mosaic of age, size, and structure. Stand conditions were likely more open on upper slopes (above 3100 feet), particularly on steep terrain and southerly aspects. Stand conditions in the lower portions of the slope (below 3100 feet) and on north aspects would have been less open, with more structural diversity, particularly on productive sites often associated with dormant landslides.

Fire return intervals in the vicinity of the Trinity Divide of the Klamath Mountains in the pre-1840 period, ranged from 7 to 50 years depending on the site. The average pre-1840 fire return interval was 17.1 years for all sites. Evidence indicates that these fires were most likely late season burns, probably late summer through early fall (Skinner, pers. comm.).

It is widely accepted that the contemporary fire regime contrasts sharply from regimes occurring in this region prior to European settlement. However, knowledge of actual ecosystem conditions prior to settlement is incomplete, and a historic perspective is necessary for assessing ecosystem trends that have occurred following the advent of the National Forest System.

The following narratives describe the vegetation types as they are believed to have been during this period and their related fire characteristics:

Douglas-Fir forest

The natural fire regime in Douglas-fir forests varies from frequent, low intensity surface fire to moderate severity fires of mixed intensity. Douglas-fir forests have differing fire regimes because of variability in length of fire season, climate, fuel accumulation rates, and understory composition. Preliminary data (Skinner, 1991) indicate a fire free interval on the Mt. Shasta Ranger District of 15 to 25 years. It is likely that considerable variation in frequency and severity of fires existed within drainages due to the topographic variation and micro-climatic differences in the northwestern portion of California.

Mixed Conifer Forest

Mixed conifer forests were probably different in terms of structure, species composition and pattern. Overall, stands were more open than they are today, with few being as dense and multi-storied. The relatively denser stands within the landscape were likely to have developed on north-facing slopes, in riparian areas and areas of deep, productive soils. The more open stands occurred on south-facing slopes. White fir would have occurred less as a component of mixed conifer stands and would have been confined more to upper elevations. Douglas-fir would have been a co-dominant primarily at lower elevation and on northerly aspects, with ponderosa pine being more of a significant component throughout the mixed conifer stands. Past fire return intervals averaged from 8 to 20 years. The range of return intervals occurred on the order of 5 to 50 years. Fires were frequent and of low to moderate intensity.

Montane Shrub Communities

The occurrence of shrub communities is largely determined by site capability, and probably has not changed significantly since just prior to European settlement. Under historic fire regimes, these communities were maintained in a more vigorous condition than what exists today. Post-fire response of most of the species in the landscape is either through vigorous root crown sprouting or germination of stored seedbanks. These communities burned on a regular and frequent basis.

Live Oak stands

There were probably more pure stands of live oak with less encroachment of conifer species under historic fire regimes. Stands were sparsely stocked with a minimal understory. These communities probably burned more often and hotter than forested communities.

Plant Species of Concern - Step 4, Historical Relative Abundance and Conditions of Species and Their Habitat

The historical relative abundance and distribution of, Niles' madia (*Madia doris-nilesiae*), Canyon Creek stonecrop (*Sedum paradisum*), and mountain lady's slipper (*Cypripedium montanum*) in the Lower Hayfork Creek Watershed is not known due to their recent discovery in the watershed. Niles' madia and Canyon Creek stonecrop are recently described species. Mountain lady's slipper was historically more abundant throughout its range but no data is available pertaining specifically to the Lower Hayfork Creek Watershed.

The distribution of habitat for Niles' madia (ultramafic soils/outcrops) has not changed since 1944. Habitat conditions have changed to varying degrees. Ultramafic sustrates in the Jud Rusch Analysis Area appear to support somewhat increased vegetative cover since 1944, with the exception of some logged sites, while those in the 1987 Burned and Olsen Analysis Areas have drastically reduced vegetative cover due to the 1987 fires. Other areas of ultramafic substrates in the watershed appear to be relatively unchanged since 1944. Some of the habitat for Niles' madia has been reduced or degraded through use as road beds or from soil disturbance, usually by compaction from heavy equipment. Other disturbance factors may have resulted in the addition of new habitat such as the creation of road cuts and the removal of vegetative cover by fires.

Since the status of this plant prior to these disturbances is not known, it not possible to determine whether the disturbance resulted in a net gain or loss of habitat.

The historical relative abundance of habitat for mountain lady's slipper was much greater in 1944 than it is today due to extensive logging of its suitable habitat, closed canopy and old-growth forest, since then. Fire suppression, logging, and collection for horticultural trade have resulted in extirpation of populations over the species range.

Distribution of habitat for Canyon Creek stonecrop, rock outcrops, gravelly slopes, and scree, has probably changed little since 1944. Vegetative cover has likely increased, which may have improved conditions. Road cuts and rock removal may have eliminated or increased habitat for this plant, depending on how much rock was removed or exposed.

The exotic pest plants of concern in the Lower Hayfork Creek Watershed, yellow star thistle (*Centaurea solstitialis*), bull thistle (*Cirsium vulgare*), and cheat grass (*Bromus tectorum*) are natives of Europe (thistles) and Eurasia (cheat grass) and would not have been present in the years before European settlement of the land. Since these plants are disturbance followers, the increased number of roads, landings, and clear cuts since 1944 has resulted in a drastic increase of habitat.

The persistence of species in Pacific Northwest forests through time is attributed to the vegetation adaptations to fire. If the fire regime is altered, then the capacity for that species to survive in an environment may be eliminated (Pyne, 1984). In pine and mixed-conifer forests, frequent fires result in mineral seedbeds that facilitate establishment of species such as ponderosa pine, sugar pine, and Douglas-fir. Fire exclusion, or infrequent fires will favor species such as true firs, incense-cedar, and other shade tolerant, fire intolerant species (Parsons, & DeBeneditti, S.H. 1979). When high-severity fires occur within ecosystems that have evolved under low-severity fire, ecological effects are well outside the natural range of variability. High-severity fires are outside the natural range of variability today primarily in the extent of area affected by high-severity. Historically there were always patches of high-severity within the areas burned by mostly low-to-moderate severity fires. This gives us our complex stand structures and patch patterns characteristic of the Klamath Mountains.

By continuing to suppress low-to-moderate severity fires, we are managing in a way that insures that the fires that will affect most of the landscape are the high-severity stand replacement type fires (Skinner, 1994). Impacts, from high-severity fires can include soil erosion, loss of soil organic matter and structure, soil cover, mineral nutrients, soil micro-organisms, and hydrophobic soil effects. Off site effects can include physical, biological and chemical changes in water quality.

Anytime a component of a watershed is modified or changed, the whole watershed will function differently. Fire is a major component of the watershed and by attempting to exclude it we are impacting the other components of the watershed, signs of these impacts are now beginning to materialize, what the long-range environmental impacts will be is unknown.

Historically, the frequent, low-severity surface fires typical of this watershed killed only a small percentage of living trees while consuming much of the coarse woody debris, therefore input rates of coarse woody debris were slow and relatively constant. Fire exclusion and past timber harvest has resulted in the formation of a dense "midstory" of shade-tolerant conifers and shrubs. The overall increase in surface fuels and the laddering effect of existing vegetation has increased the threat and occurrence of crown fires where historically they were rare. Though fire regimes have been altered by land use, fires still greatly influence the watershed. Fire exclusion is a powerful form of vegetation manipulation, not likely to result in ecosystem preservation where the historic plant and animal communities were fire-dependent (Heinselman, 1971). Through fire exclusion and past management practices we are essentially trying to produce climax communities over the entire landscape, where such situations never occurred historically.

Historically, oak woodlands and grasslands frequently underburned. Whether by Native Americans or lightning ignited fires, results were the killing of competing vegetation in the grasslands and increased the health and productivity in the mature oaks. Frequent fires in oak woodlands and grasslands halt encroaching conifers.

Stream Channels

What were the historic morphological characteristics of stream valleys and the general sediment transport and deposition processes in the watershed?

200 years ago, most stream reaches within the Lower Hayfork Watershed Analysis area had the same channel types that they have today. There are two focuses in this step. The first focus is on identification of the few channels that were different 200 years ago. The second focus is on identification of channel processes that are a concern. In some cases, the channel type remains the same, but past channel processes represented more stability in the channel, and/or were more in equilibrium with the aquatic and riparian ecosystems in the local watersheds.

Channel reaches that now have D channel types previously had C channel types; there may one or two exceptions where a D channel was previously an E channel.

200 years ago, channel processes strongly coincided with the channel type where they were occurring. For example, C channel types were characterized by the presence of a moderate to very high amount of sediment in the channels. Channels adjusted by shifting laterally and routing some of the sediment on downstream, keeping the width/depth dimensions and shapes that define a C channel type. E channel types were characteristically deep and narrow; sediment was routed on downstream efficiently. Although exceptions were possible as a result of a natural flood and/or mass wasting processes, streams generally remained stable, or adjusted to changes without becoming D or G channel types. D and G channel types generally represent unstable channels.

Water Quality

What were the historic water-quality characteristics of the watershed?

The information needed to establish an accurate account of historic water quality conditions are not available. Water rights for most of the major water users in the Hayfork Valley were established before 1918, while flow records were not kept until 1954. Thus, water use patterns in 1954 were already established and were probably similar to current use patterns.

Although historic stream temperature data are also not available, it is likely that lower Hayfork Creek has always been a temperature sensitive stream. The stream channel morphology in both the gorge area and the lower uncontained reach of Hayfork Creek has probably changed very little from historic conditions. The lower uncontained reach has certainly always been wide with limited amounts of stream side shading and Higgins (1996) suggested that Hayfork Creek warms up as it passes through the gorge area which receives the full arc of the summer sun. Without historical flow data, however, it is not possible to determine how this temperature sensitive condition historically affected water temperature in Hayfork Creek.

Inorganic and organic pollutants were probably of no concern historically. And although current fine sediment levels are considered to be elevated, overall bedload movement and stream turbidity in lower Hayfork Creek is probably similar to historic conditions.

The information needed to accurately describe historic water quality conditions in the tributaries to lower Hayfork Creek is also not available. Logically, historic water quality conditions in most of the tributaries were probably very similar to the water quality conditions which presently exist in the tributaries, since water quality conditions are quite good in the majority of the tributary streams. Olsen Creek, Jud Creek and Rusch Creek may be exceptions. Although no current or historic flow records exist, water use in Olsen Creek has probably changed flow conditions in that stream. At least one source has suggested that water quality, and in particular fine sediment level, has been compromised in Jud and Rusch Creeks (Aley and Gilroy, 1993). Another source, however, indicates that fine sediment in Rusch Creek is not a limiting condition (Higgins, unpublished). Although water quality information on Rusch Creek appears inconclusive, water quality conditions in both Rusch and Jud Creeks is probably at least slightly altered from historic conditions as a result of the management activities which have taken place in those two drainages.

Species and Habitats

What was the historic relative abundance and distribution of species of concern and the condition and distribution of their habitats in the watershed?

Wildlife - Is the Lower Hayfork Watershed currently fulfilling its assigned biological role in the overall strategy for maintaining viable populations of species associated with late-successional and old-growth forest ecosystems as described in the FSEIS, the subsequent ROD, and the Shasta-Trinity National Forests Land and Resource Management Plan? Specifically; is this watershed providing adequate connectivity between LSRs RC-330 and RC-332? Connectivity is a measure of the extent to which the landscape pattern of the late-successional and old-growth ecosystem provides for biological and ecological flows that sustain late-successional and old-growth associated animal and plant species across the range of the northern spotted owl.

The rationale for focusing this analysis on the issue of connectivity is presented below. This focus does not imply that other wildlife issues are henceforth dropped from consideration. Rather, many wildlife concerns (e.g., possible impacts to red-legged frog, western pond turtle, or willow flycatcher habitat) are best dealt with at the project (i.e., site specific) level.

Riparian species (e.g., western pond turtle, northern red-legged frog, or willow flycatcher) are not likely to have significant impacts to their habitats due to management requirements imposed by the Forest Plan within Riparian Reserves to assure consistency with the Aquatic Conservation Strategy. In addition, the important population of pond turtles in Hayfork Creek lies within a corridor that is likely to receive little if any management activity. Further, any concerns with riparian dependant wildlife species are largely addressed by the issues and questions dealing with erosion processes, hydrology, stream channels, and water quality.

No bald eagle or peregrine falcon nest sites are known to occur within the watershed. The potential falcon nest sites north of Hayfork Creek would not be affected by probable future management activities. Probable future management activities within the watershed would not likely affect foraging opportunities for these two species.

Current conditions within the Lower Hayfork Watershed strongly suggest that wildlife species associated with early seral stage forest conditions or shrub habitat are not limited by the amount of these habitats currently available in the watershed. Further, these habitats recover much faster after disturbance events (e.g., stand replacing fire or timber harvesting) than do mature, late-successional, or old-growth forest habitats.

The Lower Hayfork Watershed lies between two large LSRs and thus must provide adequate connectivity to fulfill its function in the overall strategy to maintain viable populations of species associated with late-successional and old-growth forest ecosystems (e.g., northern spotted owl, northern goshawk, american marten, and fisher). Connectivity is a measure of the extent to which the landscape pattern of the late-successional and old-growth ecosystem provides for biological and ecological flows that sustain late-successional and old-growth associated animal and plant species across the range of the northern spotted owl. Further, suitable habitat for maintaining connectivity (typically mature or older forest) can take long periods of time to recover after disturbance events (e.g., stand replacing fire or timber harvest).

Fisheries. Formal scientific data on fish abundance was not collected in the South Fork Trinity basin prior to 1960. Although data on long-term population trends are not available, fisheries managers, scientists and the public concur that in recent decades there has been a substantial decline in the numbers of fish returning to the South Fork Trinity River and it's tributaries.

Spring chinook were historically the most abundant salmon species returning to the South Fork Basin. In 1963 an estimated 7,000 to 10,000 spring chinook spawned in the South Fork and it's tributaries (Pacific Watershed Associates, 1994). Spring chinook historically spawned in the main stem of Hayfork Creek and in the lower end of tributaries such as Salt Creek and Tule Creek, with the majority of spawning activity concentrated in the lower two miles of the main stem. Historic numbers of salmon in Hayfork Creek are not available, however, the results of surveys conducted from 1990 to 1993 represent a tremendous decline in spring chinook numbers within the Hayfork basin (Pacific Watershed Associates, 1994). During the 1990 to 1993 survey period redds were found in only one of the three years (1993). There were only six redds found during that one year.

Historic data indicates that fall chinook were present in the South Fork basin in fewer numbers than spring chinook. Although historic run strength of fall chinook in lower Hayfork Creek is not known, carcass surveys and redd counts conducted in 1964 indicate that there were 3,337 fall chinook which spawned in the lower 2.5 miles of Hayfork Creek and downstream of Hyampom in the South Fork Trinity. (Lafaunce, 1967) Fall chinook returns to the South Fork basin from 1985 to 1993 range from 345 to 2640.

Winter steelhead numbers are reported to have declined within the South Fork Trinity basin, but not as drastically as other fish species such as spring chinook. After 1964, the numbers have shown alternating period of decline and resurgence, although overall, the trend appears to be downward. In 1964 there were 5,000 redds counted in the upper South Fork Trinity, Hayfork Creek and their tributaries. (Lafaunce, 1965) In contrast, only 352 redds were counted in 1972. (Rogers, 1973) Angler interviews indicate a resurgence in abundance of steelhead in the late 1970's but a subsequent decline in the 1980's. Weir counts for the South Fork Trinity River yielded estimates of 2,356 and 3,500 steelhead in the 1990-1991 and 1991-1992 sampling periods respectively. (Pacific Watershed Associates, 1994). During that period of time relatively high concentrations of redds were found in middle and upper Hayfork basin tributaries such as Big Creek and the East Fork of Hayfork Creek. Information inclusive only of the Lower Hayfork Analysis Area is not available, however, the majority of both historic and current spawning and rearing appears to be concentrated in the upper reaches of the drainage, above the Lower Hayfork Analysis Area.

Summer Steelhead runs in the South Fork basin are not believed to have ever been substantial. Summer steelhead have been occasionally cited in Hayfork Creek in recent years, but again, their former abundance in Hayfork Creek is not known. Similarly, coho salmon were never dominant in the South Fork Trinity basin and no historical population estimates for this species was ever calculated in the South Fork basin. Current numbers in the South Fork are very low and no record of coho presence in Hayfork Creek exists.

Unfortunately, there is little information regarding historic fish habitat condition in lower Hayfork Creek or it's tributaries. The present "good" condition of the habitat (excluding water yield and water quality) suggests that habitats have not changed significantly despite significant historic events. The 1964 flood is considered to be a significant event which drastically altered stream channel conditions within the South Fork Trinity basin, resulting in tremendous channel aggradation, channel widening and filling of pool habitat. However, the flood appears to have had relatively little impact on Hayfork Creek. For instance, streambed elevation increases at USGS gaging stations recorded from 1964 to 1965 showed an increase of 12.9 feet in the South Fork Trinity near Salyer, but only a 0.6 foot increase in Hayfork Creek near Hyampom. Little discernable difference between pre and post 1964 channel condition could be gleaned through review of aerial photos taken before and after the flood (1944, 1960 and 1978).

Human Uses

What were the major historical human uses in the watershed, including tribal and other cultural uses?

Roads - This landscape element development can be traced back to trail routes used by Chamariko and Wintu American Indian groups in Lower Hayfork. These early trails were later used by Euro-american settlers to access Hayfork Creek, the surrounding high country, and Hyampom and Hayfork Valleys. Later on the Forest Service used many of these prehistoric trail routes and expanded this system for range management, Forest inventory, and fire protection. From these trails the current Forest Service and County road systems developed.

The County road system now in place is used to access the community of Hyampom with Hayfork and various parcels of private property. Off the main County Highway (Hyampom Road) Forest Service system roads were put in to carry out timber management, fire protection, range management, and recreation.

Heritage - Evidence from archeological investigations suggest early occupation of the Lower Hayfork Creek watershed analysis area occurred between 10,000 and 5,000 Years Before Present (YBP). Paleoenvironmental data indicates that between 10,000 YBP to 2800 YBP the temperature was warmer in the North Coast Ranges and Klamath Mountains. Alpine glaciers on South Fork Mountain and Black Rock Mountain receded, and streamflows in the South Fork of the Trinity were reduced. During this time it is believed resources were more abundant and diverse. Early occupation of this area is represented by artifact assemblages characterized by wide stem projectile points, small serrated bifaces, flake tools, milling slabs and edge flaked spalls (Hildebrandt & Hayes 1984).

Starting around 2000 YBP the climate cooled significantly. This cooling period is thought to have lasted a thousand years and is referred to as the "Little Ice Age". During this time it appears upland resources decreased in abundance and diversity. At this same time the productivity of anadromous fish runs improved. Settlements in this area were probably located in areas where oaks were present in association with fish runs. At this time it appears use of the Lower Hayfork Creek Watershed became limited to short term task activities carried out by small groups. Artifact assemblages representing this time include large corner notched, side notched, contracting stemmed and serrated leaf shaped projectile points, formed flaked tools, small non-serrated bifaces, manos and pestles (Hildebrandt & Hayes 1984).

Between 1494 to 1820 AD it is suggested that the climate and upland habitat was similar to what it is today. During this time it appears that semi-sedentary settlements occurred which indicated social-political complexity where production and exchange was occurring. The artifact assemblage representing this time would include small barbed corner-notched projectile point, mortars, pestles and clam disk beads used as money (Fredrickson 1974).

Many wildlife species that we are familiar with today were present during the prehistoric period. Species that formed large herds (elk and deer) or were far roaming (wolf and grizzly bear) were in much greater numbers due to large expanses of habitat that was unencumbered by fences, settlements, or the mosaic of land use practices of the Europeans who were to follow. Other species that proliferated in the human altered environments are more common today than during this period (coyote). Native Americans observed how natural fire improved forage for many wildlife species that they depended on. They continued the practice by setting fires to ensure healthy herds of deer and elk. There is ethnographic evidence for the Chimariko people utilizing two converging fires to hunt both small and large game animals (Silver 1978).

Archaeologists feel two American Indian groups occupied the Lower Hayfork Creek area. The earliest that can be named were the Chimariko. These people spoke a language related to the Hokan stock, a linguistic grouping ranging from southern Oregon to Central America (Silver 1978). It is felt their territory originally took up the main Trinity from Burnt Ranch to Junction City southward to Hayfork Valley and Hyampom Valley. Inference for this comes from linguistic evidence and geographic locations having both Chimariko and Wintu names. Evidence for this comes from the Chimariko word for Hyampom maytsa, meaning 'field' or 'flat'. The Wintu referred to Hyampom as xayinpom, which means ground 'pom', of the xayinbas 'Chimariko Indians'. Hayfork also had a Chimariko name tsanqhoma which has no defined meaning. Two other locations within Lower Hayfork area had Chimariko place names. One is a falls on Hayfork Creek two miles upstream from Hyampom called hexasutse. No meaning was given for this name. Second, Grassy Flat has both a Chimarkio and a Wintu name. The former is paxkhotce maytca, the first word has no literal meaning, but the second maytca is 'field'. The Wintu name phakotse ts'araw is felt to be related to the Chimariko form. The first word has no literal meaning, but the second ts'araw means 'field'. It is felt the Wintu word is borrowed from the Chimariko based on the final syllable -tce (Wintu - tse), a common suffix in Chimariko (Bauman 1980).

From linguistic evidence there appeared to be considerable bilingual sharing of language. Once this easy sharing of language was adopted these two distinct cultures slowly assimilated into each other. From ethnographic work it is felt the Chimariko in the Salyer/Burnt Ranch area were assimilating into the Hupa tribe and in the Hyampom area into the Wintu (Bauman 1980).

Little detailed information is known about Chimariko culture. At the time of Euro-American contact Chimariko life centered around village communities. Each village grouping had a single headman. Villages contained a sweathouse and several multi-family dwellings. These structures were constructed in a circular pattern. Sweathouses could hold between 8 to 10 men. Here men would sweat daily, gamble, or sleep. Women were excluded except for ceremonial sweating together. Dwellings were 10 to 14 feet in diameter and could contain two or more families (Silver 1978).

Subsistence centered on the riverine resources provided by the Trinity River. This subsistence was balanced with acorn and pine nut gathering. In addition, seed gathering was done, including burning for a better wild-seed crop. Hunting added to the diet a wide range of game (bear, deer, small mammals, bobcat, and various bird species) (Silver 1978).

The second American Indian group occupying the Lower Hayfork Watershed was the Nor-El-Muk Wintu (DuBois 1935, Merriam 1962, Powers 1878). This group spoke a Wintuan language related to the Penutian Stock of languages in California. Linguists feel the Hokan language spoken by the Chimariko is older than the Wintuan Penutian. The reasoning for this is the peripheral location in California of Hokan speaking peoples compared to Penutian groups. Hokan speakers are located in the Klamath, Northeast, and Coast Range Mountain areas of California. In comparison, the Penutian speakers inhabited a centralized block of territory encompassing the central Sierra's, Great Central Valley, and the San Francisco Bay area. This suggests a recent movement of Penutian speakers into California pushing and fragmenting the Hokan groups to peripheral areas (Shipley 1978).

The Wintu depended upon the salmon for a substantial percentage of their food intake. Steelhead, suckers, trout, and freshwater shellfish and eel were utilized. The Nor-El-Muk were proficient fishermen and depended heavily on seasonal runs of salmon and other aquatic resources. Fall runs of King salmon as well as Silver salmon and Steelhead trout made their way up the South Fork of the Trinity River. Periodic blocking of this stream and/or its tributaries by large slides may have occurred, but it is probably safe to assume that during most years the fish runs were abundant and fluctuations probably only moderate in severity, meaning that minimum fish runs in poor years were not less that about 1/2 maximum availability during good years (Jensen 1979).

One of the most important fishing devices was the fish weir. Weirs were built across streams to impede the progress of the fish and thus concentrate their numbers and make them easier to catch. Although seines and set gill nets were seldom used the efficiency of the weirs perhaps made extensive use of seines unnecessary, although dip nets were known to have been used in certain circumstances. The Wintu also constructed Salmon houses, effective underwater entrapments similar to weirs. Issac Cox (1853) recorded his observations of how the local Indians harvested the plentiful salmon in Hyampom Valley: "The fish were usually speared in the riffles of the river and creeks. Nets were used for trout. A special set of conical shaped basket-like nets were also used to catch salmon and steelhead. Another method of catching fish was that of suffocating them by dumping sacks of a certain type weed into the water. The powdered weed would become lodged in the fish's gills causing it to suffocate.". With large fish catches the Wintu became experts at preserving fish by drying, smoking and grinding into a powder.

The most important plant food for the Wintu was acorn with the black oak being preferred. Manzanita berries were made into flour and consumed as a soup and cider. Various berries, wild fruits, bulbs, tubers, grasses, seeds and nuts were also eaten. The Wintu hunted deer, brown bear, ducks, geese, squirrels, rabbits and other small animals. Deer hunting was particularly important and occurred both on an individual as well as communal basis. When hunted individually the deer would be stalked using deer antlers as a decoy. When several men were employed in stalking a deer, the one whose arrow first grazed the animal was considered to be the owner of the carcass, even though it may not have been his arrow which killed the animal. Communal deer hunts were usually initiated by enterprising persons (DuBois, 1935). The individual would state a specific duration for the hunt, usually two or three days. Then the individuals would gather in an area where deer had been recently spotted and the hunt would proceed by means of driving the deer into a pit or snare through brush-lined passageway (Kroeber 1925). A communal hunt might also involve a large drive in which women and children chased deer into a canyon at the mouth of which men stationed with bows and arrows would be waiting.

In addition to deer, Brown bear were hunted during the fall months when the animals were heaviest and moved slowly. Several methods of hunting are mentioned, including killing the animals within their own dens, smoking the animals to death while they were sleeping and utilizing several hunters and dogs to run the bears down, tire them and then kill them with arrows or short thrusting spears. A variety of ceremonial actions usually accompanied and followed successful as well as unsuccessful bear hunts (Silver 1978 and Lepena 1978).

Trails were particularly important to the Wintu. Places along these routes held special meaning such as the sites of a legendary event or the home of mythological beings (Masson 1966). Indian trails were often used by early day trappers and explorers. Some of these trails evolved into wagon roads and highways.

The Chimariko and Wintu utilized fire to manage and conserve their resources. They burnt to control brush, promote growth of seed producing plants, mushrooms, herbs, bulbs and to enhance forage for deer and other game (Baumhoff 1978). Acorn groves were burnt for growth, production and for easier acorn collection. It has also been suggested that burning of acorn groves was utilized as a form of pest management. Grassy areas were burnt regularly to prevent encroachment by surrounding vegetation. They were also burnt for grasshopper harvesting. Grasshoppers were obtained by encircling a grassy area. People sang and danced as they drove the grasshoppers into the center of a grassy area. The grass in the center was set afire with wormwood torches. After the blaze had subsided the grasshoppers were gathered (DuBois 1935). Burning was also conducted to clear and fertilize patches of ground for sowing tobacco and to promote growth of materials used in making baskets (Baumhoff 1978). Burning provided new tender young shoots for a desirable basket material which was easier to work and weave. Plant species that were burnt for utilization as basket material in this area included redbud, mock orange, hazel nut, choke cherry and willow (Patton 1994).

The first Euro-American explorations across the inland boundaries of California territory began in 1826, although trappers may have crossed the northern frontier before that time (Bancroft 1866). The first recorded crossing of northern California was that of Jedediah Smith in April of 1828. Smith and his party of men crossed the divide to the Hay Fork of Trinity River, reaching it at Wildwood. They followed Hayfork Creek down to the South Fork of the Trinity River continuing on to the Klamath River. Jedediah recorded little of his impressions of the valley other than, "The river to which I [Jedediah Smith] had given the name Smiths [SFTR] was 40 yards wide with a strong current and wide sandbars. Its course was NNW". He made no mention of Lower Hayfork or any of the other South Fork Trinity River tributaries.

Tribal Use - American Indian use essentially follows the history described above. Currently, local Indian groups still collect materials for basketry and traditional foods. This use is growing and many local tribes are looking toward the Forest Service to help improve habitat for this activity.

Religious and ceremonial sites were also important to the Wintu. Many places had religious significance including mountains, knolls, caves, rocks, rivers, water falls and other natural features. These areas were believed to be inhabited by spirits, each of which had its own significance and code of conduct. Although most of these sites are currently indistinguishable from other behaviorally unmodified areas, some areas were modified through minor rock realignments and or etching of petroglyphs.

Economic/Social - Within the Lower Hayfork Watershed Analysis area we have an estimated 5,000 years of recorded human history. American Indians were the first humans to flow through this landscape. Settlement and subsistence was focused in the late fall, winter, and early spring along the streams and valley bottoms in the landscape area. Into the late spring, summer, and late fall the flow of human use moved up out of the canyons and valleys toward upland ridgelines and watersheds. Resources attracting the flow of human use were anadromous fisheries and game mammals. In addition, gathering and collection of plant material was done for food and utilitarian use.

In the 1850's American Indian pattern of landscape use was first modified by Euro-American culture. As time progressed into the 20th-century Euro-American cultural concept of private/public property, agriculture, industrial, and transportation became dominant, which changed human flows within the landscape.

This early settlement by Euro-americans was focused around farming and ranching in Hyampom Valley, mining along the South Fork of the Trinity River, and Hayfork Creek. Grazing was another occupation in the Lower Hayfork area during this period. Domesticated stock grazed included cattle, sheep, and horses. These occupations and activities have decreased in the last 50 years. Most notably is the mining, which is mainly recreational now.

The post World War II era brought in the lumber industry to Hyampom Valley and the Hayfork area. This influx of mill and logging workers were a marked change from the mainly farm, ranching, and mining occupations. This mix continued through the post war years up to the 1980's. At this time the mills started closing taking away their workers and economic stimulus.

The communities adjacent to Lower Hayfork have experienced a significant change in the their economies. In the decades following World War II the timber industry was dominant within Trinity County, in particular, Hayfork and Hyampom. Management of private timber holdings and US Forest Service land was focused on supporting this industry. In direct relation, many businesses and industries derived a significant portion of their income by providing goods and services to timber employees and companies. Local schools and County governments were also significantly supported.

Following the 1987 fire salvage the timber economy began to decline. In particular, the level of timber harvest on public lands was reduced in response to management concerns over endangered species, fisheries decline, and watershed quality.

Reflecting this economic change has been the disruption of the social system centered around the timber industry. The recent closer of the Sierra Pacific Mill in Hayfork furthers this and will take more jobs out of the community. This also removes from the community people who supported the social network of families and friends. Related to this will be the thinning of the support base for civic and charitable activities. All this will bring about a period of uncertainty and change.

What may help this situation is a core group of long term residents who have weathered through the 20th-century natural and economic changes. Many of these people, related to early settlers, have sustained these communities and their cultural identity. They have maintained a connection with the original ranching and farming economy of the area. This group should help carry the community through this period of change.

A new element to the local society has come in over the last 20 years. These people are either retired, semi-retired, or own small summer/vacation homes. Many of the former large land holdings have been split up into smaller parcels to accommodate this new population. These people have brought in new philosophies as it pertains to utilization and management of the National Forests. This groups more environmental outlook has come into conflict with the more timber oriented elements of the community. Appreciated or not, this former group is changing the economic and social focus of these communities, toward a more diversified Forest resource management.

Recreation - Through most of the historic period recreation use was centered around hunting and fishing. Along with this, early settlers utilized and appreciated the Forest for the resources and beauty it provided.

Recreation over the past century has not changed significantly. Only that more people are coming to the Forest to enjoy its varied beauty and resources. Currently, within the landscape, the flow of recreation use is centered on three primary opportunities. One use involves fishing along Hayfork Creek, hunting, primarily in the fall which can occur anywhere within the landscape, and third is mining along the Hayfork Creek. Fishing and mining use activities are primarily dependent upon water flows. Hunting use is more concentrated to those areas containing early seral vegetation that is in close proximity to cover. Most of the human recreation use is confined to the road systems found within and adjacent to the landscape. It is seasonal in nature with this use occurring during the regulated mining, fishing, and hunting seasons.

STEP 5: SYNTHESIS AND INTERPRETATION

Purpose

- To compare existing and reference conditions of specific ecosystem elements.
- To explain significant differences, similarities, or trends and their causes.
- To identify the capability of the system to achieve key management plan objectives.

Lower Hayfork Creek Desired Future Conditions

Ecosystem Function

Healthy, balanced, sustainable forest managed as a whole for diversity, and for the enhancement and restoration of fish and wildlife habitat, biological corridors, vegetation, soil and water quality. Develop ecological standards for maintenance and utilization of resources in areas of early to late successional habitat. Provide for a healthy watershed managed for stability, control of siltation and protection of anadromous and native fish habitat. Provide alternatives to the use of chemical pesticides. There may be some biological, mechanical or manual controls that are appropriate to use. There are some members that disagree with the preclusion of the use of pesticides.

Forest Ecosystem Management

Utilization of up-to-date geographical information systems (GIS), accessible to the public. Research and utilize historical information regarding the past natural and Native American use of the area. Develop procedures allowing for community participation and review. Seek and obtain funding to achieve ecosystem management plan goals.

Develop an ecosystem plan capable of producing a variety of forest products and managed mineral and grazing opportunities. Enhance forest resources by managing timber harvest to encourage growth, diversity, sustainable timber production, and utilization of salvage materials.

Use modern silvicultural methods and reforestation techniques to achieve an all age, multi-story, fire-resistant forest. Provide alternatives to clearcutting. It is understood that there may be instances such as fire or insect kill where a certain amount of clearcutting may be necessary to restore the forest to a healthy condition or for research.

Encourage research, experimental methods, small logging operations, utilization of resources without waste, and fuel load reduction. Make forest resources available for traditional native products. Conduct ongoing monitoring of total process.

Ecosystem Protection

Reduce fuel loads, and maintain adequate access for fire protection. Create and maintain fuel breaks to aid in control of future catastrophic fires. Research introduction of fire as a management tool and to maintain fire dependent species. Establish standards for methods of prevention and control of destructive insects, diseases and invasive plants.

Ecosystem Amenities

Protect historical and natural features. Provide recreational opportunities for camping, fishing, and wildlife viewing, accessible for diverse users. Include access to falls, lakes and caves. Construct, maintain and sign trails, some set aside for different users (i.e. hiking, biking, equestrian) and manage to avoid overuse of areas.

Ecosystem Restoration and Rehabilitation

Restore biological diversity in the forest, watershed and wetlands. Replant and improve timber stands in older clearcuts and burn areas; salvage and thin for fuel reduction. Rehabilitate watersheds, fisheries and provide habitat for wildlife. Improve and restore range lands. Maintain, stabilize or close roads to minimize stream sedimentation.

Human Considerations

Provide for local involvement and education. Manage for long term ecological benefit and economic stability. Incorporate historical and Native American values and techniques. Promote mutual trust of public and agency involvement on resource management. Respect the rights of private property owners and the public and develop a process which allows for consideration of their values.

Economic Considerations

Provide economic base for local communities utilizing diverse forest products while improving the forest. Develop and support local industry by giving preference to local contractors and workers, including young people, for forest jobs. Encourage new industry to process forest derived products locally. Develop a program which utilizes the funding and revenues generated from this project for restoration and rehabilitation of the Lower Hayfork Creek management area.

Core Topics and Questions

Erosion Processes. Hydrologic Processes, Channel Conditions, Water Quality Conditions and Species and their Habitats - a discussion of step 5 core questions as these core areas relate to watershed restoration.

Successful watershed restoration is accomplished by first identifying the conditions which limit ecosystem function and productivity and then developing a strategy for correcting those limiting conditions. Within the Lower Hayfork Analysis Area, and in any watershed, erosion and hydrologic processes as well as channel and water quality conditions directly influence aquatic species and their habitats. Through the analysis, we have sought to understand these relationships and believe we have identified those conditions which limit productivity within the Lower Hayfork Analysis Area. We have used our understanding of these relationships and limiting conditions to develop recommendations for restoring the aquatic ecosystem. A discussion of our understanding of those relationships follows.

Water quality and channel conditions in the tributaries to lower Hayfork Creek are generally considered "good", with many of the tributaries supporting moderate densities of resident rainbow trout and steelhead. In contrast, comparison of historic and current fish abundance in lower Hayfork Creek, indicates that fish production capability is greatly reduced even though channel conditions are not believed to have noticeably changed from historic conditions.

Current water quality conditions are thought to be the primary factor which limits aquatic productivity in lower Hayfork Creek. Water temperatures during the summer are frequently at levels considered intolerable for salmonids and intermittent flows have been reported in lower Hayfork Creek. Lower Hayfork Creek is naturally a temperature sensitive stream, making it particularly susceptible to any activities which might reduce summer base flows and increase water temperature. Although historic temperature and flow data are not available, high water use and poor riparian conditions in the Hayfork Valley are known to have major effects on this already sensitive condition. The result is an aquatic ecosystem that is primarily limited by extremely low summer base flows and high temperatures.

Bedload movement and sediment levels are not presently limiting aquatic productivity within the Lower Hayfork Analysis Area. The Model Steelhead demonstration plan characterized overall improvement potential as low because of good stream channel conditions and the Action Plan for Restoration of the South Fork Trinity Watershed and its Fisheries indicated that "addressing the water problems could trigger the potentially rapid recovery of anadromous populations" in Hayfork Creek. Localized areas of mass wasting have been identified in various locations within the Lower Hayfork Analysis Area. Most of these areas are naturally occurring with management activities doing little to accelerate erosion rates at the disturbed sites. Previous mining and grazing practices have been cited as degrading stream banks along lower Hayfork Creek and roading and timber harvest activities have also been suggested as contributing to accelerated rates of erosion with the analysis area. Cumulative watershed effects analysis, using equivalent roaded area indicates that harvest and roading activities are approaching an established 60% of "threshold of concern" level. Subbasins identified as nearing this 60% of threshold level are the Upper Rusch, Lower Rusch, Jud, East Jud, Grassy Mountain, Grassy Flat and the East Hyampom subbasins.

In summary, low summer base flows and high water temperatures are considered the primary factors which limit aquatic ecosystem function and productivity. Sediment and bedload are not presently recognized as limiting. However, cumulative watershed effects analysis indicates that recent management activities may have created a trend toward a limiting condition and there may be "hotspots" in various subasins which threaten the "good" channel conditions that presently exist within the watershed.

Hydrology

What are the natural and human causes of change between historical and current hydrological conditions?

What are the influences and relationships between hydrological processes and other ecosystem processes (e.g., sediment delivery, fish migration)?

Flood Flows- The slow, steady decrease in water yield is in great part a result of the steady increase in evapotranspiration as trees and other vegetation at clearcut harvest units on National Forest lands grow toward maturity. This is also true at acreage burned at a moderate to very high intensity by wildfires.

The higher average cubic feet per second/square mile of land at Hayfork Creek near Hyampom is a reflection of the higher values of subsurface water flows at the subwatersheds south of Hayfork Creek, and between its mouth and Halfway Ridge. From December to February, water percolates into these soils. This holds down the magnitudes of peak flows during flooding. Then, during the other months, water yield per square mile of land is greater compared to other areas in the Lower Hayfork Watershed Analysis area.

The greater damage caused during flooding in 1964, when compared to 1955, is strongly related to the much greater presence of roads, road crossings, and timber harvest units - particularly where road crossings were concentrated at individual streams.

The higher percentage of clay in the soils at the Lower Hayfork Watershed Analysis area is a factor in the greater retention of water in the soil. This is more available for evapotranspiration, so that water yield/year/square mile of land is lower compared to the water yield in upper subwatersheds of the South Fork Trinity River.

The longer duration, higher magnitude flooding characteristics of the flood of 1964 were major factors in the formation of D channels [Rosgen Stream Classification System] in Hayfork Creek.

Lower Flows- At lower baseflow values, stream temperatures during August and September can reach about 85 degrees Fahrenheit at Hayfork Creek. These lower baseflow values are a lesser, yet still significant concern during the months of June and July, when water temperatures can reach into the upper 70's.

Water temperature and streamflow data at Hayfork Creek near Hyampom for 1963 show that when general streamflows and baseflows were at greater than average flows from June 1 to October 1, maximum water temperatures did not exceed 72 degrees Fahrenheit. Water quantities for these months were as follows:

June 15 - 181 cfs.	Aug. 15 - 46 cfs.
July 01 - 135 cfs.	Sept. 01 - 38 cfs.
July 15 - 84 cfs.	Sept. 15 - 32 cfs.
Aug. 01 - 55 cfs.	Oct. 01 - 28 cfs.

Vegetation

What are the natural and human causes of change between historical and current vegetative conditions?

What are the influences and relationships between vegetation and seral patterns and other ecosystem processes in the watershed (e.g., hydrologic maturity, channel stability, shade, disturbance, species movements, soil and erosion processes)?

A subjective analysis of the trends and causes of range was conducted by comparing aerial photographs from 1944 to the most recent photography, 1990.

Canyonlands Analysis Area

In the area east of the Hayfork confluence the ranches appear to be much the same as in the 1990 aerial photographs, with the exception of some expansion in 1990. Small meadows have been encroached by conifer and hardwoods. There is a series of east-west trending ridges (continuing into Hyampom Earthflows) that had dense stands in 1944 that have increased canopy closure in 1990. The grass and herb seral stage covers a greater area in 1944.

Hyampom Earthflows Analysis Area

Natural meadows have been converted to farming and ranching, while the remaining meadows have been slightly encroached by conifers and hardwoods. Sag ponds have filled with vegetation and decreased in size. The 1944 photographs show north facing slopes with very dense, closed stands, which are not obvious in the 1990 photographs. Shrub fields have increased in size and the open ponderosa pine/grass communities (Grassy Flats) are being encroached by Douglas-fir. Overall, the density of the forested stands have increased since 1944.

Halfway Ridgelands Analysis Area

Meadow encroachment by conifers and hardwoods is evident. The density of the forested stands has increased, especially on north slopes.

1987 Burned Area and Olsen Creek Analysis Area

The 1987 fires have set back the successional clock. Where vegetation is still intact, overall structure remains similar. There are several large open patches on north-western aspects in 1944 that appear to have resulted from fire. These are still evident in 1990.

Jud-Rusch Analysis Area

In 1944 there was a network of well connected, closed canopy forest in late seral stages. These stands have become denser where they have not been harvested. Open Jeffrey pine stands have become denser and are being encroached by other vegetation. Open grassy ridges are more evident in 1990 compared to 1944. Hardwoods and conifers were well established on these sites in 1944. This is probably the result of lightning caused fire. Overall vegetation patterns look similar with less productive sites remaining the same and more productive sites increasing in density.

Little Creek Analysis Area

The shrubfield on the upper, south side of Hayfork Bally is smaller in area when compared to the 1990 photographs. Conifers were established in draws and encroaching into the shrubfield in 1944 but have been burned out in 1990. Overall vegetation patterns are similar from 1944 to 1990. Most vegetation is in early to mid and mid-seral stages in a very patchy mosaic.

Pattison Area

Vegetation patterns have remained remarkably the same with the exception of conifers filling in drainages and moving upslope. There appears to be a fairly uniform size class throughout the area, possibly the result of fires from 75 to 120 years ago. There was no apparent evidence of fire between 1944 and 1990 but, two fires occurred in 1994. Each was less than 10 acres in size. Seral stages have increased from early-mid seral to late-mid seral in conifer and conifer/hardwood stands. A patch effect has been created by the predominance of conifer forests on north and north-east slopes and conifer/hardwoods, hardwoods and shrubs on the south and south-west slopes. Ridgetops are commonly open, vegetated by hardwoods, shrubs and forbs.

Over eighty years of fire suppression has altered the historic fire regime to one of infrequent, moderate-to-high severity stand replacement fires. Present stand densities, species composition, fuels levels, insect and disease levels, as well as, tree mortality levels fall outside the natural range of variability. This contributes to declining health of the community. Increased human habitation and forest management and activities are major processes contributing to existing vegetation communities and densities.

Special Forest Products

Permits for special forest products, commercial and noncommercial, issued from the Hayfork Ranger Station in 1994 through 1996 include:

Noncommercial	Commercial
Douglas-fir cones and boughs	Douglas-fir boughs
Ponderosa pine cones and boughs	Incense cedar boughs
Jeffrey pine cones	Jeffrey pine cones
Sugar pine cones	Manzanita branches
Manzanita branches and burls	Princes' pine
Elderberry	Yarrow
Raspberry	Mullien
Blackberry	
Gooseberry	
Cascara	
Buckbrush	
Wild grape	

Noncommercial	Commercial
California aralia	
Angelica	
Horehound	
Yellow dock	
Saint Johnswort	
Mullien	
Princes' pine	
Yarrow	
Wild oat	
Moss and lichens	

The majority of the listed plants are common and are likely to be found throughout the Lower Hayfork Creek watershed making them potential plants for future harvest. Other special forest plants not listed above but having potential for future harvests in the watershed include dwarf Oregon grape, yerba santa, sheep sorrel and pennyroyal.

Plant Species of Concern - The natural and human causes of change between historical and current species distribution for Niles' madia and Canyon Creek Stonecrop is not known since these species are of recent discovery. Habitat quality for Niles' madia has been degraded in some areas by human-caused soil disturbance, fire suppression, and introduction of exotic pest plants. In some areas it may have been improved, created, maintained, or removed by the construction and maintenance of roads. The Niles' madia population along the Hyampom Road (County Route 301) is occupying a road cut created by humans. Whether not it was present before the road was constructed is not known. From comparison of 1944 and 1990 aerial photos, it appears that this area was historically a steep, unstable slope that has been excavated since 1944, probably to accommodate debris sliding toward the road. In the spring of 1995, part of the population was removed in the process of ditch cleaning. Fire and succession are probably the natural causes of habitat change for this species; fire most likely improving the quality by creating openings in the vegetation cover and succession filling in those openings.

For Canyon Creek stonecrop, human causes of detrimental change include rock removal and removal of the tree cover. These processes may be repeated naturally through colluvial action, blowdown, and crown fires. One population occurring just outside the watershed that has colonized road cut appears to be very healthy. It is likely that the population was present on an outcrop before construction of the road and recolonized the road cut after the outcrop was removed to make way for the road. Drought probably has had a significant negative effect on this species since one population north of the watershed appears to have succumbed to it recently.

For mountain lady's slipper, human causes of change include fire suppression, logging, and collection for the horticultural trade, resulting in a loss of individuals or habitat. Natural causes of detrimental change involve removal of the tree canopy by some natural means such as blowdown or crown fires. Other possible causes of change leading to decline of the species include drought, predation, loss of a pollinator, or the loss of specific symbiotic fungi associated with deer or elk feces thought to be required for seed germination and establishment.

The exotic pest plants of concern in the Lower Hayfork Creek Watershed, yellow star thistle (*Centaurea solstitialis*), bull thistle (*Cirsium vulgare*), and cheat grass (*Bromus tectorum*) are often introduced on heavy equipment along road systems, fuel breaks, landings, and clearcuts. Grazing operations may contribute to the introduction and spread of weed seeds. Noxious weeds and exotic pest plants pose a threat to native plant communities and biological diversity. These aggressive and pernicious species compete with the native vegetation and may eventually replace them in certain areas. Yellow star thistle also has allelopathic (toxic) effects on native vegetation. Cheat grass has successfully colonized serpentine outcrops and may represent a threat to maintenance of those unique habitats in the future. High levels of disturbance are related to high numbers of these exotic pest species. The result of this is lowered levels of species richness.

Special Forest Products - With the decline in the harvest of timber on National Forest Lands there has been a shift in the types of products being extracted from the forest. The extensive transportation system has made it an easy area to access for these special products which include: firewood, mosses, cones, herbs, wildflowers and products for the floral trade.

The Forest is committed to community stability for the timber dependent communities of northern California. There are many efforts currently underway to diversify the economics of these areas. This includes special forest products and cooperation with local groups working on job re-training and contracting and a community based Geographic Information System. Currently the Watershed Center and PSW are developing proposals for research and monitoring and a contract inventory has been completed for special forest products.

With the dwindling timber harvest on public lands, people in forest dependent rural communities are seeking alternative sources of income. Special forest products are increasingly recognized as underutilized and potentially lucrative resources that may partially help to fill the need. Products ranging from mushrooms, pine cones, lichen-covered sticks and medicinal herbs to value-added wildcrafting products such as floral wreaths, manzanita burls, and madrone furniture, are being gathered from public lands throughout the Pacific Northwest.

The mandate of the USDA Forest Service is shifting to include working with rural people and communities to develop strong, diversified and sustainable rural economies consistent with sustainable ecosystem management principles (Thomas, 1994). Special forest products are recognized as an important component of such efforts and a National Strategy for Special Forest Products is currently under development.

Current permits for special forest product harvest are granted on a ranger district wide basis and it is difficult to specify exactly what the current interest and harvest volumes of special forest products in the Lower Hayfork Creek watershed are. However, the trend on the Hayfork Ranger District may be assumed to be indicative of growing interest in special forest products in the area. In 1990 and 1991 only one use permit was logged on the district. In 1992 there were suddenly 16 permits; in 1993 eighteen, in 1994 twenty-three and in 1995 there were 6 permits issued.

Special Use Permits on the Hayfork Ranger District have been issued to allow collecting rights for pine cones, mushrooms, beargrass, ferns, conifer seedlings, manzanita, dogwood, prince's pine, boughs, items for the commercial floral trade, yarrow and other miscellaneous products. There is also a consistent demand for Christmas tree cutting permits. There were 400 Christmas tree permits sold on the district in 1993, in 1994 there were 213 and in 1995 280 were sold. In addition, there may be considerable volume of harvesting occurring without permits.

In years prior to organized fire suppression activities fire was the environmental factor that initiated new successions, controlled the species composition and age structure of the forests and produced vegetation patterns upon which animal components of the ecosystem also depended (Heinselman, 1971). These fires thinned stands and helped maintain an "open and park-like" forest with an understory of herbs and shrubs (Cooper, 1961). Ponderosa pine seedlings and saplings were thinned out by low-severity fires, and depended on fire to eliminate other competing vegetation. The principal cause of mortality in small trees following fire was crown scorch rather than damage to the cambium or roots. Vegetation remaining on site after fires had less competition for moisture, giving them more resistance to insect attack and disease.

Forests in the Klamath Mountains that developed under pre-suppression era fire regimes were generally more open and had fire resistant trees such as ponderosa pine, sugar pine, and Douglas-fir as the most characteristic dominant trees. Stands contained a diversity of species and age classes but relative densities were lower. Many of the fires were of large extent and would burn for months. As would be expected, there was a good deal of site-by-site variation in terms of fire behavior, periodicity, and effects on associated vegetation (Biswell, 1972). Where fuel buildup and high intensity conditions occurred at the time of burning, small areas of stand replacing fires would occur. Within these newly created openings or gaps, patches of regeneration were established. Within large gaps, fire tolerant (and shade intolerant) species were favored, given proper seedbed conditions. Unburned patches were left throughout the low intensity fire areas, where the fuel profile was discontinuous and/or the fire burned during low-intensity burning conditions.

Fire suppression activities have led to retarding rates of fire disturbance which has allowed the ingrowth of fire intolerant species, specifically incense cedar and white fir. Many of the larger pines have either died or were systematically harvested. Natural regeneration of all species has occurred in greater numbers, further increasing stand densities. Smaller size classes now account for a higher percentage of the total stand. The increasing competition for available light, water, and nutrients creates stress on vegetation, facilitating suppressed growth, lack of vigor and susceptibility to damaging attacks by insects and pathogens. Fire exclusion has created forest patterns of even-age vegetation which has greater opportunity to develop larger severer fires.

Fire regimes in the mixed conifer forest are far more complex and variable than those of other vegetation types in the Klamath province. Mixed conifer forests contain ponderosa pine, Douglas fir, white fir, sugar pine, and smaller amounts of other species (Bonnickson and Stone, 1981, Thomas and Agee 1986). Fire frequency is sometimes higher in mixed-conifer forest, than in ponderosa pine forests because of increases in litter production (Martin, 1982).

Species must possess certain adaptive traits in order to successfully establish, grow, and reproduce in fire-influenced ecosystems. These traits in general can be separated into two categories; those which enhance the survival of the individual and those which enhance the survival of the species (Gill, 1981). Traits that enhance individual survival include thick bark that protects cambial tissues and sprouting from below-ground plant organs. Traits which enhance species survival include fire-stimulated flowering, seed storage on the plant (i.e. serotinous cones) and fire-stimulated germination of dormant seeds in the soil. In addition to genetic traits, age and vigor of individual plants will influence their response to fire. Environmental conditions are also important for survival, such as type of fire, frequency of recurrence, season of burn, fuel consumption, fire intensity, site characteristics (slope, aspect, soil), and associated species (Lotan, et al. 1981).

Adaptations that facilitate species survival in low-severity fire regimes are of little value in the high-severity fire regimes.

Conifers

In the Pacific Northwest all conifers are obligate seeders, depending solely on seeds for reproduction (Well, 1969). All commonly occurring conifer species in the Lower Hayfork Creek Watershed area (Douglas-fir, Jeffrey pine, white fire, ponderosa pine, sugar pine, and incense cedar) are resistant to fire as mature individuals. However, as saplings ponderosa pine are the most fire resistant, followed by sugar pine, Jeffrey pine, Douglas-fir, incense cedar, and white fir. Thus in frequent fire forests ponderosa pine becomes a stand dominant and white fir becomes less common. In the absence of frequent fires, fire intolerant species such as white firs and cedars will become the dominant species (Parsons and DeBenedetti, 1979).

Knob-cone pine is completely dependent on serotinous cones for reproduction. Typically fires hot enough to melt the resins and release the seeds kill the parent trees. Knob-cone pine species are relatively short-lived, living between 80 to 120 years. Fire suppression activities which lengthen the fire cycle to longer periods may ultimately eliminate the species (Rundel, 1983).

Grey pine, a California endemic, is one of the least shade tolerant of all trees, beyond the seedling stage. Thin bark of younger trees and high resin contents of the species' make Grey pine fire intolerant (Silvics of North America. Volume 1, Conifers. U.S.D.A.).

Hardwoods

The response of hardwood species to fire is variable, different species within the same family have different responses. California Black Oak has decreased in abundance as a result of fire exclusion. Whereas tanoak can successfully germinate and survive under a conifer overstory, fire exclusion has probably resulted in an increase of this species (Parsons and DeBenedetti, 1979 - Bonnicksen and Stone, 1982 - Kauffman and Martin, 1987). Kauffman and Martin (in press) have found tolerance of tanoak, chinquapin, and California black oak increase with individual plant size.

Madrone, tanoak, mountain dogwood, and various other oaks are epicormic sprouters (sprouting occurs beneath bark on stems and branches) as well as basal sprouters (sprouting from dormant buds that are located on subterranean plant organs). Epicormic sprouting occurs when the dormant buds that are located on trunks and large branches are stimulated to grow as a result of fire-induced mortality of existing foliage. Tanoaks and black oaks are also capable of cryptogeal germination (seeds germinate below ground), a survival characteristic in low-severity fire regimes (Gill, 1981 - Rundel, 1983).

Obligate sprouters depend solely on sprouting from dormant buds for reproduction and obligate seeders depend solely on seeds for reproduction. Species capable of reproducing through either seeds or sprouts are faculative sprouters (Wells, 1969). The majority of hardwoods and shrubs in the Lower Hayfork Watershed are faculative sprouters.

Deerbrush ceanothus, whitethorn ceanothus, and greenleaf manzanita have refractory seeds or hardseeds, with a physical barrier to germination, seeds have the capacity to lay dormant in the soil for hundreds of years and generally do not germinate to any great extent until dormancy is broken by fire or some other physical disturbance (Kauffman, 1990).

In many plant species below ground organs, (lignotubers, root crowns, or basal burls,) are regarded as an adaptive trait to fire and other disturbances (Gill, 1981). Tanoak and many manzanita and ceanothus species have this trait.

Most oak woodlands in the Pacific Northwest have cultural significance to native american peoples. Native americans used acorns, bracken fern, and other forbs in the vicinity of oak woodlands, as well as hunting wildlife in these areas (Norton, et al. 1984). Oak woodland fires were ignited by Indians and/or lightning, it is felt that Indian burning was significant in oak woodlands. These fires would remove understory shrub species and kill small oak trees and conifer trees which might have otherwise turned the oak woodlands into forests (Habeck, 1961).

Meadows

Wet meadows in the Hayfork Creek Watershed are disappearing or becoming smaller. This can be attributed to several factors which include a lowering of the groundwater table related to channel downcutting, human uses, and fire suppression allowing overstocking of vegetation throughout the watershed. Cumulative effects of these factors has facilitated the encroachment of upland vegetation into the meadows.

Prior to organized fire suppression, fires and livestock grazing were regular processes in the maintenance of meadows and grasslands. A late season fire could frequently be carried through meadows once the herbaceous growth had cured. This type of fire would generally kill most tree seedlings attempting to occupy the site. Perennial grasses produce seeds in abundance 1 to 2 years after germination; most woody plants require several years to reach seed-bearing age. Fires that are frequent enough to inhibit seed production in woody plants usually restrict the shrubs to a relatively minor part of the grassland or meadow (Cooper, 1961).

Infrequent fire tends to favor large trees over grasses and herbs in plant community/forest interface areas.

Recurrent burning and grazing historically maintained the grasslands and meadows, as well as provided a defense from the encroaching shrubs and forest. Management could use these same tools to re-establish and maintain meadows and grasslands within the watershed.

Riparian areas

The mesic conditions associated with riparian areas can provide a barrier to fire spread and can slow fires considerably. The cooler temperatures, humidity, and less flammable vegetation and topographic position combine to reduce fire intensities except under the most extreme conditions. Occasionally stand replacing fires do occur within riparian areas and the effects to vegetation and channel conditions can be severe.

Riparian areas can be both directly and indirectly affected by fire (Agee 1993). Direct effects are those associated with burning within the riparian zone itself. Lower intensity fires do not often kill the above ground component of most shrubs and deciduous trees. Fire effects on upslope areas may be more important to riparian habitats than fire actually occurring within the riparian zone. These indirect effects include the movement of sediment, biomass or water through riparian zones. Where riparian areas are not burned there is less downstream damage from fire.

Fire affects water yield, peak flows, and flood flows. The effect of fire is to increase the amount of overland flow of water, leading to floods and other destructive forces. Fire causes an immediate but short-term increase in sediment that can cause catastrophic damages. Fire does not increase the long-term or total sediment yield, just the timing of it. In unburned watersheds the sediment yields are low-to-nonexistent for up to 30 years, then a high flood will deliver catastrophic volumes. If a fire/flood sequence occurs, widespread damages will occur. In frequent fire watersheds recurring fire cycles regulate the sediment yield by flushing out stored, unstable sediments. Thus the sediment yield is moderate each year, without catastrophic volumes even in high flood years (Buckhouse, 1993).

Fire plays an important role in both the creation and loss of coarse woody debris. Coarse woody debris is primarily snags, downed logs and large branches greater than 3 inches in diameter. Coarse woody debris is important in relation to fire behavior, fire effects on existing vegetation, and long-term post-fire effects on the ecosystem.

The Effects of Fire on Fish and Wildlife

The impact(s) of fire on fish and wildlife may be beneficial, detrimental, or without effect, depending on timing, scope, severity, and area, site characteristics (soil type and depth, slope, moisture, exposure), and on species under consideration (Neitro et al. 1985).

The primary effect of fire on fish is in habitat deprivation. Fire can increase water temperature and sediment as well as result in the long-term loss of woody debris from stream channels. The most long lasting and severe effects on fish habitat from fire occurs when it is associated with the loss of streamside vegetation (Swanson et al., in press).

The major influence of fire on wildlife are impacts on vegetation structure and composition, dead and down woody material, and snags. The loss of dead and down woody material and snags removes essential habitat components for a variety of wildlife and reduces species diversity. Wildlife species adapted to a specific arrangement and amount of habitat components. The greater the diversity of habitats, the greater diversity there is in wildlife species (Odum, 1971).

Fire is an important disturbance that influences both input and removal of coarse woody debris. The role of coarse woody debris includes nutrient and carbon storage, site for plant establishment, the maintenance of soil stability, and the presence of wildlife habitat. In frequent low-severity fire regimes the input of coarse woody debris is relatively continuous, will small amounts added with each fire. Fire may be the primary means of coarse woody debris removal in these regimes. In infrequent high-severity fire regimes huge inputs of coarse woody debris occur following fire. Decay or decomposition is more important in forests with long fire return intervals (J. B. Kauffman, 1990).

Species and Habitats

What are the natural and human causes of change between historical and current species distribution and habitat quality for species of concern in the watershed?

What are the influences and relationships of species and their habitats with other ecosystem processes in the watershed?

Human Uses

What are the causes of change between historical and current human uses?

What are the influences and relationships between human uses and other ecosystem processes in the watershed?

General Synthesis as Detailed at the Subwatershed Basis

This step synthesizes the major disturbance events within the Lower Hayfork Watershed with current conditions, reference conditions, desired conditions, key issues and questions the team developed, and the focused management objectives for the watershed the team was provided.

Relatively large-scale stand-replacing fires along with relatively intense past timber harvest activity have somewhat reduced some current management options with the Lower Hayfork Watershed. This is most evident for stated management objective of green-tree-retention timber harvesting as well as the key issues and questions related to water quality and connectivity. For example, within some subwatersheds, past harvesting occurred largely upon relatively easy to access areas such as ridgetops and gentle slopes, leaving future options that will likely require more sophisticated designs of roads or harvest systems and silvicultural prescriptions to avoid water quality and connectivity problems. Within selected subwatersheds, thresholds of concern for water quality and/or connectivity are either close to, or have been, exceeded.

Conversely, past fires, timber harvesting, imprudent road building, along with continuing aggressive fire suppression present opportunities for other stated management objectives related to watershed restoration, forest health prescriptions in overstocked stands and fuels hazard reduction.

To address these seeming contradictions and synthesize the information presented in steps 1 through 4, the team developed four basic indices. These four basic indices reflect the four basic key issues/questions developed during step 2 in relation to the three basic management objectives presented by line officer direction to the IDT at project inception. These indices include parameters to "quantify": 1) watershed condition as measured by CWE modelling; 2) potential harvest opportunities as measured by an estimate of the acreage of CAS lands; 3) connectivity as estimated by vegetation conditions reflective of 11-40 conditions; and 4) fire/fuels concerns as measured by stand, topographic, or "values-at-risk" conditions.

We used these same indices to help describe current conditions (Step 3) to make clear the logic leading through to management recommendations (Step 6). The team also attempted to apply the indices to describing reference conditions (Step 4) when available information allowed.

The basis for each index is briefly described so that the logic behind each is made clear and to assure that results from future iterations of the Lower Hayfork Watershed Analysis can reproduce or compare with results.

Synthesis

General roading recommendations - Analyze the trade offs between road construction and harvest techniques. Consider lithology in road construction. Dioritic soils being more susceptible.

Watershed sensitivity needs to be assessed on project level.

High priority GTR are 3S and 3P and 4S and 4P
Other GTR opportunity are 3N and 3G and 4N and 4G.
Thinning opportunities are 2N and 2G.

Potential loss to crown fire is assessed by looking at >70% canopy closure on slopes >40% and on south and west aspects.

Hazard & Risk ratings are taken from the South Fork Management Unit Hazard & Risk Analysis. Hazard & Risk Analysis is the process of determining the estimated fire behavior of a given land base, output is rated considering flame length and rate-of-spread.

Subwatershed: BEAR CREEK

Vegetation Management -

- Analysis: Highest opportunity. The most CAS acres are available here for GTR and commercial thinning.
- Opportunities: Gross Acres of High GTR (3/4 S/P) - 375 acres
- Gross Acres of other GTR (3/4 N/G) - 700 acres
- Gross Acres of thinning - 2 N/G - 100 acres
- Concerns: Social - Is part of the Pattison released roadless area. Unroaded
- It is in pristine condition. Provides refugia habitat for fish.

- Pay attention to what we are doing.
- Pay close attention to monitoring.
- May not want to lose or compromise water temperature or hydrological processes that would compromise water temperature of the subwatershed. Monitor water temperature.
- May be difficult to build roads due to steepness. Limited by benches to build switches on.
- Unknowns: No archeological information, no TES plant surveys
- Recommendations: Consider all of the harvest opportunities identified above.
- Insure high water quality conditions. To do this strictly follow standards and guides from LMP.

Watershed Condition/Restoration

Analysis: Watershed is at 1.1% There are 2678 acres available for treatment at 60% TOC. There are 1668 acres available for treatment at 40% TOC.

- Opportunities: None
- Concerns: None
- Recommendations: One of the better watershed for vegetation management

Connectivity

- Analysis: Opportunities: Other GTR 497 acres excess suitable habitat
- Pre-commercial thinning opportunities - 30 acres of plantations.
- Seral stage distribution
- Old-forest 12%
- mid seral forest 59%
- early seral forest 29%
- -Forest health
- Analysis: PP3G = 10 acres
- Opportunity: Thinning pp3G stands to reduce probability of successful bark beetle group kill

Fire & Fuels

- Analysis: Hazard & Risk Rating = Medium/High
- 162 acres of private lands
- 819 acres with high crown fire potential
- High recorded fire occurrence
- Historic fire regime of frequent low-intensity fires.
- 39 acres of plantations
- Opportunities: Underburning (for hazard reduction & forest health).
- Thin high crown fire potential areas.
- Construction of fuel buffers adjacent to private lands.
- Construction of shaded fuelbreaks along major ridges.
- Use livestock grazing for hazard reduction where appropriate.
- Protect plantations from loss to wildfire
- Concerns: Alteration of historic fire regime
- Late Successional Reserves
- Private land interface

- Limited accessibility for fire suppression forces
- Potential crown fire areas
- Overstocked stands/moisture stress (forest health).
- Encroachment of fire intolerant vegetation
- Plantation loss to wildfire

Subwatershed: LOWER LITTLE

Vegetation Management

- Analysis: High priority for GTR.
- Seral stage distribution is old-growth and late seral is 24% of the watershed, middle seral stage is 55% and early seral stages are 21%.
- Opportunities: Gross Acres of High GTR - 1050 acres
- Gross Acres of other GTR -1100 acres
- Gross Acres of commercial thinning - 2 N and G 100 acres
- Concerns: Has diorite soils.
- Unknowns:Lower portion of lower little no archeological surveys, the rest has b een surveyed.
- Recommendations: Consider all of the harvest opportunities identified above.

Watershed Condition/Restoration

- Analysis: Watershed is at 5.72% ERA. There are 1035 acres available for treatment at 60% TOC. There are 180 acres available for treatment at 40% TOC.
- 4.3 miles of level 1 road currently open.
- Opportunities: Road maintenance opportunities
- Concerns:
- Recommendations: Bring down road density by closing maintenance level 1 roads which means controlling access during wet weather periods to reduce surface erosion.

Connectivity

- Analysis: 100 Acre owl core at the south end of the subwatershed
- Opportunities: 240 acres of dispersal habitat above the 50% level
- Pre-commercial thinning opportunities - 600 acres of plantations.
- Seral stage distribution
- Old-forest 75%
- mid seral forest 14%
- early seral forest 11%
- -Forest health
- Analysis: PP3G = 10 acres
- Opportunity: Thinning PP3G stands to reduce probability of successful bark beetle group kill

Fire & Fuels

- Analysis: Hazard & Risk Rating = Medium
- 11 acres of private lands

- 539 acres with high crown fire potential
- 600 acres of plantations
- High recorded fire occurrence
- Historic fire regime of frequent low-intensity fires.
- Opportunities: Underburning (for hazard reduction & forest health).
- Thin high crown fire potential areas.
- Construction of fuel buffers adjacent to private lands.
- Construction of shaded fuelbreaks along major ridges.
- Protect plantations from loss to wildfires.
- Use livestock grazing for hazard reduction where appropriate.
- Concerns: Alteration of historic fire regime
- Private land interface
- Potential crown fire areas
- Plantation losses to wildfire
- Overstocked stands/moisture stress (forest health)
- Encroachment of fire intolerant vegetation.

Subwatershed: LOWER RUSCH (This includes lower Rusch and Rusch 1-4)

Vegetation Management -

- Analysis: Good opportunity for vegetation management.
- Opportunities: Gross Acres of High priority GTR - 350 acres
- Gross Acres of other GTR - 550 acres
- Gross Acres of thinning - 2 N and G 75 acres
- Concerns: May be difficult to build roads due to steepness. Limited by benches t o build switches on. Contains high amounts of dioritic soils.
- 100 acres of owl core area are in center of priority GTR area inLower Rusch.
- Recommendations: Consider all of the harvest opportunities identified above.
- Unknowns: There appear to be some significant data gaps in inventory information regarding productivity.

Watershed Condition/Restoration

- Analysis: There is concern over subwatersheds Rusch 3 and 4.
- Road density is a concern in all of the subwatersheds.
- Fine sediment compares with that of other watersheds in the area.
- Watershed ERA is at 1.1% Acres available (60%) Acres Available 40%)
- Lower Rusch2.48 521.53 287
- Rusch 1 3.84 122.32 54
- Rusch 2 5.16 86.36 24
- Rusch 3 10.10 -5.07
- Rusch 4 13.35-78.59
- Opportunities: To decrease road density through closure or decommissioning. Road upgrades are an opportunity.
- Concerns: Rusch 3 and Rusch 4 combined open road density is 5.72 miles/sq. mi.
- Closing 2 1/4 miles of level 1 road can reduce this to 3.13 miles/sq. mi.

- All of Rusch is the priority for road closures.
- Main Rusch creek road has a private parcel at the bottom.
- Recommendations: One of the better watershed for vegetation management

Connectivity

- Analysis: There are 2 owl cores in Lower Rusch.
- Opportunities: Other GTR 78 acres suitable habitat in excess of
- There are over 200 acres of plantations available for precommercial thinning in the headwaters of Rusch 1,2 and 3. Concern: Rusch 1,2 and 3 are the highly fragmented parts of this group of subwatersheds.
- Seral stage distribution
- Rusch 1
- Old-forest 75%
- mid seral forest 14%
- early seral forest 11%

Fire & Fuels

- Analysis: Hazard & Risk Rating = Medium
- 88 acres of high crown fire potential
- 200 acres of plantations
- High recorded fire occurrence
- Historic fire regime of frequent low-intensity fires.
- 1 acre of private land
- Opportunities: Underburning (for hazard reduction & forest health).
- Thin high crown fire potential areas.
- Construction of shaded fuelbreaks along major ridges.
- Protect plantations from loss to wildfire.
- Use livestock grazing for hazard reduction where appropriate.
- Concerns: Alteration of historic fire regime
- High recorded fire occurrence.
- Overstocked stands/moisture stress
- Encroachment of fire intolerant vegetation.

Subwatershed: EAST HYAMPOM

The community of Hyampom is in the west portion of the subwatershed.

Vegetation Management -

- Analysis: Good opportunity for vegetation management.
- Opportunities: Gross Acres of High priority GTR - 1000 acres
- Gross Acres of other GTR - 600 acres
- Minimal commercial thinning opportunities.
- Concerns: May be difficult to build roads due to mass wasting.

- The subwatershed has been surveyed, and there are known sites that may need evaluation or mitigation.
- Recommendations: Consider all of the harvest opportunities identified above.

Watershed Condition/Restoration

- Analysis: Watershed ERA is at 8.17% TOC is 14 therefore 8.17% Puts it close to 60% TOC. Slumps are the biggest sediment producers.
- There are only 44.13 acres available for treatment at this point. Road upgrade would increase the acreage for treatment.
- Opportunities: To decrease road density through closure or possible decommissioning. Road upgrades are an opportunity. Contributor of the roads to ERA and sediment production is the County road. There are 19 miles of road. Ten of these are private and County roads. Opportunity to join in coop venture with the County to improve maintenance standards and upgrade the road.
- Concern: Since the watershed is near threshold should operate with caution.

Connectivity

- Analysis:
- Opportunities: Other GTR 475 acres suitable habitat in excess of 50%
- There are over 434 acres of plantations available for precommercial thinning.
- Concern: This subwatershed is within the foraging territory of peregrine falcon.
- Seral stage distribution
- Old-forest 32%
- mid seral forest 36%
- early seral forest 32%

Fire & Fuels

- Analysis: Hazard & Risk Rating = Medium/High
- 445 acres of private lands (interfaces community of Hyampom).
- 434 acres of plantations
- 44 acres with high crown fire potential
- High recorded fire occurrence
- Limited fire suppression access in some locations
- Historic fire regime of frequent low-intensity fires.
- Opportunities: Underburning (for hazard reduction & forest health).
- Construction of fuelbuffers adjacent to private lands.
- Construction of shaded fuelbreaks along ridgetops.
- Protect plantations from loss to wildfire.
- Thin potential crown fire areas.
- Use livestock grazing for hazard reduction where appropriate.
- Concerns: Alteration of historic fire regime
- Private land/urban interface areas
- Potential crown fire areas
- Plantation losses to wildfire

- Overstocked stands/moisture stress (forest health).
- Encroachment of fire intolerant vegetation.

Subwatershed: HALFWAY

Vegetation Management -

- Analysis: Good opportunity for vegetation management.
- Opportunities: Gross Acres of High priority GTR - 175 acres
- Gross Acres of other GTR - 700 acres
- Gross Acres of commercial thinning - 50 acres
- Concerns: Yes. It maybe difficult to build roads due to steepness. Contains high amounts of dioritic soils. All of the identified acres are in the bottom of the watershed in pockets. There are pond turtles along the creek.
- Some archeological survey will be required and possible site evaluation and mitigation.
- Recommendations: Consider all of the harvest opportunities identified above.

Watershed Condition/Restoration

- Analysis: Watershed ERA is at 7.16%
- Opportunities: To decrease road density through closure. Road upgrades are an opportunity.
- There are 329 acres available for treatment.

Connectivity

- Analysis:
- Opportunities: There are 217 acres of suitable habitat in excess of 50%
- There are over 222 acres of plantations available for precommercial thinning. Plantations are concentrated at the top of the ridge.
- Seral stage distribution
- Old-forest 28%
- mid seral forest 46%
- early seral forest 26%

Fire & Fuels

- Analysis: Hazard & Risk Rating = Medium/high
- 20 acres of private lands
- 42 acres with high crown fire potential
- 222 acres of plantations
- High recorded fire occurrence
- Historic fire regime of frequent low-intensity fires.
- Opportunities: Underburning (for hazard reduction & forest health).
- Thin high crown fire potential areas.
- Construction of fuel buffers adjacent to private lands.
- Construction of shaded fuelbreaks along major ridges.
- Protect plantations from loss to wildfire.

- Use livestock grazing for hazard reduction where appropriate.
- Concerns: Alteration of historic fire regime.
- Private land interface
- Potential crown fire areas
- Plantation loss to wildfire
- Overstocked stands/moisture stress (forest health)
- Encroachment of fire intolerant vegetation.

Subwatershed: HEADWATERS OLSEN

Vegetation Management -

- Analysis: Moderate opportunity for vegetation management.
- Opportunities: Gross Acres of High priority GTR - 50 acres
- Gross Acres of other GTR - 500 acres
- Commercial thinning opportunities - 25 acres
- Concerns:
- Recommendations: Consider all of the harvest opportunities identified above.
- There are no archeological concerns. The area has been surveyed and no sites found.

Watershed Condition/Restoration

- Analysis: Low priority for road building due to unsuitable ground.
- Watershed ERA is at 8.86% TOC. There are 87.84 acres are available for treatment.
- Opportunities: To decrease road density through closure. Road upgrades are an opportunity.

Connectivity

- Analysis:
- Opportunities: Connectivity is a concern due to the 1987 fire and low acreage of suitable habitat.
- There are over 427 acres of plantations available for precommercial thinning.
- Seral stage distribution
- Old-forest 1%
- mid seral forest 73%
- early seral forest 26%
- -Forest health
- Analysis: PP3N = 15 acres
- Opportunity: Thinning PP3N stands to reduce probability of successful bark beetle group kill

Fire & Fuels

- Analysis: Hazard & Risk Rating = Medium
- 108 acres with high crown fire potential.
- 427+ acres of plantations
- High recorded fire occurrence
- Historic fire regime of frequent low-intensity fires.

- Opportunities: Underburning (for hazard reduction & forest health)
- Thin high crown fire potential areas.
- Construction of shaded fuelbreaks along major ridges.
- Protect plantations from loss to wildfires.
- Use livestock grazing for hazard reduction where appropriate.
- Concerns: Alteration of historic fire regime
- Potential crown fire areas
- Plantation loss to wildfire.
- Overstocked stands/moisture stress (forest health).
- Encroachment of fire intolerant vegetation.

Subwatershed: GRASSY FLAT CREEK

Archeological site evaluation and mitigation may be necessary. There are no archeological surveys in the subwatershed.

Vegetation Management -

- Analysis: Moderate opportunity for vegetation management.
- Opportunities: Gross Acres of High priority GTR - 375 acres
- Gross Acres of other GTR - 475 acres
- Minimal commercial thinning opportunities.
- Concerns: Contains high amounts of dioritic soils, may limit road construction.
- Recommendations: Consider all of the harvest opportunities identified above.

Watershed Condition/Restoration

- Analysis: Road density is not as high as other subwatersheds. Mass wasting is an issue in this subwatershed.
- Watershed ERA is at 6.16%. TOC is 14% and there are 206 acres are available for treatment.
- Opportunities: To decrease road density through closure or decommissioning. Road upgrades are an opportunity.
- Recommendations: One of the better watersheds for vegetation management.

Connectivity

- Analysis:
- Opportunities: There are 332 acres of suitable habitat in excess of 50%.
- This area lies within the foraging habitat of a peregrine falcon. There was a martin siteing here in 1987. There are over 152 acres of plantations available for pre-commercial thinning.
- Concern: This is a ecologically diverse area with grassy meadows, serpentine pockets and springs.
- Seral stage distribution
- Old-forest 43%
- mid seral forest 15%
- early seral forest 42%
- -Forest Health

- Analysis: 1 acre PP3Ncres
- Opportunity: Thinning to reduce probability of successful bark beetle group kill
- Recommendation: Maintain habitat diversity. Consider sensitive plant populations in management activities.

Fire & Fuels

- Analysis: Hazard & Risk Rating = Medium/high
- Children's summer camp
- 78 acres of private lands
- 20 acres with high crown fire potential
- 152 acres of plantations
- High recorded fire occurrence
- Historic fire regime of frequent low-intensity fires.
- Opportunities: Underburning (for hazard reduction & forest health).
- Construction of fuel buffers adjacent to private lands.
- Thin high crown fire potential areas.
- Protect plantations from loss to wildfire.
- Use livestock for hazard reduction where appropriate.
- Concerns: Remoteness/accessibility of children's summer camp.
- Alteration of historic fire regime.
- Potential crown fire areas.
- Plantation loss to wildfire.
- Overstocked stands/moisture stress (forest health).
- Encroachment of fire intolerant vegetation.

Subwatershed: JUD CREEK (This includes Jud and East Jud subwatersheds).

There may some archeological survey needed and possible site evaluation and mitigation.

Vegetation Management -

- Analysis: Moderate opportunity for vegetation management.
- Opportunities: Gross Acres of High priority GTR - 300 acres
- Gross Acres of other GTR - 700 acres
- Gross Acres of commercial thinning - 25 acres
- Concerns: Contains high amounts of dioritic soils and steep slopes may limit road construction.
- Recommendations: Consider all of the harvest opportunities identified above.
- Consider helicopter logging.

Watershed Condition/Restoration

- Analysis:
- Watershed ERA for Jud is at 8.2% and East Jud is 8% and TOC is 14% for both.
- There are 34 acres available for treatment.
- Opportunities: To decrease road density through closure. Road upgrades are an opportunity.

Connectivity

- Analysis: There are connectivity concerns in the headwaters leading to Butter Creek and into the Rusch Creek drainage.
- Opportunities: There are 268 acres of suitable habitat in excess of 50%.
- There is a 100 acre owl core. There are over 274 acres of plantations available for pre-commercial thinning.
- Seral stage distribution
- Old-forest 50%
- mid seral forest 10%
- early seral forest 40%

Fire & Fuels

- Analysis: Hazard & Risk Rating = Medium/high
- 25 acres of private lands
- 150 acres with high crown fire potential.
- 274 acres of plantations
- High recorded fire occurrence.
- Historic fire regime of frequent low-intensity fires.
- Opportunities: Underburning (for hazard reduction & forest health).
- Thin high crown fire potential areas.
- Construction of fuel buffers adjacent to private lands.
- Construction of shaded fuelbreaks along major ridges.
- Protect plantations from loss to wildfire.
- Use livestock grazing for hazard reduction where appropriate.
- Concerns: Alteration of historic fire regime
- Private land interface
- Potential crown fire areas
- Plantation loss to wildfire
- Overstocked stands/moisture stress (forest health).
- Encroachment of fire intolerant vegetation.

Subwatershed: UPPER RUSCH (Includes East Middle Rusch, West Middle Rusch, West Fork Rusch and Headwaters Rusch).

Archeological site evaluation and mitigation may be necessary. The entire area has been surveyed.

Vegetation Management -

- Analysis: Moderate opportunity for vegetation management.
- Opportunities: Gross Acres of High priority GTR - 550 acres
- Gross Acres of other GTR - 550 acres
- Minimal commercial thinning opportunities.
- Concerns: Contains high amounts of dioritic soils and steep slopes that may limit road construction.

- Recommendations: Consider all of the harvest opportunities identified above.

Watershed Condition/Restoration

- Analysis: Current open road density is 5 miles/sq. mile. If 9.2 miles of level 1 roads are closed then open road density would be 2.74.
- Watershed ERAs are 11% for East Middle Rusch, 10% for West Middle Rusch, 12% for West Fork Rusch and 11% for Headwaters Rusch. Acres of treatment for the subwatersheds are as follows: -107 for East Middle Rusch, -30 for West Middle Rusch, -43 for West Fork Rusch and -35 for Headwaters Rusch.
- Opportunities: This subwatershed is the highest priority for road closure. Road upgrade is a high priority in this subwatershed.
- Recommendations: Road rocking.

Connectivity

Analysis:

- Opportunities: Connectivity is a major concern in this subwatershed. There may be many more acres of suitable habitat identified upon field review.
- West fork Rusch and Headwaters Rusch are important connector to Butter Creek and areas to the south. There is a 100 acre owl core in West Middle Rusch. There are over 510 acres of plantations available for pre-commercial thinning, evenly distributed across the subwatershed.
- Seral stage distribution
- Old-forest 62%
- mid seral forest 29%
- early seral forest 09%
- -Forest Health
- Analysis: 33 acres PP3N
- Opportunity: Thinning to reduce probability of successful bark beetle group kill

Fire & Fuels

- Analysis: Hazard & Risk Rating = Medium
- 3 acres of private lands
- 52 acres with high crown fire potential
- 510 acres of plantations
- High recorded fire occurrence
- Historic fire regime of frequent low-intensity fires.
- Opportunities: Underburning (for hazard reduction & forest health).
- Thin high crown fire potential areas.
- Construction of fuel buffers adjacent to private lands.
- Construction of fuelbreaks along major ridges.
- Protect plantations from loss to wildfire.
- Use livestock grazing for hazard reduction where appropriate.
- Concerns: Alteration of historic fire regime
- Private land interface

- Potential crown fire areas
- Plantation loss to wildfire.
- Overstocked stands/moisture stress (forest health).
- Encroachment of fire intolerant vegetation.

Subwatershed: GRASSY MOUNTAIN

Archeological site evaluation and mitigation may be necessary. The entire area has been surveyed.

Vegetation Management -

- Analysis: Moderate opportunity for vegetation management.
- Opportunities: Gross Acres of High priority GTR - 450 acres
- Gross Acres of other GTR - 350 acres
- Minimal commercial thinning opportunities.
- Concerns: Contains high amounts of dioritic soils and steep slopes that may limit road construction.
- Recommendations: Consider all of the harvest opportunities identified above.
- *Watershed Condition/Restoration*
- Analysis: Current open road density is 5 miles/sq. mile. If 9.2 miles of level 1 roads are closed then open road density would be 2.74.
- Watershed ERAs are 11% for East Middle Rusch, 10% for West Middle Rusch, 12% for West Fork Rusch and 11% for Headwaters Rusch. Acres of treatment for the subwatersheds are as follows: -107 for East Middle Rusch, -30 for West Middle Rusch, -43 for West Fork Rusch and -35 for Headwaters Rusch.
- Opportunities: This subwatershed is the highest priority for road closure. Road upgrade is a high priority in this subwatershed.
- Recommendations: Road rocking.

Connectivity

- Analysis:
- Opportunities: Connectivity is a major concern in this subwatershed. There may be many more acres of suitable habitat identified upon field review.
- West fork Rusch and Headwaters Rusch are important connector to Butter Creek and areas to the south. There is a 100 acre owl core in West Middle Rusch. There are over 510 acres of plantations available for pre-commercial thinning, evenly distributed across the subwatershed.
- Seral stage distribution
- Old-forest 45%
- mid seral forest 12%
- early seral forest 43%
- Forest Health
- Analysis: 29 acres PP3N
- Opportunity: Thinning PP3N stands to reduce probability of successful bark beetle group kill

Fire & Fuels

- Analysis: Hazard & Risk Rating = medium
- 19 acres of private lands
- 237 acres of plantations
- 63 acres with high crown fire potential.
- High recorded fire occurrence.
- Historic fire regime of frequent low-intensity fires.
- Opportunities: Underburning (for hazard reduction & forest health).
- Thin high crown fire potential areas.
- Construction of fuel buffers adjacent to private lands.
- Construction of shaded fuelbreaks along major ridges.
- Protect plantations from loss to wildfire.
- Use livestock for hazard reduction where appropriate.
- Concerns: Alteration of historic fire regime
- Private land interface
- Potential crown fire areas
- Plantation loss to wildfire.
- Overstocked stands/moisture stress (forest health).
- Encroachment of fire intolerant vegetation.

Subwatershed: LOWER OLSEN

Archeological site evaluation and mitigation may be necessary. The entire area has been surveyed.

Vegetation Management -

- Analysis: Moderate opportunity for vegetation management.
- Opportunities: Gross Acres of High priority GTR - 225 acres
- Gross Acres of other GTR - 300 acres
- Commercial thinning opportunities - 75 acres
- Concerns:
- Recommendations: Consider all of the harvest opportunities identified above.

Watershed Condition/Restoration

- Analysis: Current open road density is 5 miles/sq. mile. If 9.2 miles of level 1 roads are closed then open road density would be 2.74.
- Watershed ERAs are 11% for East Middle Rusch, 10% for West Middle Rusch, 12% for West Fork Rusch and 11% for Headwaters Rusch. Acres of treatment for the subwatersheds are as follows: -107 for East Middle Rusch, -30 for West Middle Rusch, -43 for West Fork Rusch and -35 for Headwaters Rusch.
- Opportunities: This subwatershed is the highest priority for road closure. Road upgrade is a high priority in this subwatershed.
- Recommendations: Road rocking.

Connectivity

- Analysis:
- Opportunities: Connectivity is a major concern in this subwatershed. There may be many more acres of suitable habitat identified upon field review.
- West fork Rusch and Headwaters Rusch are important connector to Butter Creek and areas to the south. There is a 100 acre owl core in West Middle Rusch. There are over 510 acres of plantations available for pre-commercial thinning, evenly distributed across the subwatershed.
- Seral stage distribution
- Old-forest 1%
- mid seral forest 50%
- early seral forest 49%

Fire & Fuels

- Analysis: Hazard & Risk Rating = medium/high
- 304 acres of private lands
- 545 acres of plantations
- 13 acres with high crown fire potential.
- High recorded fire occurrence.
- Historic fire regime of frequent low-intensity fires.
- Opportunities: Underburning (for hazard reduction & forest health).
- Thin high crown fire potential areas.
- Construction of fuel buffers adjacent to private lands.
- Construction of shaded fuelbreaks along major ridges.
- Protect plantations from loss to wildfire.
- Use livestock for hazard reduction where appropriate.
- Concerns: Alteration of historic fire regime
- Private land interface
- Potential crown fire areas
- Plantation loss to wildfire.
- Overstocked stands/moisture stress (forest health).

Subwatershed: BIG CANYON

Archeological site evaluation and mitigation may be necessary. The entire area has been surveyed.

Vegetation Management -

- Analysis: Moderate opportunity for vegetation management.
- Opportunities: Gross Acres of High priority GTR - 300 acres
- Gross Acres of other GTR - 125 acres
- Commercial thinning opportunities - 25 acres
- Concerns: Contains high amounts of dioritic soils and steep slopes that may limit road construction.
- Recommendations: Consider all of the harvest opportunities identified above.

Watershed Condition/Restoration

- Analysis: Current open road density is 5 miles/sq. mile. If 9.2 miles of level 1 roads are closed then open road density would be 2.74.
- Watershed ERAs are 11% for East Middle Rusch, 10% for West Middle Rusch, 12% for West Fork Rusch and 11% for Headwaters Rusch. Acres of treatment for the subwatersheds are as follows: -107 for East Middle Rusch, -30 for West Middle Rusch, -43 for West Fork Rusch and -35 for Headwaters Rusch.
- Opportunities: This subwatershed is the highest priority for road closure. Road upgrade is a high priority in this subwatershed.
- Recommendations: Road rocking.

Connectivity

- Analysis:
- Opportunities: Connectivity is a major concern in this subwatershed. There may be many more acres of suitable habitat identified upon field review.
- West fork Rusch and Headwaters Rusch are important connector to Butter Creek and areas to the south. There is a 100 acre owl core in West Middle Rusch. There are over 510 acres of plantations available for pre-commercial thinning, evenly distributed across the subwatershed.
- Seral stage distribution
- Old-forest 55%
- mid seral forest 17%
- early seral forest 28%

Fire & Fuels

- Analysis: Hazard & Risk Rating = medium
- N/A acres of private lands
- 187 acres of plantations
- 34 acres with high crown fire potential.
- High recorded fire occurrence.
- Historic fire regime of frequent low-intensity fires.
- Opportunities: Underburning (for hazard reduction & forest health).
- Thin high crown fire potential areas.
- Construction of shaded fuelbreaks along major ridges.
- Protect plantations from loss to wildfire.
- Use livestock for hazard reduction where appropriate.
- Concerns: Alteration of historic fire regime
- Potential crown fire areas
- Plantation loss to wildfire.
- Overstocked stands/moisture stress (forest health).

Subwatershed: HEADWATERS LITTLE

Archeological site evaluation and mitigation may be necessary. The entire area has been surveyed.

Vegetation Management -

- Analysis: Moderate opportunity for vegetation management.
- Opportunities: Gross Acres of High priority GTR - 50 acres
- Gross Acres of other GTR - 250 acres
- Minimal commercial thinning opportunities.
- Concerns: Contains high amounts of dioritic soils and steep slopes that may limit road construction.
- Recommendations: Consider all of the harvest opportunities identified above.

Watershed Condition/Restoration

- Analysis: Current open road density is 5 miles/sq. mile. If 9.2 miles of level 1 roads are closed then open road density would be 2.74.
- Watershed ERAs are 11% for East Middle Rusch, 10% for West Middle Rusch, 12% for West Fork Rusch and 11% for Headwaters Rusch. Acres of treatment for the subwatersheds are as follows: -107 for East Middle Rusch, -30 for West Middle Rusch, -43 for West Fork Rusch and -35 for Headwaters Rusch.
- Opportunities: This subwatershed is the highest priority for road closure. Road upgrade is a high priority in this subwatershed.
- Recommendations: Road rocking.

Connectivity

- Analysis:
- Opportunities: Connectivity is a major concern in this subwatershed. There may be many more acres of suitable habitat identified upon field review.
- West fork Rusch and Headwaters Rusch are important connector to Butter Creek and areas to the south. There is a 100 acre owl core in West Middle Rusch. There are over 510 acres of plantations available for pre-commercial thinning, evenly distributed across the subwatershed.
- Seral stage distribution
- Old-forest 32%
- mid seral forest 20%
- early seral forest 48%
- -Forest Health
- Analysis: 29 acres PP3N
- Opportunity: Thinning PP3N stands to reduce probability of successful bark beetle group kill

Fire & Fuels

- Analysis: Hazard & Risk Rating = medium
- N/A acres of private lands
- 125 acres of plantations
- 180 acres with high crown fire potential.
- High recorded fire occurrence.
- Historic fire regime of frequent low-intensity fires.
- Opportunities: Underburning (for hazard reduction & forest health).

- Thin high crown fire potential areas.
- Construction of shaded fuelbreaks along major ridges.
- Protect plantations from loss to wildfire.
- Use livestock for hazard reduction where appropriate.
- Concerns: Alteration of historic fire regime
- Potential crown fire areas
- Plantation loss to wildfire.
- Overstocked stands/moisture stress (forest health).

Subwatershed: BEAR

Archeological site evaluation and mitigation may be necessary. The entire area has been surveyed.

Vegetation Management -

- Analysis: Moderate opportunity for vegetation management.
- Opportunities: Gross Acres of High priority GTR - 100 acres
- Gross Acres of other GTR - 250 acres
- Minimal commercial thinning opportunities.
- Concerns: Contains high amounts of dioritic soils and steep slopes that may limit road construction.
- Recommendations: Consider all of the harvest opportunities identified above.

Watershed Condition/Restoration

- Analysis: Current open road density is 5 miles/sq. mile. If 9.2 miles of level 1 roads are closed then open road density would be 2.74.
- Watershed ERAs are 11% for East Middle Rusch, 10% for West Middle Rusch, 12% for West Fork Rusch and 11% for Headwaters Rusch. Acres of treatment for the subwatersheds are as follows: -107 for East Middle Rusch, -30 for West Middle Rusch, -43 for West Fork Rusch and -35 for Headwaters Rusch.
- Opportunities: This subwatershed is the highest priority for road closure. Road upgrade is a high priority in this subwatershed.
- Recommendations: Road rocking.

Connectivity

- Analysis:
- Opportunities: Connectivity is a major concern in this subwatershed. There may be many more acres of suitable habitat identified upon field review.
- West fork Rusch and Headwaters Rusch are important connector to Butter Creek and areas to the south. There is a 100 acre owl core in West Middle Rusch. There are over 510 acres of plantations available for pre-commercial thinning, evenly distributed across the subwatershed.
- Seral stage distribution
- Old-forest 52%
- mid seral forest 21%

- early seral forest 27%

Fire & Fuels

- Analysis: Hazard & Risk Rating = medium/high
- 167 acres of private lands
- 117 acres of plantations
- 28 acres with high crown fire potential.
- High recorded fire occurrence.
- Historic fire regime of frequent low-intensity fires.
- Opportunities: Underburning (for hazard reduction & forest health).
- Thin high crown fire potential areas.
- Construction of shaded fuelbreaks along major ridges.
- Protect plantations from loss to wildfire.
- Use livestock for hazard reduction where appropriate.
- Concerns: Alteration of historic fire regime
- _?_Private land interface
- Potential crown fire areas
- Plantation loss to wildfire.
- Overstocked stands/moisture stress (forest health).

STEP 6: RECOMMENDATIONS

The recommendations considered by the Lower Hayfork Creek Watershed Analysis IDT are formatted as they respond to the focused objectives of Forest Health, Fuels Hazard Reduction, and Watershed and Fisheries Habitat Restoration. General recommendations which do not directly respond to the focused objectives, but are recommended by the IDT, are also provided.

FUELS HAZARD REDUCTION RECOMMENDATIONS

Recommendation: Underburning. Underburning will be used to re-introduce low-intensity fire back into the ecosystems within the watershed. Underburning (along with various silvicultural methods) will allow resident vegetation more moisture thus becoming healthier and increasing resistance to insects and disease. Underburning will also help maintain acceptable fuel loadings, sustain fire dependent vegetation, and lead to the overall health of the ecosystems.

Initially Fire/Fuels Managers will use fuelbreaks and existing ridgeline roads as anchor points to facilitate successful burning operations. Burning will be implemented during the fall seasons of the year to follow historic patterns to the extents feasible. Ecosystem Management Plans/NEPA documents will have site-specific areas with detailed descriptions. All use of prescribed fire will be implemented with an approved burn plan by trained and fully qualified personal. All prescribed fire operations will be implemented following North Coast Air Quality laws and regulations.

Initial burning operations with be implemented in A.M.A. areas to validate site-specific prescriptions and their effects.

It is anticipated that fire can be allowed to back down into some riparian areas. A Hydrologist will be consulted to assist in the identification of these areas and will be invited to participate/view burning operations as they are being implemented. A Hydrologist in addition to other ID Team specialists will be requested to assist in monitoring plans for underburn areas.

Some areas within the watershed may require various levels of pre-treatments to facilitate underburning operations due to the past 80 years of fire suppression/exclusion.

Native American burning will also be implemented within the underburn areas where feasible.

Recommendation: Shaded Fuelbreaks. Shaded fuelbreaks are 100' to 300'+ wide strips (fuels and terrain are generally the width limiting factors) on which vegetation has been modified so that fires burning into them may be more readily extinguished. Overstory trees are thinned to approximately 40% canopy closures and most understory vegetation is removed. Thinning of canopies help dropping crown fires back to the ground, lowering fire effects and facilitating fire suppression. Canopies of remaining trees are to provide enough shade to inhibit ingrowth of brush species in the understories. Shaded fuelbreaks are also used as safety areas for fire suppression forces when needed. Fuelbreaks will also be used as anchor points for underburning operations.

Recommendation: Fuel Reduction Buffers Adjacent to Private Lands . Protection buffers of varying widths (slope, terrain, and various site-specific conditions will be limiting factors) on which existing vegetation will be manipulated to provide an area similar to shaded fuelbreaks in areas where national forest lands and private lands interface. Private land owners are encouraged to continue the fuel buffers on their lands. (Forest Fire Prevention standards and guidelines will guide projects specifics).

Recommendation: Thin Potential Crown Fire Stands. Areas identified as having slopes exceeding 40%, canopy closures of 70% and greater, with south and west aspects have the greatest potential of developing crown fires. Thinning of these areas will assist fire suppression forces in containing fire starts faster and with less threat to life and property. Fire effects on the environment will also be less. Thinning specifications will require site-specific on the ground silvicultural prescriptions. A team consisting of at least a certified Silviculturist, Fuels Specialist, Wildlife Biologist, Soils Specialist, and Hydrologist will be required to mark on the ground thinning areas. Thinning materials may consist of merchantable and non-merchantable materials. All thinning materials (in excess of various resource requirements) will be treated to further reduce fuel levels.

Recommendation: Livestock Grazing. Following the 1987 Fire Siege (Trinity, Bear, and Gulch Fires within the watershed) grasses were sown over all burned areas. Many of the grasses are not native to the area and have established themselves in and around plantations planted after the fires and subsequent timber harvests. In many areas these grasses present a fire hazard and/or have become competitors with the plantations. Allowing the controlled grazing of livestock in these areas (as well as various other sites) will assist in reducing fire hazards and competition to plantations.

Portable water sources may be used where needed to keep livestock from degrading riparian areas, a Hydrologist will be consulted to make these determinations.

Recommendation: Plantation Protection. Thinning of commercial and pre-commercial plantations ("Consider") spacing leave trees 10'x 10' or 12'x 12' to reduce likelihood of crown fires developing and permit mechanized equipment to operate effectively within stands. Consider a 25'x 25' or greater spacing of leave trees in 100' or greater buffers around unit boundaries or along roadsides to act as protection buffer. Pruning of lower limbs on trees >3" in diameter should also be considered. Thinning slash should be treated in the most cost effective manner feasible.

Recommendation: Water Source Development and Improvement. Improve and designate existing water sources for fire suppression use, dust abatement, and wildlife use. Some areas may require approach improvements and capacity improvements requiring the use of mechanized equipment. A Hydrologist and other appropriate specialists will need to approve individual sites and improvements on a case-by-case basis.

Recommendation: Activity Fuel Treatment. Timber harvest activities conducted within the watershed will be required to treat fuels produced through their implementation. Fuel treatments will be based on site-specific analysis and identified in ecosystem management plans/NEPA documents. BD funds will be collected from the timber sales to treat activity fuels produced.

Recommendation: Fuel Monitoring and Evaluation. Plans will be developed at the ecosystem management level to validate prescription parameters and track project(s) effects. It is hoped that monitoring can be consolidated with other resource specialties.

WATERSHED AND FISHERIES HABITAT RESTORATION RECOMMENDATIONS

Recommendation: Methods Recommended to Reduce Adverse Affects of Mass Wasting Processes. Mass wasting is a significant geomorphic process within lower Hayfork Creek and is a significant source of sediment within the watershed. The following recommendations should be considered:

1. As a part of NEPA, the potential for proposed management activities to contribute to slope instability should be completely evaluated, specifically, but not limited to Grassy Mountain, Grassy Flat and Rusch Creek subwatersheds. Portions of all of the other subwatersheds also have unstable areas. Detailed field evaluation will be needed to assess slope stability hazards related to proposed management activities, especially timber harvest activities, new road construction and vegetation stocking reduction. As a part of this investigation, the highly unstable component of the Riparian Reserves should be identified and inventoried.
2. Active instability along the main channel is high, and as demonstrated, appears to be historically and perhaps prehistorically high. No attempt should be made to stabilize mass wasting features adjacent to Hayfork Creek, other than relatively passive measures such as riparian planting.
3. Roads which are contributing to mass wasting should be identified and evaluated for closure or obliteration.

Recommendation: Management Activities Proposed Within Riparian Reserves . The Lower Hayfork Watershed Analysis team has agreed that some activities are appropriate within a broad range of conditions throughout the Riparian Reserves of the Lower Hayfork Analysis Area. These activities include, precommercial thinning, limited use of prescribed fire, and road improvement and maintenance work to include road rocking, blading, ditch work, and culvert improvement and replacement work. Other activities such as road building have not been determined to be inappropriate. However, the level of analysis completed for the Lower Hayfork Watershed Analysis Area cannot possibly provide explicit direction for the many activities which might be proposed throughout the analysis area. This is not to say that activities other than those mentioned above are not appropriate within the Riparian Reserves of the analysis area. Only that activities proposed within the Riparian Reserve will need to be analyzed based on the site specific conditions which exist at the locations where the activity is being proposed and evaluated in the context of the landscape scale conditions established within this analysis.

The Lower Hayfork Watershed Analysis provides the foundation upon which proposed activities within Riparian Reserves can be evaluated. The analysis provides an overall assessment of riparian conditions throughout the analysis area and identifies conditions which presently limit ecosystem function and productivity. **Desired condition regarding the function and productivity of the aquatic ecosystem are stated through a set of objective in the Aquatic Conservation Strategy. Using our knowledge of the Aquatic Conservation Strategy objectives, the conditions known to be limiting at the landscape scale, and site specific conditions, proposed activities in riparian reserves can be evaluated.**

The Lower Hayfork Watershed Analysis indicates that the Aquatic Conservation Strategy objectives regarding water quality condition, spatial and temporal connectivity and sediment regimes may be currently compromised, or show a trend toward being compromised, at least in certain sub-basins within the analysis area. Logically, there is very little flexibility for implementing activities in Riparian Reserves which could further compromise attainment of those objectives. There may be greater latitude to take risks that cause short term affects but have overall long-term benefits in sub-basins where objectives are not compromised and a trend toward a degraded condition has not been established, Those activities must, however, be designed with a primary focus on attaining Aquatic Conservation Strategy Objectives.

Within the Lower Hayfork Analysis Area, stream temperature and summer base flows are recognized as the primary conditions that limit aquatic ecosystem function and productivity. The high water temperatures occur in lower Hayfork Creek, with the tributaries playing a critical role in creating cool water refuges. Because of the magnitude of the problem, any activity within the Riparian Reserve which would act to decrease summer base flows or increase water temperature would be considered extremely high risk and is not recommended. Examples might include vegetative treatments which might reduce stream side shading to the extent that water temperatures would be further compromised.

Greater flexibility may be present for proposed activities which may potentially accelerate erosion process, since bedload movement and sediment levels are not presently considered as limiting aquatic productivity . Each of the sub-basins vary with respect to an established "60% of threshold" concern level. Those sub-basins which have low percentages may have greater resiliency than those sub-basins which are above the "60% of threshold" concern level. In those sub-basins where concern levels are low, greater risks may be appropriate, while those same types of risks are not appropriate in sub-basins above the "60% of threshold" concern level. Those sub-basins above the 60% threshold level include Big Canyon, East Middle Rusch, Headwaters Rusch, Lower Olsen, Rusch 3, Rusch 4, West Fork Rusch, and Middle Fork Rusch.

The Riparian Reserves were included as an integral part of the strategy for maintaining connectivity across the landscape. Attainment of Aquatic Conservation Strategy Objectives for Riparian Reserves was also expected to maintain high quality habitat for wildlife species. Activities which reduce canopy closure and remove down woody material may reduce the capability of riparian reserves to meet connectivity criteria and serve as high quality habitat. The Lower Hayfork Watershed Analysis provides a basis for evaluating proposed activities within the Riparian Reserves with regard to this connectivity issue. Through the analysis, current connectivity conditions were evaluated for each sub-basin. In those sub-basins where concern levels are low, greater risks may be appropriate, while those same types of risks are not appropriate in sub-basins where concern levels are high. For many types of activities, that risk can only be determined through site specific analysis of the proposed site.

Recommendation: Develop Transportation Plan. A Transportation Plan should be developed for the entire watershed. The plan needs to 1) define the existing road system and proposed road system needed to access and manage the watershed, given all public, resource and administrative needs, 2) identify the maintenance needs over time for the system, 3) identify traffic regulations and seasonal closures necessary to protect the transportation system from roadbed damage and provide for resource protection, 4) identify measures necessary to maintain or improve stream crossings and 5) identify surface stabilization needs to control erosion and allow for seasonal use.

Location: The entire watershed, perhaps extending well outside of the watershed for specific analysis such as defining the minimum transportation system needed.

Restoration: The restoration needs will be identified in the transportation plan and prioritized by the following subwatersheds:

1. East Rusch, West Rusch, Middle Rusch, Headwaters Rusch and West Fork Rusch.
2. Lower Rusch, Rusch 1,2,3 and 4
3. Jud and East Jud
4. Grassy Flat, Grassy Mountain and East Hyampom
5. Halfway and Big Canyon
6. Lower Olsen
7. Rest of Watershed

The types of restoration projects will be, road closures, road upgrades, maintenance needs, road rocking and possible some road decommissioning.

Recommendation: Partnership with Trinity County. Pursue partnership opportunities for road restoration work with Trinity County.

Recommendation: Conduct "maintenance" level restoration efforts within the Lower Hayfork Analysis Area. An aggressive watershed restoration program focused on erosion control measures is not recommended within the Lower Hayfork Analysis Area. Rather, restoration at a "maintenance" level, where restoration activities are conducted to sustain the existing good habitat conditions is recommended. Under this strategy, localized "hotspots" which threaten this condition should be addressed. These "hotspot" areas are identified within the recommendation section specific to individual sub-basins.

Recommendation: Pursue partnership opportunities with other agencies and groups currently working to address the water quality and water yield problems within the Hayfork basin. The most degraded and limiting condition in lower Hayfork Creek is a result of poor water quality and water yield, largely a result of activities taking place in the Hayfork Valley. Although the Middle and Upper Hayfork watershed analyses are not scheduled until 1997 and 1998, respectively, other agencies and interest groups are working to address the extreme water quality and water yield problems. Agencies and groups such as NRCS and the South Fork CRMP are interested in pursuing partnership opportunities in order to address watershed restoration needs at the basin level. Greater success in restoring the watershed are anticipated from these cooperative efforts that could included focused watershed analyses and possibly early completion of the Middle and Upper Hayfork WA's.

Recommendation: Design restoration activities to return information regarding the effectiveness of those restoration efforts. Watershed restoration has been and still is a priority item for many land management agencies. Although it is a major area of focus, our knowledge and ability to successfully restore watersheds to a desired conditions is quite limited. It is therefore of paramount importance that we continually learn the effectiveness of our actions so that future efforts will realize greater success. With that in mind, the following principles should be incorporated into the design of any planned restoration activities.

1. Evaluate existing conditions. Establish a baseline for comparison purposes between pre and post treatment conditions.
2. Document project goals and specific objectives as explicitly as possible to insure future assessment and return of information.
3. Develop an effectiveness monitoring strategy concurrent with project planning and well before implementation of the project.
4. Those projects that return the greatest amount of information regarding the effectiveness of the effort should receive highest priority.

Recommendation: Conduct Monitoring efforts to fill existing data gaps identified during analysis of the Lower Hayfork Watershed

1. Resume stream temperature monitoring in lower Hayfork Creek as this information will be essential to track effectiveness of future restoration activities.
2. Monitor sediment levels to evaluate effectiveness of planned restoration activities and to evaluate strengths and limitations of the cumulative watershed effects model
3. Field verify channel types for future evaluation of channel conditions as well as the assumptions upon which portions of the watershed analysis has been based.

FOREST HEALTH RECOMMENDATIONS

Recommendation: Regeneration Opportunities on Understocked CAS Sites. Conduct site-specific analysis of under-stocked stands which may be suitable for regeneration harvest on suitable (CAS) lands through the development of silvicultural prescriptions. Indicators of stand conditions which may be candidates include size/density stands of 3 S or P, or 4 S or P. Subwatersheds currently deficient in connectivity habitat may be priority for treatment.

Recommendation: Thinning Opportunities on Overstocked Young Growth CAS Sites. Conduct site-specific analysis of well-stocked stands which may be suitable for intermediate (thinning) harvest on suitable (CAS) lands through the development of silvicultural prescriptions. Indicators of stand conditions which may be candidates include size/density stands of 2 N or G. Thin overstocked stands to restore vigor and prevent mortality. Many mature stands in the watershed are beyond the natural range of variability in carrying capacity due to fire suppression and the subsequent encroachment of a shade tolerant understory. This has led to conditions of low vigor, resiliency to stressors and excessive mortality.

Recommendation: Regeneration Opportunities on CMAI CAS Sites. Conduct site-specific analysis of stands which may be suitable for regeneration harvest on suitable (CAS) lands which have culminated mean annual increment (CMAI) through the development of silvicultural prescriptions. Indicators of stand conditions which may be candidates include size/density stands of 3 N or G, or 4 N or G.

Recommendation: Plantation Thinning Opportunities Conduct site-specific analysis of plantations which may be suitable for stocking-control (thinning) through the development of silvicultural prescriptions. Indicators of stand conditions which may be candidates include size/density stands of UX or XUX. Subwatersheds currently deficient in connectivity habitat may be priority for treatment.

Recommendation: Ponderosa Pine/Jeffrey Pine Thinning Opportunities. It is recommended that ponderosa and Jeffrey pine stands be thinned to reduce the probability of successful bark beetle group kill. Older stands should be thinned, while younger stands could be managed through a combination of thinning and underburning. These treatments may be integrated with fuels reduction activities to achieve mutual benefits. In areas where the sudden death of a group of pine has resulted in the accumulation of unacceptably high levels of fuel, the risk of mortality can be lowered by thinning. Thinning pine stands will reduce the probability of a successful *Dendroctonus* group kill by both increasing the amount of soil moisture available to each leave tree, as well as by increasing the spacing between leave trees to the outer limits of effectiveness of the aggregating pheromone. The only reliable and effective method to thin existing stands of thick-barked mature pines is to mechanically cut some trees. Prescribed fire can be used to open up some very young pine stands, or to maintain an open condition in an older pine stand after it has been thinned.

Recommendation: Sugar Pine Enhancement Opportunities. Locating resistant parent trees and outplanting resistant stock are critical to maintenance of sugar pine at or near historical levels in the Lower Hayfork Creek watershed. Other management activities such as pruning and localized Ribes removal may be used in stands where only non-resistant sugar pine are available and it is desired to recruit sugar pine as a part of the future overstory. Although sugar pine will not disappear from the watershed, without some actions to protect it and promote regeneration of resistant trees its demographics will change as immature trees will not be available to move into mature and overmature age classes.

Recommendation: Special Forest Products Opportunities. Harvesting of special forest products is likely to increase in volume and in diversity of products gathered. This raises concern about the sustainability of harvest methods employed and volumes gathered. In some cases, such as careless mushrooming, overharvest can soon threaten a species' distribution. Standards and guidelines should be developed pro-actively. For potentially sensitive plants, ecological guidelines for sustainable harvesting may need to be researched and set on a bioregional zone, in some cases, on a watershed by watershed basis. At the same time, for more abundant products, a standardization of fees for permits across forest jurisdictional lines within bioregions would be appropriate. It would be important to include economic botanical surveying in future watershed analysis projects and to develop approaches to gathering information on special forest products with existing information.

Recommendation: Special Forest Products: Scheduling Opportunities. Areas where vegetation management treatments are planned should be identified as collecting areas prior to treatment to maximize the benefits to special forest products in these areas.

Recommendation: Special Forest Products: Monitoring Opportunities. Existing guidelines on the Hayfork Ranger District are largely drawn from experience and policy on other districts and forests. A self monitoring process is currently used to keep track of general harvest locations and will begin to yield more specific information regarding harvest impacts as monitoring continues. Currently, several local special forest products gatherers are working with the USDA Forest Service to develop specific monitoring regimes for several valued crops e.g. prince's pine. It would be important to develop an overall plan for special forest products monitoring on the Forest beginning with a focus on sustainable harvest methods and volumes for products already in demand. Monitoring and inventory in conjunction with the Watershed Center and PSW Forest and Range Experiment Station, where appropriate, is recommended to insure consistency on a Forest-wide basis.

Recommendation: Fire History/Archaeological Survey Opportunities. In the future, to gain a better understanding of patterns of variability in the landscape, a fire history study and increases in archaeological surveying would be useful to shed light on natural ranges of variability of vegetative patterns for the prehistoric period.

GENERAL LOWER HAYFORK CREEK RECOMMENDATIONS

Recommendation: Designate NSO Core Areas. Prior to any ground disturbing activities within 1/2 mile of known spotted owl activity centers, the 100 acre core areas must be ground verified and marked.

Recommendation: Survey for Goshawk. Prior to any ground disturbing activities in 3N or better stands on slopes of less 35%; survey for the presence of goshawks. Develop management strategies responsive to survey results.

Recommendation: Survey for Western Pond Turtle. Prior to any implementing any ground-disturbing activities near Western Pond Turtle habitat, survey for Western Pond Turtle in Grassy Flats subwatershed ponds and the subwatersheds adjoining Hayfork Creek.

Recommendation: Connectivity. Until an overall watershed-wide strategy for maintaining connectivity is developed, maintain at least 50% of each subwatershed in at least 11-40 condition. In currently deficient subwatersheds, target stands and prescription to speed the development of at least 11-40 conditions.

Recommendation: Connectivity Modeling. Develop a strategy for providing adequate connectivity watershed-wide. Develop a model (i.e., growth) to test and/or demonstrate the effectiveness of the strategy. (Arlene is a good contact person at the SO) Note: This is an AMA so this strategy should be relatively innovative and lend itself to demonstration and testing so as to provide good information for developing "Matrix" strategies.

Recommendation: Protection of Historic Heritage Sites. Undertakings related to the three focused objectives all have the potential to adversely effect Historic heritage properties. One of the key areas we know about which has a large concentration of sites is Lower Olsen Creek. Evaluation and mitigation of some of these sites may be necessary to reduce impacts of watershed restoration or fuels reduction work.

Recommendation: Archaeological Survey Needed. Fuels reduction work in the Pattison area related to fuel breaks will need archaeological survey, if these are carried through to NEPA analysis. This area has not been surveyed and the potential of finding high elevations sites along the ridgelines is very possible. In addition, stream-side flats and benches along the north side of Hayfork Creek in the Pattison area will need to be surveyed also, due to the high probability of prehistoric habitation, if undertakings are proposed here. The remaining portions of Lower Hayfork, where projects may be proposed, need to be reviewed also to determine if they may impact recorded sites.

Recommendation: Economic/Social. Implementation of proposed undertakings addressing the three focused objectives would benefit the economic and social well-being of the Hyampom and Hayfork communities. This would help maintain existing jobs and businesses while potentially creating more. Work generated would not create a dramatic growth situation, but would help lessen the impact of the current economic downturn. The key point is that projects generated from this watershed analysis will inject much needed money and capital into the local economy. However, whatever comes out of Lower Hayfork, the local economy is moving toward a more diversified base. If it can transition successfully, it will weather future economic downturns better. The collapse of the timber industry in many western rural areas demonstrates the economic and social impacts, which would of been lessened if these economies had been better balanced.

Recommendation: General Recreation. No particular recommendations for recreation. Suffice it to say that improved fuels situation will lessen the fire hazard from dispersed recreation. Also, the closing of unneeded roads and watershed restoration projects related to erosion control have secondary recreation benefits in enhancing water quality for human use, fisheries, and wildlife.

Recommendation: Tribal Uses. The recommendation here is a broad one. When possible we should look for opportunities to enhance traditional gathering resources. Enhancement could be through burning, on bear grass, or pruning work, on redbud, as examples. These projects could be tied to our fuel reduction work and Forest Health projects. Special Forest Products management would be another avenue. Past Bear Grass burning in Butter Creek was very well received by the American Indian community. More projects of this kind would be welcomed.